INSPIRE
Infrastructure for Spatial Information in Europe

D2.8.II/III.4 Data Specification on Geology – Draft Guidelines

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Change Log

Version	Changed Sections	Changes made
2.9	All	Text has been updated to reflect comments
	4 Data content	Data model has been significantly changed to reflect comments. The GeologyCore has been simplified and separated from GeoSciML; the Hydrogeology has been modified and simplified; Geophysics has been modified to reflect comments
	10 Portrayal	Significant updates and extension
	Annex D	The data model extensions will be documented in Annex D but this section is not yet ready
	Annex E	The codelists have been updated in light of the comments
3.0	Executive summary	Text edited and updated
	2 Overview 5 Data content and structure	Text edited and updated Major revision of hydrogeology model. Some changes to geology and geophysics models. Text, diagrams and feature catalogues updated to reflect changes in data model. Codelists for core model moved from Annex E
	11 Portrayal	Some updates and extension
	Annex D	Descriptions of the Geology and Geophysics extensions added
	Annex E	All core model codelists.

Foreword
How to read the document?

This document describes the *"INSPIRE data specification on Geology* – Guidelines" version 3.0 rc*2 as developed by* the Thematic Working Group (TWG) Geology using both natural and a conceptual schema language.

The data specification is based on a common template used for all data specifications and has been harmonised using the experience from the development of the Annex I data specifications.

This document provides guidelines for the implementation of the provisions laid down in the draft Implementing Rule for spatial data sets and services of the INSPIRE Directive.

This document includes two executive summaries that provide a quick overview of the INSPIRE data specification process in general, and the content of the data specification on *Geology* in particular. We highly recommend that managers, decision makers, and all those new to the INSPIRE process and/or information modelling should read these executive summaries first.

The UML diagrams (in Chapter 5) offer a rapid way to see the main elements of the specifications and their relationships. The definition of the spatial object types, attributes, and relationships are included in the Feature Catalogue (also in Chapter 5). People having thematic expertise but not familiar with UML can fully understand the content of the data model focusing on the Feature Catalogue. Users might also find the Feature Catalogue especially useful to check if it contains the data necessary for the applications that they run. The technical details are expected to be of prime interest to those organisations that are/will be responsible for implementing INSPIRE within the field of *Geology.*

The technical provisions and the underlying concepts are often illustrated by examples. Smaller examples are within the text of the specification, while longer explanatory examples and descriptions of selected use cases are attached in the annexes.

In order to distinguish the INSPIRE spatial data themes from the spatial object types, the INSPIRE spatial data themes are written in *italics.*

Interoperability of Spatial Data Sets and Services – General Executive Summary

The challenges regarding the lack of availability, quality, organisation, accessibility, and sharing of spatial information are common to a large number of policies and activities and are experienced across the various levels of public authority in Europe. In order to solve these problems it is necessary to take measures of coordination between the users and providers of spatial information. The Directive 2007/2/EC of the European Parliament and of the Council adopted on 14 March 2007 aims at establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment.

INSPIRE will be based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure are being specified: metadata, interoperability of spatial data themes (as described in Annexes I, II, III of the Directive) and spatial data services, network services and technologies, data and service sharing, and monitoring and reporting procedures.

INSPIRE does not require collection of new data. However, after the period specified in the Directive[1] Member States have to make their data available according to the Implementing Rules.

Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines. It is important to note that “interoperability” is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure. It is expected that users will spend less time and efforts on understanding and integrating data when they build their applications based on data delivered within INSPIRE.

In order to benefit from the endeavours of international standardisation bodies and organisations established under international law their standards and technical means have been utilised and referenced, whenever possible.

To facilitate the implementation of INSPIRE, it is important that all stakeholders have the opportunity to participate in specification and development. For this reason, the Commission has put in place a consensus building process involving data users, and providers together with representatives of industry, research and government. These stakeholders, organised through Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO)[2], have provided reference materials, participated in the user requirement and technical[3] surveys, proposed experts for the Data Specification Drafting Team[4] and Thematic Working Groups[5] and participated in the public stakeholder

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[1] For all 34 Annex I,II and III data themes: within two years of the adoption of the corresponding Implementing Rules for newly collected and extensively restructured data and within 5 years for other data in electronic format still in use

[2] The current status of registered SDICs/LMOs is available via INSPIRE website: *http://inspire.jrc.ec.europa.eu/index.cfm/pageid/42*

[3] Surveys on unique identifiers and usage of the elements of the spatial and temporal schema,

[4] The Data Specification Drafting Team has been composed of experts from Austria, Belgium, Czech Republic, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Switzerland, UK, and the European Environment Agency

[5] The Thematic Working Groups of Annex II and III themes have been composed of experts from Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, UK, the European Commission, and the European Environment Agency

consultations on draft versions of the data specifications. These consultations covered expert reviews as well as feasibility and fitness-for-purpose testing of the data specifications[6].

This open and participatory approach was successfully used during the development of the data specification on Annex I data themes as well as during the preparation of the Implementing Rule on Interoperability of Spatial Data Sets and Services[7] for Annex I spatial data themes.,

The development framework elaborated by the Data Specification Drafting Team aims at keeping the data specifications of the different themes coherent. It summarises the methodology to be used for the data specifications and provides a coherent set of requirements and recommendations to achieve interoperability. The pillars of the framework are the following technical documents[8]:

- The Definition of Annex Themes and Scope describes in greater detail the spatial data themes defined in the Directive, and thus provides a sound starting point for the thematic aspects of the data specification development.
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The *Generic Conceptual Model* defines the elements necessary for interoperability and data harmonisation including cross-theme issues. It specifies requirements and recommendations with regard to data specification elements of common use, like the spatial and temporal schema, unique identifier management, object referencing, some common code lists, etc. Those requirements of the Generic Conceptual Model that are directly implementable will be included in the Implementing Rule on Interoperability of Spatial Data Sets and Services.

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- The Methodology for the Development of Data Specifications defines a repeatable methodology. It describes how to arrive from user requirements to a data specification through a number of steps including use-case development, initial specification development and analysis of analogies and gaps for further specification refinement.
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- The Guidelines for the Encoding of Spatial Data defines how geographic information can be encoded to enable transfer processes between the systems of the data providers in the Member States. Even though it does not specify a mandatory encoding rule it sets GML (ISO 19136) as the default encoding for INSPIRE.

- The Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development provides guidelines on how the “Observations and Measurements” standard (ISO 19156) is to be used within INSPIRE.
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- The Common data models are a set of documents that specify data models that are referenced by a number of different data specifications. These documents include generic data models for networks, coverages and activity complexes.

- The structure of the data specifications is based on the “ISO 19131 Geographic information - Data product specifications” standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language[9].

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[6] For Annex II+III, the consultation phase lasted from 20 June to 21 October 2011.

[7] Commission Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, published in the Official Journal of the European Union on 8th of December 2010.

[8] The framework documents are available in the “Framework documents” section of the data specifications web page at *http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2*

[9] UML – Unified Modelling Language

- A consolidated model repository, feature concept dictionary, and glossary are being maintained to support the consistent specification development and potential further reuse of specification elements. The consolidated model consists of the harmonised models of the relevant standards from the ISO 19100 series, the INSPIRE Generic Conceptual Model, and the application schemas[10] developed for each spatial data theme. The multilingual INSPIRE Feature Concept Dictionary contains the definition and description of the INSPIRE themes together with the definition of the spatial object types present in the specification. The INSPIRE Glossary defines all the terms (beyond the spatial object types) necessary for understanding the INSPIRE documentation including the terminology of other components (metadata, network services, data sharing, and monitoring).

By listing a number of requirements and making the necessary recommendations, the data specifications enable full system interoperability across the Member States, within the scope of the application areas targeted by the Directive. Once finalised (version 3.0), the data specifications are published as technical guidelines and provide the basis for the content of the Implementing Rule on Interoperability of Spatial Data Sets and Services[11]. The content of the Implementing Rule is extracted from the data specifications keeping in mind short- and medium-term feasibility as well as cost-benefit considerations. The requirements included in the Implementing Rule will be legally binding for the Member States according to the timeline specified in the INSPIRE Directive.

In addition to providing a basis for the interoperability of spatial data in INSPIRE, the data specification development framework and the thematic data specifications can be reused in other environments at local, regional, national and global level contributing to improvements in the coherence and interoperability of data in spatial data infrastructures.

[10] Conceptual models related to specific areas (e.g. INSPIRE themes)
[11] In the case of the Annex II+III data specifications, the extracted requirements will be used to formulate an amendment to the existing Implementing Rule.

Geology – Executive Summary

In the INSPIRE context Geology could be seen as a “reference data theme” as it provides information for several themes of Annex III: Mineral resources, Natural Risk Zones, Soil, Energy resources, and it has a specific relationship with one of the most important natural resources, water, through groundwater bodies contained in aquifers. Geomorphology describes the Earth’s present-day surface, and the processes creating its geometry.

The use of geological data

Geological data are used in various domains requiring knowledge of the surface and underground geological environment: detecting geo-hazards; ensuring the safe disposal of wastes, nuclear wastes, carbon capture and storage; ensuring the safe construction of buildings; providing information for environmental planning; providing information for natural resources exploration; vulnerability of the underground to contamination; providing indicators for climatic change; providing construction material and minerals. For groundwater and aquifers uses are: water supply (water abstraction); groundwater resources (water availability); providing base flow for rivers, wetlands; protecting ecosystems dependent on groundwater; groundwater quality and quantity assessment; transboundary groundwater management.

How geoscientists could provide this useful information?

Geological information provides basic knowledge about the physical properties and composition of the geologic materials (rocks and sediments) outcropping at the land’s surface and forming the underground, and about their structure and their age. It also provides knowledge about aquifers, i.e. subsurface units of rocks or sediments of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater. Knowledge about landforms is also provided.

The main product delivered by geologists for the users is a **geological map** which is the result of an **interpretation** of the observations and measurements made on rocks and sediments, on and under the surface. Because the rocks forming the subsurface are visible or accessible only on very small parts of the surface, the outcrops, geologists have to interpret these observations and measurements to group rocks in geologic units, and to connect other information observed locally to identify the general geological structure.

Boreholes are another important source of information for interpreting the subsurface geology. These can provide a stratigraphic and lithological log, analogous to a vertical geological map, and can also be used to gather samples and make measurements of various properties at depth.

All this information is interpreted to make geological maps. The landforms (geomorphologic features) are often indicated on general geological maps, and are detailed on specific, applied geomorphological maps.

Geophysical information

Since geophysics provides valuable information on the physical properties of rocks (like density, porosity, magnetic susceptibility, etc.), regardless of their organization as geologic units, geophysics is part of the INSPIRE Geological data specifications. Geophysical boundaries may or may not coincide with geological boundaries, depending on the changes of physical properties within and outside the geological units. Geophysics provides extra - quite often the only - information on the organization of the units in the subsurface. These results are processed by geophysicists in order to deliver the 1D, 2D, 3D or even 4D spatial distribution of the property. The spatial property distributions are then interpreted by geologists to build geological models of the subsurface, for instance to detect hydrocarbon bearing structures or zones of mineral resources.

Hydrogeological information

Hydrogeology describes the flow, occurrence, and behavior of water in the underground environment. It is a science located between hydrology and geology, and both have a strong influence on the understanding of groundwater flow and solute transport. Hydrological processes are responsible, for example, for the characterization and understanding of water supply derived from recharge of aquifers. On the other hand the physical properties and composition of the geologic materials (rocks and sediments) create the main environment for groundwater flow and storage. Rocks and sediments also influence groundwater quality in terms of their chemical composition.

The INSPIRE groundwater model describes two basic elements: the rock system (including aquifers, dependent on the geological condition) and the groundwater system (including groundwater bodies), completed by hydrogeological objects (such as water wells). See annex C for a detailed description of this domain.

Which geological data to provide through INSPIRE?

Based on the analysis of the potential types of users and identification of use cases the TWG developed a core data model. In order to address additional geological information required by some use cases the use of GeoSciML v3.0 is recommended as an extension of the INSPIRE core data model. GeoSciML V3.0. GeoSciML – developed by geological community - is described in Annex D.2.

The core data model contains the main types of GeologicFeatures (GeologicUnits, GeologicStructures, and GeomorphologicFeatures). The geometry of these features is described in MappedFeatures and can be included in geological maps and profiles in the form of points, lines and polygons. The data model also enables a description of the lithological/stratigraphical characteristics of borehole logs, thematic maps, geophysical surveys and measurements, and features related to hydrogeology (aquifers and groundwater bodies).

Basic geological knowledge and applied maps

As mentioned above, Geology is used by other thematic domains which are interested only in specific properties of the underground (to prevent landslides, to insure safe disposal of wastes etc). Geological surveys provide the basic knowledge about the Earth, but this basic information must then be processed by experts to transform it into the specific maps (named applied maps) required by thematic users. As very often the needs of thematic users concern a local area, the basic knowledge must be supplemented by new data related to specific properties (for example the porosity of the local rocks is needed in an assessment of a landslide).

The INSPIRE Geology model provides elements to build applied maps but does not describe these applied features.

Geophysics core and extension models

The core model focuses on availability and location of key geophysical features.The geophysicsCore schema includes

- Metadata on high rank gravity, magnetic and seismological stations that are part of international and national observation networks.
- Metadata on geophysical measurements carried out with the intension of exploring earth resources (hydrocarbons, mineral deposits, ground water, geothermal energy, etc.)
- Metadata on measurements and campaigns of environmentally sensitive datasets, e.g. from contamination tracing, groundwater vulnerability, seismic hazard assessment studies, earthquake monitoring.
- Collective metadata on gravity, magnetic, airborne geophysical campaigns that cover large areas and provide basic geological information for scientific research and more detailed applied studies.

Use cases require delivery of more detailed information about geophysical procedures, measurement and processing results. The geophysicsCore schema includes:

- Extended codelists, hierarchical vocabularies, structures, and associations to O&M classes to serve more specific user requirements.
- Generic measurement class type for objects that do not fit into the simple categories of the core model
- Geophysical models (profiles, maps, 3D models, results of data processing and interpretation) that can directly be used to analyze the geologic environment have high importance for the user.
- Convenience classes and links to the Observation and Measurement schema to deliver geophysical information either in industry standard format or as GML coverages. Explanations and examples are provided in Annex A to help data providers in encoding their observation data.

Acknowledgements

Many individuals and organisations have contributed to the development of these Guidelines.

The Thematic Working Group Geology and Mineral Resources (TWG-GE-MR) included:
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External experts for hydrogeology: Bernhard Wagner, Janusz Michalak.

Other contributors to the INSPIRE data specifications are the Drafting Team Data Specifications, the JRC data specifications team and the INSPIRE stakeholders - Spatial Data Interested Communities (SDICs) or Legally Mandated Organisations (LMOs).

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Table of contents

1 Scope

This document specifies a harmonised data specification for the spatial data theme *Geology* as defined in Annex II/III of the INSPIRE Directive.

This data specification provides the basis for the drafting of Implementing Rules according to Article 7 (1) of the INSPIRE Directive [Directive 2007/2/EC]. The entire data specification will be published as implementation guidelines accompanying these Implementing Rules.

2 Overview

2.1 Name

INSPIRE data specification for the theme Geology.

2.2 Informal description

Definition:

Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology

[Directive 2007/2/EC]

Description:

From the definition, we detail each word. **Geology** is the study of the past and present aspects of the Earth, including its history and life on Earth.
The **composition** of an earth material describes what it consists of (its components), both the weight percentage of elements or molecules (chemical composition), and the species and number of particles, e.g. minerals (mineralogical composition), clasts and fossils.
The **structure** of an earth material describes the physical arrangements of its components. A geologic structure is a configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an earth material.

The composition and structure of earth materials

- are reflected by their physical properties (e.g. density, porosity, and mechanical, magnetic, electrical, seismic and hydraulic properties)
- influence geological processes (genesis, fracturing, alteration)
- control the properties of aquifers
- control the morphology of the landscape
- control their use as a natural resources
- determine their behavior during natural and industrial processes

The **bedrock** is a general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

Aquifer is a wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well.

Groundwater is all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. This zone is commonly referred to as an aquifer.

Groundwater body is a distinct volume of groundwater within an aquifer. Generally the groundwater body is not exactly correlated with the main (deeper) groundwater aquifers because it was based on the surface water basins. This means that an aquifer is not always equivalent to a groundwater body (GWB) (the methodology differs in different member states).

Geomorphology provides basic knowledge about the present shape of the sub-aerial and submerged parts of the Earth surface and its dynamics (genesis and involved processes).

The analysis of reference material and examples of use, briefly described in the Executive Summary, shows the wide range of uses with various sets of rock properties required for different uses: a geologist in charge of mineral prospecting, or mining waste protection, does not request the same information about rocks as an engineer dealing with natural hazards who is more interested in underground stability.

This data specification identifies two kinds of application schemas for Geology:

- The **core schemas**: able to provide the basic geological, hydrogeological and geophysical knowledge on an area, with a limited number of attributes,
- The **extension schemas**: able to provide the more specific geological and geophysical knowledge.

The core **Geological** data model contains:

- Geologic Features with Geologic Events, Geologic Units, Geologic Structures, and Geomorphologic Features. The geometry of these features is described in Mapped Features, and is included in geological maps and profiles in the form of points, lines and polygons. Mapped Features and Boreholes can be bundled in Collections,
- Thematic Class for reclassifying GeologicFeatures as some thematic class for thematic maps,
- The lithology of rock units,
- The processes of Geologic Events and their environments and ages
- The types of Shear Displacement Structures and Folds
- Borehole details, such as location and purpose.

Geophysics provides essential information on the physical properties of geological structures. The core data model includes:

- High rank geophysical stations that are part of international and national observation networks
- Important types of geophysical measurements that are most often requested or provided by stakeholders
- Measurements that have basic role in improving geological knowledge, especially in environmental and engineering context.
- Measurement campaigns that include any number of measurements and allow data providers to deliver metadata in a collective manner.

The **Hydrogeology** data model contains:

- The Aquifer System comprising HydrogeologicUnits, Aquifers, Aquitards, Aquicludes and the AquiferSystem,
- The Groundwater System comprising GroundWaterBody, and its relationships to the Aquifer System, Hydrogeology Objects, and WFD_GroundWaterBody
- Hydrogeology Objects, both natural and man-made, including Wells

The extension models:

- For geology it is recommended be the GeoSciML v3 schema, which allows a wide range of geological information to be delivered,

- For geophysics guidance and examples are included to demonstrate the usage of the Observations & Measurements schema in delivering measurement and processing results.

2.3 Normative References

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[ISO 19107] EN ISO 19107:2005, Geographic Information – Spatial Schema

[ISO 19108] EN ISO 19108:2005, Geographic Information – Temporal Schema

[ISO 19108-c] ISO 19108:2002/Cor 1:2006, Geographic Information – Temporal Schema, Technical Corrigendum 1

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19113] EN ISO 19113:2005, Geographic Information – Quality principles

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19123] EN ISO 19123:2007, Geographic Information – Schema for coverage geometry and functions

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19138] ISO/TS 19138:2006, Geographic Information – Data quality measures

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[ISO19157] ISO/DIS 19157, Geographic information – Data Quality

[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

NOTE This is an updated version of "EN ISO 19125-1:2006, Geographic information – Simple feature access – Part 1: Common architecture". A revision of the EN ISO standard has been proposed.

[Regulation 1205/2008/EC] Regulation 1205/2008/EC implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

[Regulation 2000/60/EC] DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy

[Regulation 2006/118/EC] DIRECTIVE 2006/118/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the protection of groundwater against pollution and deterioration

Web sites describing the data model standard:
- **GeoSciML:** http://www.geosciml.org
- **WaterML:** http://www.opengeospatial.org/projects/groups/waterml2.0swg

2.4 Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[12].

Specifically, for the theme Geology, the following terms are defined:

(1) GeologicFeature
The abstract GeologicFeature class represents a conceptual feature that is hypothesized to exist coherently in the world. This corresponds with a "legend item" from a traditional geologic map * while the bounding coordinates of a Geologic Feature may be described, its shape is not. The implemented Geologic Feature instance acts as the "description package"

(2) MappedFeature
A spatial representation of a GeologicFeature. A MappedFeature is part of a geological interpretation. It provides a link between a notional feature (description package) and one spatial representation of it, or part of it (exposures, surface traces and intercepts, etc) which forms the specific bounded occurrence, such as an outcrop or map polygon.

(3) Geologic Unit
A volume of rock with distinct characteristics. Includes both formal units (i.e. formally adopted and named in an official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised). Spatial properties are only available through association with a MappedFeature.

(4) Geologic Structure
Geologic Structure, in the INSPIRE context, considers shear displacement structures (including faults) and folds. A shear displacement structure is defined as a brittle to ductile style structure along which displacement has occurred. A fold is defined as one or more systematically curved layers, surfaces, or lines in a rock body.

(5) Hydrogeologic Unit
A Hydrogeologic Unit is a volume of rock that by virtue of its porosity or permeability has a distinct influence on the storage or movement of groundwater.

(6) Aquifer
A wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well.

(7) Geophysical Station
Geophysical measurement spatially referenced to a single point location.

(8) Geophysical Profile
Geophysical measurement spatially referenced to a curve.

(9) Geophysical Swath
Geophysical measurement spatially referenced to a surface.

(10) Campaign

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[12] The INSPIRE Glossary is available from http://inspire-registry.jrc.ec.europa.eu/registers/GLOSSARY

Geophysical activity extending over a limited time range and limited area for producing similar geophysical measurements, processing results or models.

2.5 Symbols and abbreviations

CGI	Commission for Geoscience Information (IUGS Commission)
IUGS	International Union of Geological Sciences
GeoSciML	GeoScience Markup Language
GWML	GroundWater Markup Language
WFD	Water Framework Directive
GWD	Groundwater Directive

2.6 Notation of requirements and recommendations

To make it easier to identify the mandatory requirements and the recommendations for spatial data sets in the text, they are highlighted and numbered.

IR Requirement X	Requirements that are reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

TG Requirement X	Requirements that are not reflected in the Implementing Rule on interoperability of spatial data sets and services are shown using this style.

Recommendation X	Recommendations are shown using this style.

2.7 Conformance

DS Requirement 1	Any dataset claiming conformance with this INSPIRE data specification shall pass the requirements described in the abstract test suite presented in Annex A.

2.8 Notation of requirements and recommendations

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Recommendation X Recommendations are shown using this style.

2.9 Conformance

DS Requirement 2 Any dataset claiming conformance with this INSPIRE data specification shall pass the requirements described in the abstract test suite presented in Annex A.

3 Specification scopes

This data specification does not distinguish different specification scopes, but just considers one general scope.

NOTE For more information on specification scopes, see [ISO 19131:2007], clause 8 and Annex D.

4 Identification information

Intentionally left empty.

NOTE Since the content of this chapter was redundant with the overview description (section 2) and executive summary, this chapter will be removed in the final v3.0 (to be published once the Implementing Rule amendment has been approved). The chapter is kept in this v3.0 release candidate in order not to change the chapter numbering (which is relevant for references in on-going and future consultations).

5 Data content and structure

- This data specification for Geology defines the following application schemas:
- The GeologyCore application schema provides the basic elements found on standard and thematic geological maps, as well as geomorphology, and boreholes.
- The GeophysicsCore applicationschema provides information on the location and availability of geophysical features.
- The HydrogeologyCore application schema provides information on the groundwater system and related rock system (including aquifers).

IR Requirement 1 Spatial data sets related to the theme Geology shall be made available using the spatial object types and data types specified in the following application schema(s): GeologyCore, GeophysicsCore, HydrogeologyCore

These spatial object types and data types shall comply with the definitions and constraints and include the attributes and association roles defined in this section.

Recommendation 1 The reason for a void value should be provided where possible using a listed value from the VoidValueReason code list to indicate the reason for the missing value.

NOTE The application schema specifies requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc. All properties have to be reported, if the relevant information is part of the data set. Most properties may be reported as “void”, if the data set does not include relevant information. See the Generic Conceptual Model [DS-D2.5] for more details.

In addition to the application schemas listed in IR Requirement 1, additional application schemas have been defined for the theme *Geology*. These additional application schemas typically address requirements from specific (groups of) use cases and/or may be used to provide additional information. They are included in this specification in order to improve interoperability also for these additional aspects.

Recommendation 2 Additional and/or use case-specific information related to the geophysical part of theme *Geology* should be made available using the spatial object types and data types specified in the following application schema(s): GeophysicsExtension.

These spatial object types and data types should comply with the definitions and constraints and include the attributes and association roles defined in this section.

Additional and/or use case-specific information related to the geology part of theme *Geology* should be made available using the spatial object types and data types specified in GeoSciMl v3.

5.1 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.1.1 Stereotypes

In the application schemas in this sections several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [DS-D2.5])

Stereotype	Model element	Description

applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
leaf	Package	A package that is not an application schema and contains no packages.
featureType	Class	A spatial object type.
type	Class	A type that is not directly instantiable, but is used as an abstract collection of operation, attribute and relation signatures. This stereotype should usually not be used in INSPIRE application schemas as these are on a different conceptual level than classifiers with this stereotype.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	An enumeration.
codeList	Class	A code list.
import	Dependency	The model elements of the supplier package are imported.
voidable	Attribute, association role	A voidable attribute or association role (see section 5.1.3).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.1.2 Placeholder and candidate types

Some of the INSPIRE Annex I data specifications (which were developed previously to the Annex II+III data specifications) refer to types that were considered to thematically belong and which were expected to be fully specified in Annex II or III spatial data themes. Two kinds of such types were distinguished:

- *Placeholder types* were created as placeholders for types (typically spatial object types) that were to be specified as part of a future spatial data theme, but which was already used as a value type of an attribute or association role in this data specification.

  Placeholder types received the stereotype «placeholder» and were placed in the application schema package of the future spatial data theme where they thematically belong. For each placeholder, a definition was specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these definitions in the specification work of the Annex II or III theme.

  If necessary, the attributes or association roles in the Annex I data specification(s) that have a placeholder as a value type shall be updated.

- *Candidate types* were types (typically spatial object types) for which already a preliminary specification was given in the Annex I data specification. Candidate types did not receive a specific stereotype and were placed in the application schema package of the future spatial data theme where they thematically belong. For each candidate type, a definition and attributes and association roles were specified based on the requirements of the Annex I theme. The Annex II+III TWGs were required to take into account these specifications in the specification work of the Annex II or III theme.

  If the type could not be incorporated in the Annex II or III data specification according to its preliminary specification, it should be moved into the application schema of the Annex I theme where it had first been specified. In this case, the attributes or association roles in the Annex I data specification(s) that have the type as a value type shall be updated if necessary.

NOTE Once the Annex II+III data specifications have been finalised by the TWGs (version 3.0), all placeholders and candidate types should have been removed. In some cases, this may require one or several of the Annex I data specifications (and the Implementing Rule on interoperability of spatial data sets and services) to be updated.

5.1.3 Voidable characteristics

If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive this stereotype.

If and only if a property receives this stereotype, the value of *void* may be used as a value of the property. A *void* value shall imply that no corresponding value is contained in the spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs, even though the characteristic may be present or applicable in the real world.

It is possible to qualify a value of void in the data with a reason using the VoidValueReason type. The VoidValueReason type is a code list, which includes the following pre-defined values:

- *Unpopulated*: The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the "elevation of the water body above the sea level" has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be 'Unpopulated'. The characteristic receives this value for all objects in the spatial data set.
- *Unknown*: The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the "elevation of the water body above the sea level" *of a certain lake* has not been measured, then the reason for a void value of this property would be 'Unknown'. This value is applied on an object-by-object basis in a spatial data set.

NOTE It is expected that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:

- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. A value (the real value or void) only needs to be made available for properties that have a minimum cardinality of 1.

5.1.4 Enumerations

Enumerations are modelled as classes in the application schemas. Their values are modelled as attributes of the enumeration class using the following modelling style:

- No initial value, but only the attribute name part, is used.
- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

Test 1	Attributes of spatial object types or data types whose type is an enumeration shall only take values included in the enumeration.

5.1.5 Code lists

Code lists are modelled as classes in the application schemas. Their values, however, are managed outside of the application schema.

5.1.5.1. Obligation

For each attribute that has a code list as its value, a tagged value called “obligation” is specified to define the level of obligation to use values from the list. The tagged value can take the following values:

- *implementingRule* means that only the values defined by the code list shall be used for the attribute. This obligation is also included in the Implementing Rule on interoperability of spatial data and services.
- *technicalGuidance* means that only the values defined by the code list should be used for the attribute. This obligation is *not* included in the Implementing Rule on interoperability of spatial data and services.

The “obligation” tagged value is reported in the feature catalogues as “Implementing Rule (requirement)” or “Technical Guidance (recommendation)”, respectively.

Test 2	Attributes of spatial object types or data types whose type is a code list with an “obligation” value of “implementingRule” shall only take values that are valid according to the code list’s specification.

Recommendation 3	Attributes of spatial object types or data types whose type is a code list with an “obligation” value of “technicalGuidance” should only take values that are valid according to the code list’s specification.

5.1.5.2. Governance

The following two types of code lists are distinguished in INSPIRE:

- *Code lists that are governed by INSPIRE (INSPIRE-governed code lists).* These code lists will be managed centrally in the INSPIRE code list register, which is managed and governed by the INSPIRE expert group on maintenance and implementation. Change requests to these code lists (e.g. to add, deprecate or supersede values) are processed and decided upon using the maintenance workflows defined by the INSPIRE expert group.

  INSPIRE-governed code lists will be made available in the INSPIRE code list register at *http://inspire.ec.europa.eu/codeList/<CodeListName>*. They will be available in SKOS/RDF, XML and HTML. The maintenance will follow the procedures defined in ISO 19135. This means that the only allowed changes to a code list are the addition, deprecation or supersession of values, i.e. no value will ever be deleted, but only receive different statuses (valid, deprecated, superseded). Identifiers for values of INSPIRE-governed code lists are constructed using the pattern *http://inspire.ec.europa.eu/codeList/<CodeListName>*/<value>.

- *Code lists that are governed by an organisation outside of INSPIRE (externally governed code lists).* These code lists are managed by an organisation outside of INSPIRE, e.g. the World Meteorological Organization (WMO) or the World Health Organization (WHO). Change requests to these code lists follow the maintenance workflows defined by the maintaining organisations. Note that in some cases, no such workflows may be formally defined.

The tables describing externally governed code lists in this section contain the following columns:

- The *Governance* column describes the external organisation that is responsible for maintaining the code list.
- If the code list is versioned, the *Version* column specifies which version of the code list shall be used in INSPIRE. The version can be specified using a version number or the publication date of a version. The specification can also refer to the “latest available version”.
- The *Availability* column specifies from where the values of the externally governed code list are available, through a URL for code lists that are available online, or a citation for code lists that are only available offline.
- In the *Formats* column the formats are listed, in which a code list is available. These can be machine-readable (e.g. SKOS/RDF, XML) or human-readable (e.g. HTML, PDF).
- In some cases, for INSPIRE only a subset of an externally governed code list is relevant. The subset is specified using the *Subset* column.
- For encoding values of externally governed code lists, rules have to be specified for generating URI identifiers and labels for code list values. These are specified in a separate table.

5.1.5.3. Vocabulary

For each code list, a tagged value called “vocabulary” is specified to define a URI identifying the values of the code list. For INSPIRE-governed code lists and externally governed code lists that do not have a persistent identifier, the URI is constructed following the pattern *http://inspire.ec.europa.eu/codeList/<UpperCamelCaseName>*.

If the value is missing or empty, this indicates an empty code list. If no sub-classes are defined for this empty code list, this means that any code list may be used that meets the given definition.

An empty code list may also be used as a super-class for a number of specific code lists whose values may be used to specify the attribute value. If the sub-classes specified in the model represent all valid extensions to the empty code list, the subtyping relationship is qualified with the standard UML constraint "{complete,disjoint}".

5.1.5.4. Extensibility

For each code list, a tagged value called “extensibility” is specified to define which additional values (other than those explicitly specified) are allowed as valid values of the code list. The tagged value can take the following values:

- *none* means that only the values explicitly specified shall / should[13] be used for the attribute.
- *narrower* means that only the values explicitly specified or values narrower than the specified values shall / should be used for the attribute.
- *any* means that, in addition to the values explicitly specified, any other value may be used.

NOTE The “extensibility” tagged value does *not* affect the possibility to update the code list values following the formal maintenance procedure. For example, even for code lists, for which the “extensibility” is set to *none*, it is still possible to add values following the maintenance procedure of the code list. As a result of this update, the code list may include additional valid values, and these additional may be used for attributes having the code list as a type.

5.1.6 Coverages

[13] It depends on the level of the “obligation” tagged value on the attribute, whether this is a requirement or recommendation.

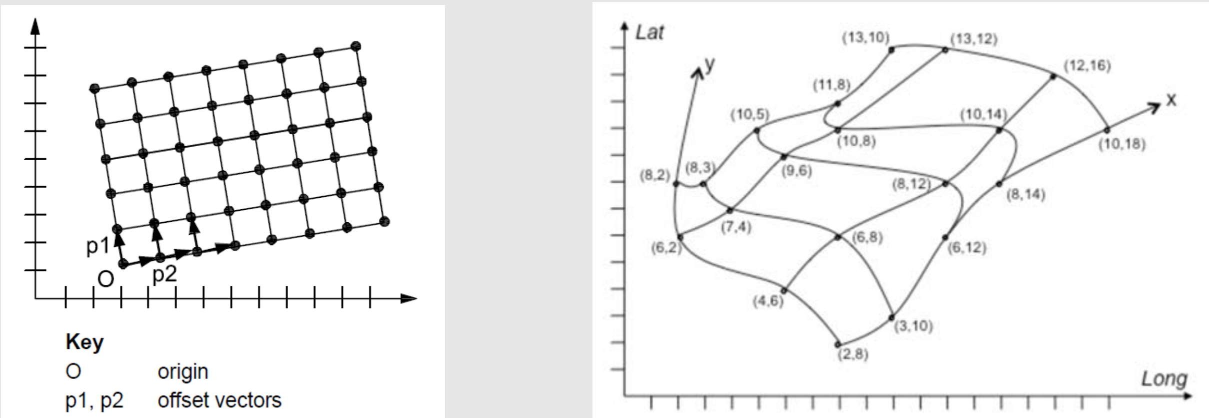
Coverage functions are used to describe characteristics of real-world phenomena that vary over space and/or time. Typical examples are temperature, elevation, precipitation, imagery. A coverage contains a set of such values, each associated with one of the elements in a spatial, temporal or spatio-temporal domain. Typical spatial domains are point sets (e.g. sensor locations), curve sets (e.g. contour lines), grids (e.g. orthoimages, elevation models), etc.

In INSPIRE application schemas, coverage functions are defined as properties of spatial object types where the type of the property value is a realisation of one of the types specified in ISO 19123.

To improve alignment with coverage standards on the implementation level (e.g. ISO 19136 and the OGC Web Coverage Service) and to improve the cross-theme harmonisation on the use of coverages in INSPIRE, an application schema for coverage types is included in the Generic Conceptual Model in 9.9.4. This application schema contains the following coverage types:

- *RectifiedGridCoverage*: coverage whose domain consists of a rectified grid – a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system (see Figure 1, left).
- *ReferenceableGridCoverage*: coverage whose domain consists of a referenceable grid – a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system (see Figure 1, right).
- *MultiTimeInstantCoverage*: coverage providing a representation of the time instant/value pairs, i.e. time series (see Figure 2).

Where possible, only these coverage types (or a subtype thereof) are used in INSPIRE application schemas.



(Source: ISO 19136:2007) (Source: GML 3.3.0)

Figure 1 – Examples of a rectified grid (left) and a referenceable grid (right)

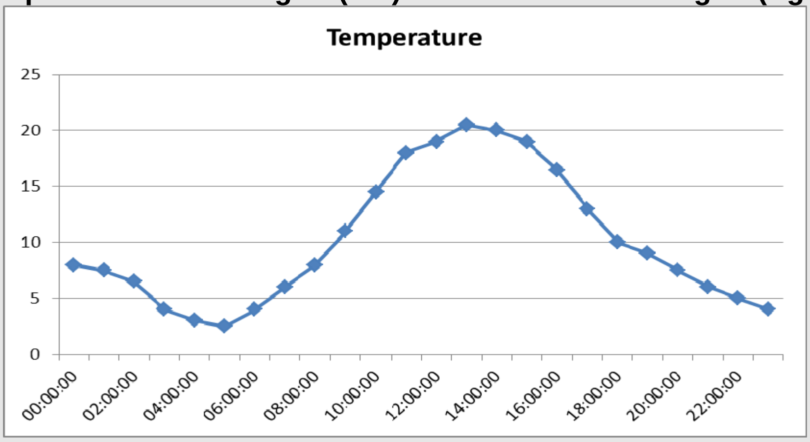


Figure 2 – Example of a MultiTimeSeriesCoverage (a time series)

5.1.7 Identifier management

> The external object identifier for the unique identification of spatial objects shall not be changed during the life-cycle of a spatial object, that is the *namespace* and *localId* attributes of the external object identifier shall remain the same for different versions of a spatial object.

5.1.8 Geometry representation

> The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1:2004.

NOTE 1 ISO 19125-1:2004 restricts the spatial schema to 0, 1 and 2-dimensional geometric objects that exist in 2-dimensional coordinate space, where all curve interpolations are linear.

NOTE 2 The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.1.9 Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

> Where the attributes beginLifespanVersion and endLifespanVersion are used, the value of endLifespanVersion shall not be before the value of beginLifespanVersion.

Recommendation 1	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

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5.2 Application schema GeologyCore

5.2.1 Description

5.2.1.1. Narrative description and UML overview

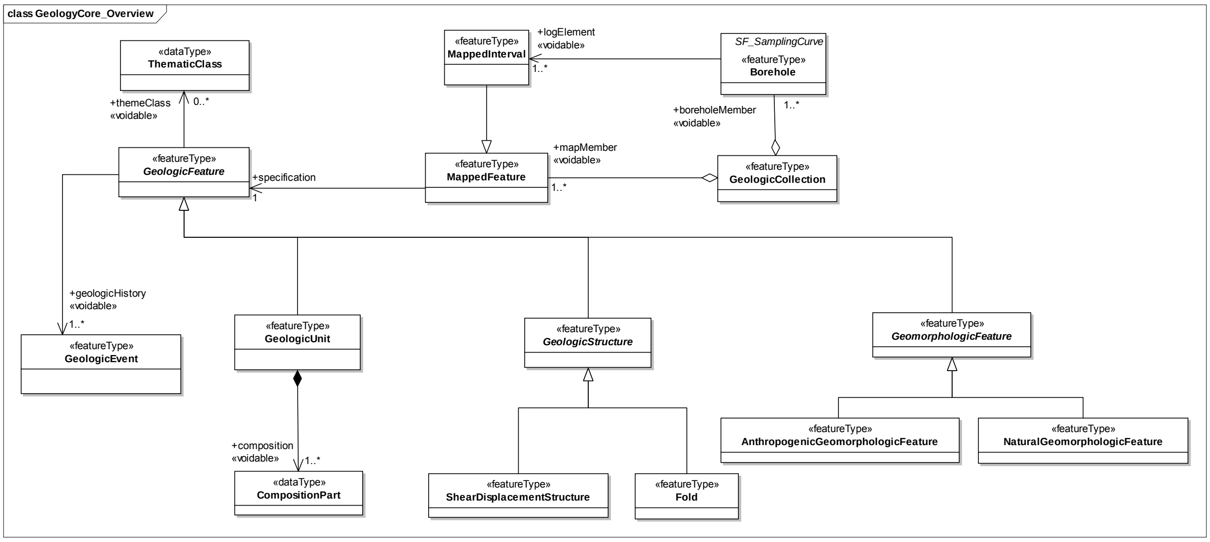

Figure 3 – UML class diagram: Overview of the GeologyCore application schema

Figure 3 shows only the spatial object types and their relationships. It does not include data types and code-lists. The properties are not visible but are shown in the following figures, which describe the main parts of the GeologyCore data model.

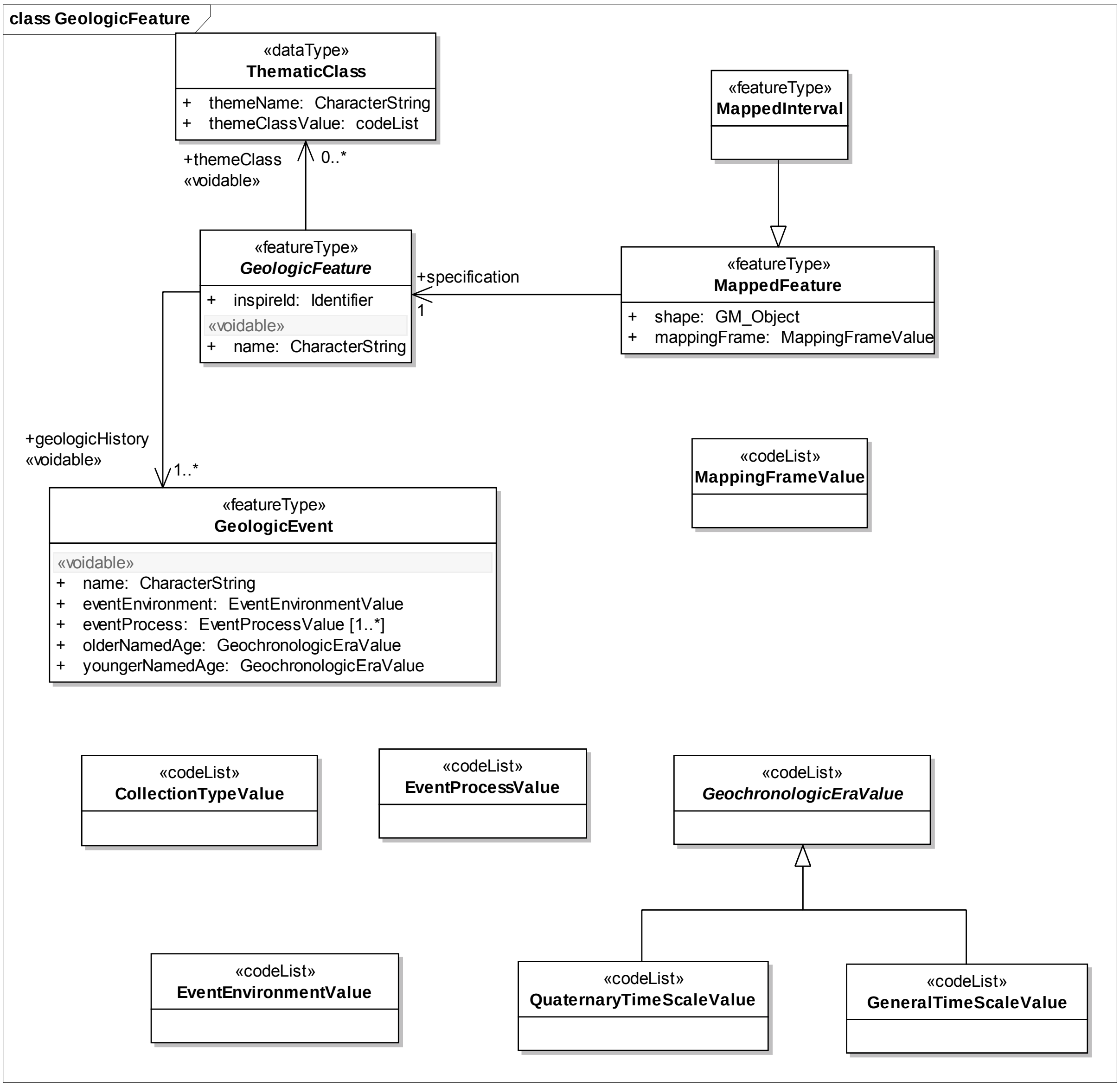

Figure 4 – UML class diagram: GeologicFeature, MappedFeature, GeologicEvent, ThematicClass

MappedFeature and *GeologicFeature* are central classes in the model.

A *MappedFeature* provides a spatial representation of a *GeologicFeature*. The *specification* association from *MappedFeature* to *GeologicFeature* allows only one Geologic Feature to be represented by any Mapped Feature.

As well as 'standard' geological maps the model allows the description of thematic maps using the *themeClass* association to *ThematicClass*. A thematic map in this context can be considered as a reclassification of the GeologicUnit in terms of some thematic property, for example reclassifying Geologic Units in terms of their susceptibility to compaction or their potential as a source of aggregate. A theme should have a name and be constrained by a codelist of class values for that theme but as each theme will have different classes, and it is likely different classification systems will have been used by different data providers, it is not possible to mandate any particular codelist of theme class values in the specification.

The abstract *GeologicFeature* class represents a conceptual geological feature that is hypothesized to exist coherently in the world, and includes as sub-types the main information classes in the model.

The implemented Geologic Feature instance acts as the "description package". There are three sub-types of *GeologicFeature* in the data model: *GeologicUnit, GeologicStructure and GeomorphologicFeature.*

A *GeologicEvent* is defined as an identifiable event during which one or more geological processes act to modify geological entities. Geological age is modelled using *GeologicEvent* – the age of some geological event occurring. A *GeologicEvent* should have a specified geologic age and process, and may have a specified environment.

The *geologicHistory* association from *GeologicFeature* to *GeologicEvent* describes a sequence of one or more Geologic Events which together describe the age or geologic history of the GeologicFeature. Commonly GeologicFeatures will have a geologicHistory comprising only one GeologicEvent, which represents the formation of the GeologicFeature.

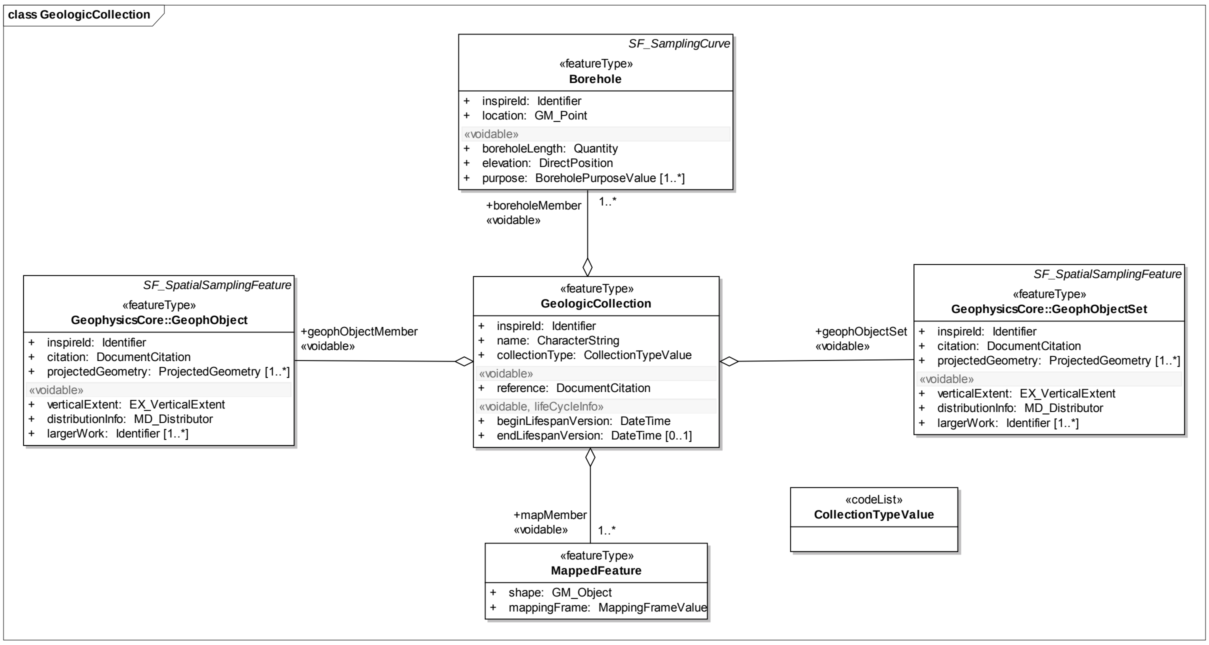

Figure 5 - UML class diagram: GeologicCollection

A *GeologicCollection* is a named or identifiable group of geological or geophysical objects. Geologic objects are commonly grouped into collections such as geological maps, thematic maps, groups of geophysical measurements or models of the same type etc, which are familiar to many user communities. The GeologicCollection class allows the delivery of a package off objects that go to make up one of these familiar collections.

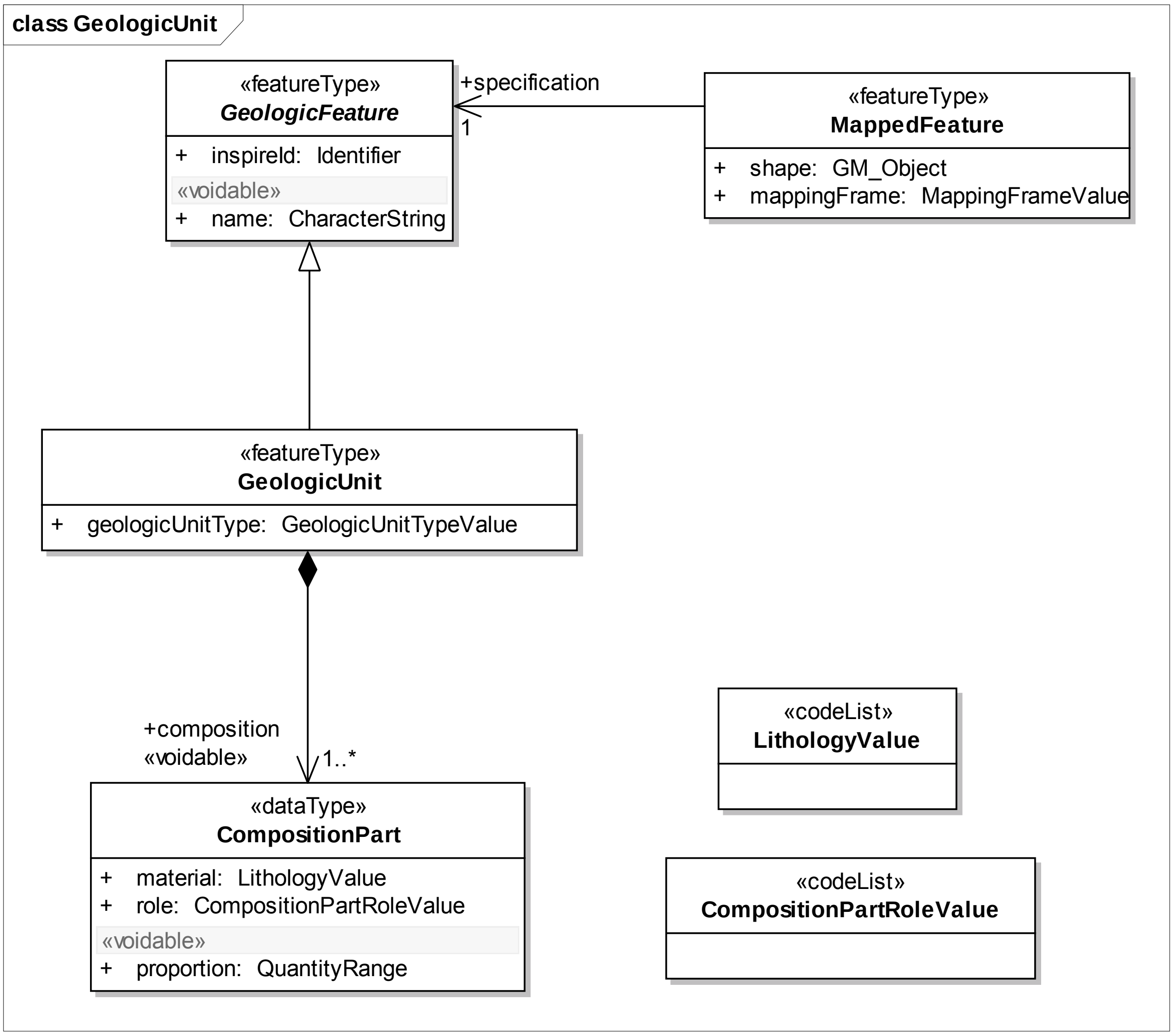

Figure 6 – UML class diagram: GeologicUnit

GeologicUnit represents a body of material in the Earth whose complete and precise extent is inferred to exist. Spatial properties are only available through association with a *MappedFeature*.

The *composition* association from *GeologicUnit* to *CompositionPart* allows the lithological description of the Geologic Unit. The composition of a Geologic Unit can be made up of several Composition Parts, for example where there are lithologically distinct components interbedded.

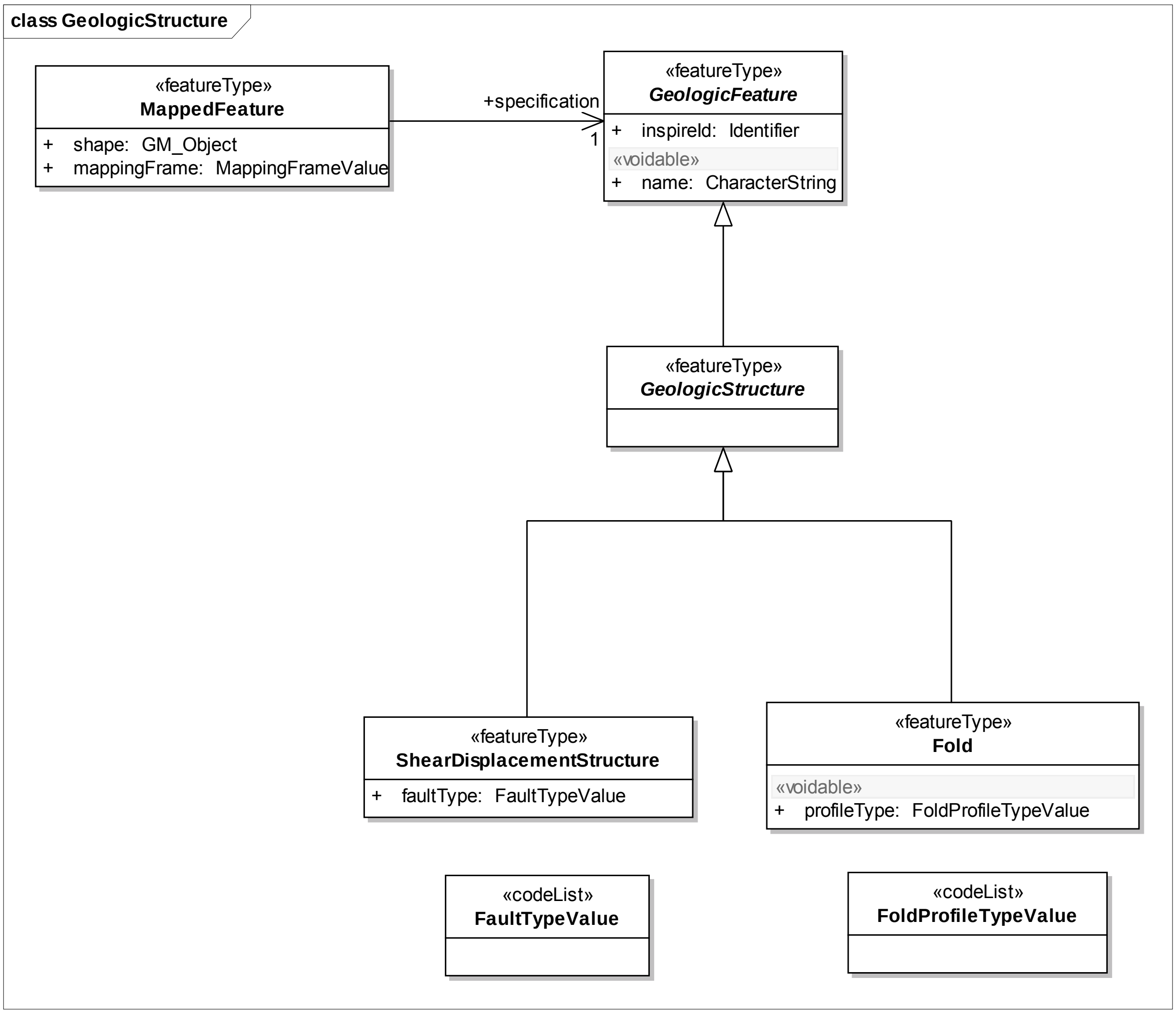

Figure 7 – UML class diagram: GeologicStructure

Geologic Structure is defined as a configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an Earth Material. The identity of a Geologic Structure is independent of the material that is the substrate for the structure.

The two types of *GeologicStructure* in the data model are *ShearDisplacementStructure* and *Fold*.

- *ShearDisplacementStructure* includes all brittle to ductile style structures along which displacement has occurred, from a simple, single 'planar' brittle (fault) or ductile surface to a fault system comprised of tens of strands of both brittle and ductile nature.

- *Fold* describes one or more systematically curved layers, surfaces, or lines in a rock body. A fold denotes a structure formed by the deformation of a Geologic Feature to form a structure that may be described by the translation of an abstract line (the fold axis) along some curvilinear path (the fold profile).

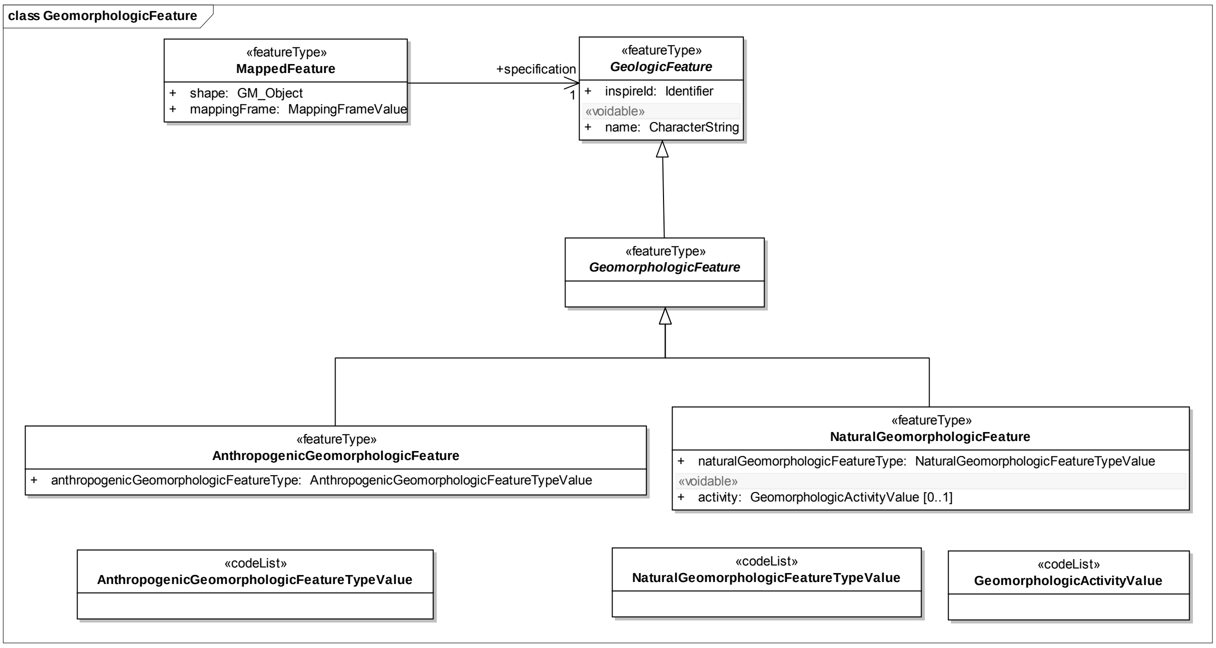

Figure 8 – UML class diagram: GeomorphologicFeature

The abstract *GeomorphologicFeature* class is a point, linear or areal landform or landscape. It is a natural or an anthropogenic surface feature and may be erosional, depositional or both. *GeomorphologicFeature* has two subtypes: *NaturalGeomorphologicFeature* and *AnthropogenicGeomorphologicFeature.*

- *NaturalGeomorphologicFeature* is a geomorphologic feature produced by natural dynamics.

- *AnthropogenicGeomorphologicFeature* is a man-made geomorphologic feature on the earth's surface (including those in shallow water), having a characteristic shape and range in composition, composed of unconsolidated earthy, organic materials, artificial materials, or rock, that is the direct result of human manipulation or activities. It can be either constructional (e.g., artificial levee) or destructional (quarry), or both.

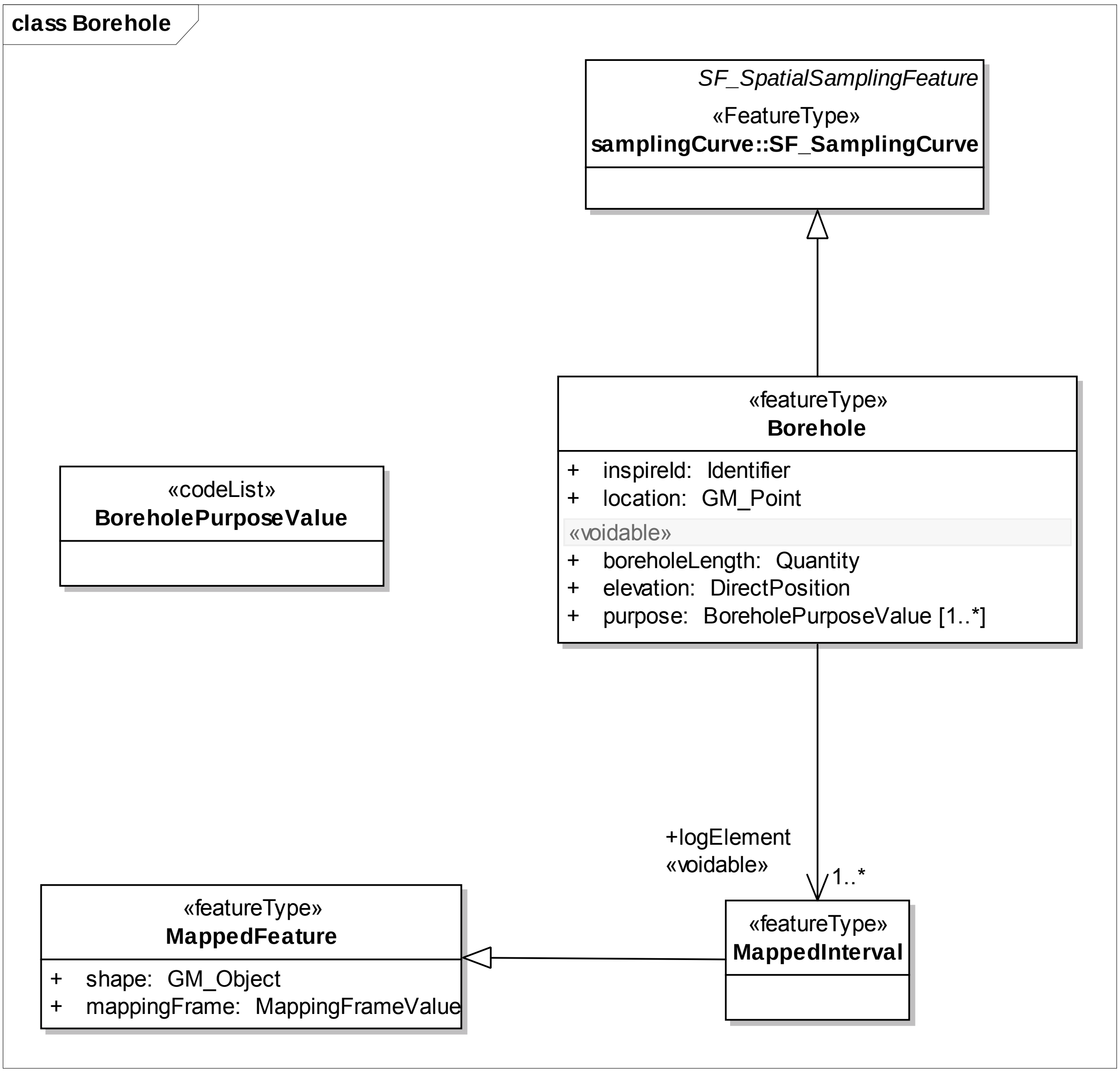

Figure 9 – UML class diagram: Borehole

Borehole is a generalized class for any narrow shaft drilled in the ground, at any angle, and it is modelled as a type SF_SamplingCurve. The logElement association to MappedInterval allows the description of a borehole log as a collection of MappedIntervals, each off which can be specified by a GeologicUnit and have a geologicHistory (age). This allows the description of lithological or stratigraphical borehole logs. A MappedInterval is a special kind of Mapped Feature whose shape is a 1-D interval and which uses the SRS of the containing borehole.

A MappedInterval is therefore an interpretation of the observations (lithological, geophysical etc) made in the original log, and it is only such interpreted borehole logs which are in scope of the data specification. These interpretations can be in terms of lithostratigraphic units described in a stratigraphic lexicon and shown on a geological map, but they can be in terms of other types of unit such as a recognisable lithological unit correlated between boreholes. The data specification does not cover the original observations upon which the interpretation was made, but these can be delivered as an extension to the specification using GeoSciML and the Observations & Measurements standard.

5.2.1.2. Consistency between spatial data sets

The observation location is specified by its coordinates.

5.2.1.3. Identifier management

There is no specific requirement to manage identifiers.

5.2.1.4. Geometry representation

IR Requirement 2	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.2.1.5. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attribute "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 2	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.2.2 Feature catalogue

Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue GeologyCore
Scope	GeologyCore
Version number	2.9
Version date	2012-06-29
Definition source	INSPIRE data specification GeologyCore

Types defined in the feature catalogue

Type	Package	Stereotypes	Section
AnthropogenicGeomorphologicFeature	GeologyCore	«featureType»	5.2.2.1.1
AnthropogenicGeomorphologicFeatureTypeValue	GeologyCore	«codeList»	5.2.2.3.1
Borehole	GeologyCore	«featureType»	5.2.2.1.2
BoreholePurposeValue	GeologyCore	«codeList»	5.2.2.3.2
CollectionTypeValue	GeologyCore	«codeList»	5.2.2.3.3
CompositionPart	GeologyCore	«dataType»	5.2.2.2.1
CompositionPartRoleValue	GeologyCore	«codeList»	5.2.2.3.4
EventEnvironmentValue	GeologyCore	«codeList»	5.2.2.3.5
EventProcessValue	GeologyCore	«codeList»	5.2.2.3.6
FaultTypeValue	GeologyCore	«codeList»	5.2.2.3.7
Fold	GeologyCore	«featureType»	5.2.2.1.3
FoldProfileTypeValue	GeologyCore	«codeList»	5.2.2.3.8
GeneralTimeScaleValue	GeologyCore	«codeList»	5.2.2.3.9
GeochronologicEraValue	GeologyCore	«codeList»	5.2.2.3.10
GeologicCollection	GeologyCore	«featureType»	5.2.2.1.4
GeologicEvent	GeologyCore	«featureType»	5.2.2.1.5
GeologicFeature	GeologyCore	«featureType»	5.2.2.1.6
GeologicStructure	GeologyCore	«featureType»	5.2.2.1.7
GeologicUnit	GeologyCore	«featureType»	5.2.2.1.8
GeologicUnitTypeValue	GeologyCore	«codeList»	5.2.2.3.11
GeomorphologicActivityValue	GeologyCore	«codeList»	5.2.2.3.12
GeomorphologicFeature	GeologyCore	«featureType»	5.2.2.1.9
LithologyValue	GeologyCore	«codeList»	5.2.2.3.13
MappedFeature	GeologyCore	«featureType»	5.2.2.1.10
MappedInterval	GeologyCore	«featureType»	5.2.2.1.11
MappingFrameValue	GeologyCore	«codeList»	5.2.2.3.14
NaturalGeomorphologicFeature	GeologyCore	«featureType»	5.2.2.1.12
NaturalGeomorphologicFeatureTypeValue	GeologyCore	«codeList»	5.2.2.3.15
QuaternaryTimeScaleValue	GeologyCore	«codeList»	5.2.2.3.16
ShearDisplacementStructure	GeologyCore	«featureType»	5.2.2.1.13
ThematicClass	GeologyCore	«dataType»	5.2.2.2.2

5.2.2.1. Spatial object types

5.2.2.1.1. AnthropogenicGeomorphologicFeature

AnthropogenicGeomorphologicFeature	
Name:	Anthropogenic Geomorphologic Feature
Subtype of:	GeomorphologicFeature
Definition:	A geomorphologic feature (ie, landform) which has been created by human activity.
Description:	EXAMPLE: dredged channel, midden, open pit, reclaimed land.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: anthropogenicGeomorphologicFeatureType	
Value type:	AnthropogenicGeomorphologicFeatureTypeValue
Definition:	A dictionary of terms describing the type of geomorphologic feature.
Multiplicity:	1

AnthropogenicGeomorphologicFeature	
Obligation:	Implementing Rule (requirement)

5.2.2.1.2. Borehole

Borehole	
Name:	Borehole
Subtype of:	SF_SamplingCurve
Definition:	A borehole is the generalized term for any narrow shaft drilled in the ground.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: boreholeLength	
Value type:	Quantity
Definition:	The distance along a borehole.
Description:	This will be determined by the data provider (ie, "length" can have different sources, like drillers measurement, loggers measurement, survey).
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: elevation	
Value type:	DirectPosition
Definition:	The vertical height above datum of the borehole collar.
Description:	This is a compromise approach to supply elevation explictly for location; this is to allow for software that cannot process 3-D GM_Point. Use null if elevation is unknown. Direct position shall have a dimension of 1, and CRS will be a "vertical" CRS (e.g. EPSG CRSs in the range 5600-5799).
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: inspireId	
Value type:	Identifier
Definition:	A unique identifier for the Borehole.
Multiplicity:	1
Attribute: location	
Value type:	GM_Point
Definition:	The location of the borehole collar.
Multiplicity:	1
Attribute: purpose	
Value type:	BoreholePurposeValue
Definition:	The purpose for which the borehole was drilled.
Description:	EXAMPLE: site investigation, mineral exploration, hydrocarbon exploration, water resources.
Multiplicity:	1..*
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)
Association role: logElement	
Value type:	MappedInterval
Definition:	1-D MappedFeature instances that are logged (interpreted) intervals within a borehole.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.2.2.1.3. Fold

Fold

Name:	Fold
Subtype of:	GeologicStructure
Definition:	One or more systematically curved layers, surfaces, or lines in a rock body.
Description:	A fold denotes a structure formed by the deformation of a Geologic Structure to form a structure that may be described by the translation of an abstract line (the fold axis) parallel to itself along some curvilinear path (the fold profile). Folds have a hinge zone (zone of maximum curvature along the surface) and limbs (parts of the deformed surface not in the hinge zone).
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: profileType

Value type:	FoldProfileTypeValue
Definition:	The type of fold.
Description:	Folds are typed according to the concave/convex geometry of the fold relative to the earth surface, and the relationship to younging direction in folded strata if known. EXAMPLE: antiform, synform, anticline, syncline, etc.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

5.2.2.1.4. GeologicCollection

GeologicCollection

Name:	Geologic Collection
Definition:	A collection of geological or geophysical objects.
Description:	Geologic objects are commonly grouped into collections such as geological maps, thematic maps, or the required input to a geological model.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: beginLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: collectionType

Value type:	CollectionTypeValue
Definition:	The type of collection.
Description:	Refers to a vocabulary of types. EXAMPLE: geological map, thematic map etc.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

Attribute: endLifespanVersion

Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1

GeologicCollection	
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: inspireId	
Value type:	Identifier
Definition:	A unique identifier for the GeologicCollection.
Multiplicity:	1
Attribute: name	
Value type:	CharacterString
Definition:	The name of the collection.
Multiplicity:	1
Attribute: reference	
Value type:	DocumentCitation
Definition:	A reference for the collection.
Multiplicity:	1
Stereotypes:	«voidable»
Association role: boreholeMember	
Value type:	Borehole
Definition:	A Borehole member of a Geologic Collection.
Description:	Association that allows Borehole objects to be included as members in a GML Collection, through the use of the GeologicCollection class.
Multiplicity:	1..*
Stereotypes:	«voidable»
Association role: mapMember	
Value type:	MappedFeature
Definition:	A Mapped Feature member of a Geologic Collection.
Description:	Association that allows MappedFeature objects to be included as members in a GML Collection, through the use of the GeologicCollection class.
Multiplicity:	1..*
Stereotypes:	«voidable»
Association role: geophObjectSet	
Value type:	GeophObjectSet
Definition:	A GeophObjectSet member of a Geologic Collection.
Multiplicity:	
Stereotypes:	«voidable»
Association role: geophObjectMember	
Value type:	GeophObject
Definition:	A GeophObject member of a Geologic Collection.
Multiplicity:	
Stereotypes:	«voidable»

5.2.2.1.5. GeologicEvent

GeologicEvent	
Name:	Geologic Event
Definition:	An identifiable event during which one or more geological processes act to modify geological entities.

GeologicEvent

Description:	A GeologicEvent should have a specified geologic age and process, and may have a specified environment. An example might be a cratonic uplift event during which erosion, sedimentation, and volcanism all take place. A GeologicEvent age can represent an instant in time or an interval of time.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: eventEnvironment

Value type:	EventEnvironmentValue
Definition:	The physical setting within which a GeologicEvent takes place.
Description:	GeologicEnvironment is construed broadly to include physical settings on the Earth surface specified by climate, tectonics, physiography or geography, and settings in the Earth's interior specified by pressure, temperature, chemical environment, or tectonics.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: eventProcess

Value type:	EventProcessValue
Definition:	The process or processes that occurred during the event.
Description:	EXAMPLE: deposition, extrusion, intrusion, cooling.
Multiplicity:	1..*
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: name

Value type:	CharacterString
Definition:	The name of the Geologic Event.
Description:	Only major Geologic Events, such as orogenies, are likely to have names.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: olderNamedAge

Value type:	GeochronologicEraValue
Definition:	Older boundary of age of event.
Description:	This is expressed using a geochronologic era defined in a vocabulary of recognised units, such as those of the International Commission on Stratigraphy (ICS) Stratigraphic Chart.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: youngerNamedAge

Value type:	GeochronologicEraValue
Definition:	Younger boundary of age of event.
Description:	This is expressed using a geochronologic era defined in a vocabulary of recognised units, such as those of the International Commission on Stratigraphy (ICS) Stratigraphic Chart.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

5.2.2.1.6. *GeologicFeature*

GeologicFeature (abstract)	
Name:	Geologic Feature
Definition:	A conceptual geological feature that is hypothesized to exist coherently in the world.
Description:	This corresponds with a "legend item" from a traditional geologic map. While the bounding coordinates of a Geologic Feature may be described, its shape is not. The implemented Geologic Feature instance acts as the "description package"
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: inspireId	
Value type:	Identifier
Definition:	A unique identifier for the GeologicFeature.
Multiplicity:	1
Attribute: name	
Value type:	CharacterString
Definition:	The name of the GeologicFeature.
Description:	EXAMPLE: a lithostratigraphic unit, mineral occurrence, or major fault. Not all GeologicFeatures will have names, for example minor faults.
Multiplicity:	1
Stereotypes:	«voidable»
Association role: themeClass	
Value type:	ThematicClass
Definition:	A thematic classification of the GeologicFeature.
Description:	A GeologicFeature may be classified according to one or more thematic schema, for example ground stability or mineral resource potential.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: geologicHistory	
Value type:	GeologicEvent
Definition:	An association that relates one or more GeologicEvents to a GeologicFeature to describe their age or geologic history.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.2.2.1.7. *GeologicStructure*

GeologicStructure (abstract)	
Name:	Geologic Structure
Subtype of:	GeologicFeature
Definition:	A configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an earth material.
Description:	The identity of a GeologicStructure is independent of the material that is the substrate for the structure.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

5.2.2.1.8. *GeologicUnit*

GeologicUnit	
Name:	Geologic Unit

GeologicUnit	
Subtype of:	GeologicFeature
Definition:	A volume of rock with distinct characteristics.
Description:	Includes both formal units (i.e. formally adopted and named in an official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised). Spatial properties are only available through association with a MappedFeature.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: geologicUnitType	
Value type:	GeologicUnitTypeValue
Definition:	The type of geological unit.
Description:	Logical constraints of definition of unit and valid property cardinalities should be contained in the definition.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Association role: composition	
Value type:	CompositionPart
Definition:	Describes the Composition of the GeologicUnit
Multiplicity:	1..*
Stereotypes:	«voidable»

5.2.2.1.9. GeomorphologicFeature

GeomorphologicFeature (abstract)	
Name:	Geomorphologic Feature
Subtype of:	GeologicFeature
Definition:	An abstract feature describing the shape and nature of the Earth's land surface (ie, a landform).
Description:	These landforms may be created by natural Earth processes (eg, river channel, beach, moraine, mountain) or through human (anthropogenic) activity (eg, dredged channel, reclaimed land, mine waste dumps).
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

5.2.2.1.10. MappedFeature

MappedFeature	
Name:	Mapped Feature
Definition:	A spatial representation of a GeologicFeature.
Description:	A MappedFeature is part of a geological interpretation. It provides a link between a notional feature (description package) and one spatial representation of it, or part of it (exposures, surface traces and intercepts, etc) which forms the specific bounded occurrence, such as an outcrop or map polygon.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: mappingFrame	
Value type:	MappingFrameValue
Definition:	The surface on which the MappedFeature is projected.

MappedFeature	
Description:	EXAMPLE: Topographic surface, Bedrock surface, Base of Permian
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: shape	
Value type:	GM_Object
Definition:	The geometry of the MappedFeature.
Multiplicity:	1
Association role: specification	
Value type:	GeologicFeature
Definition:	A description association that links a mapped feature to a notional geologic feature.
Description:	A geologic feature, such as a geologic unit may be linked to mapped features from a number of different maps. A mapped feature, however is always associated with only a single description (geologic feature).
Multiplicity:	1

5.2.2.1.11. *MappedInterval*

MappedInterval	
Name:	Mapped Interval
Subtype of:	MappedFeature
Definition:	A special kind of Mapped Feature whose shape is a 1-D interval and which uses the SRS of the containing borehole.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

5.2.2.1.12. *NaturalGeomorphologicFeature*

NaturalGeomorphologicFeature	
Name:	Natural Geomorphologic Feature
Subtype of:	GeomorphologicFeature
Definition:	A geomorphologic feature (ie, landform) that has been created by natural Earth processes.
Description:	EXAMPLE: river channel, beach ridge, caldera, canyon, moraine, mud flat.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: activity	
Value type:	GeomorphologicActivityValue
Definition:	The level of activity of a natural geomorphologic feature.
Multiplicity:	0..1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)
Attribute: naturalGeomorphologicFeatureType	
Value type:	NaturalGeomorphologicFeatureTypeValue
Definition:	The type of natural geomorphologic feature.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.2.2.1.13. *ShearDisplacementStructure*

ShearDisplacementStructure

ShearDisplacementStructure	
Name:	Shear Displacement Structure
Subtype of:	GeologicStructure
Definition:	Brittle to ductile style structures along which displacement has occurred.
Description:	These range from from a simple, single 'planar' brittle or ductile surface to a fault system comprised of tens of strands of both brittle and ductile nature.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: faultType	
Value type:	FaultTypeValue
Definition:	Refers to a vocabulary of terms describing the type of shear displacement structure.
Description:	EXAMPLE: thrust fault, normal fault, wrench fault.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.2.2.2. Data types

5.2.2.2.1. CompositionPart

CompositionPart	
Name:	Composition Part
Definition:	The composition of a geologic unit in terms of lithological constituents.
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: material	
Value type:	LithologyValue
Definition:	The material that comprises part or all of the geologic unit.
Description:	This refers to a vocabulary of lithological terms.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: proportion	
Value type:	QuantityRange
Definition:	Quantity that specifies the fraction of the geologic unit composed of the material.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: role	
Value type:	CompositionPartRoleValue
Definition:	The relationship of the composition part to the geologic unit composition as a whole.
Description:	EXAMPLE: vein, interbedded constituent, layers, dominant constituent.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

5.2.2.2.2. ThematicClass

ThematicClass	
Name:	Thematic Class
Definition:	A generic thematic classifier.
Description:	This datatype allows Geologic Features to be classified against thematic classes. This provides a generic means of delivering geological thematic map data.

ThematicClass	
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: themeClassValue	
Value type:	codeList
Definition:	The value of the thematic class.
Description:	The thematic class value should be constrained by a codelist of defined terms, but these will commonly be specific to a particular thematic map.
Multiplicity:	1
Attribute: themeName	
Value type:	CharacterString
Definition:	The name of the theme.
Multiplicity:	1

5.2.2.3. Code lists

5.2.2.3.1. AnthropogenicGeomorphologicFeatureTypeValue

AnthropogenicGeomorphologicFeatureTypeValue	
Name:	Anthropogenic Geomorphologic Feature Type
Definition:	A codelist of terms describing the type of anthropogenic geomorphologic feature.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/AnthropogenicGeomorphologicFeatureTypeTerm

5.2.2.3.2. BoreholePurposeValue

BoreholePurposeValue	
Name:	Borehole Purpose
Definition:	A codelist containing terms describing the purpose for which the borehole was drilled.
Description:	EXAMPLE: mineral exploration, water pumping, site evaluation, stratigraphic research, etc.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/BoreholePurposeTerm

5.2.2.3.3. CollectionTypeValue

CollectionTypeValue	
Name:	Collection Type
Definition:	A codelist of types of Collection
Description:	EXAMPLE: geological map, thematic map etc.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/CollectionTypeTerm

5.2.2.3.4. CompositionPartRoleValue

CompositionPartRoleValue	
Name:	Composition Part Role
Definition:	A codelist of terms to describe the role that a compositional part plays in a geologic unit.

CompositionPartRoleValue	
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/CompositionPartRoleTerm

5.2.2.3.5. EventEnvironmentValue

EventEnvironmentValue	
Name:	Event Environment
Definition:	A codelist of terms for the Geologic Environments within which Geologic Events take place.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/EventEnvironmentTerm

5.2.2.3.6. EventProcessValue

EventProcessValue	
Name:	Event Process
Definition:	A codelist of terms specifying the process or processes that occurred during an event.
Description:	EXAMPLE: deposition, extrusion, intrusion, cooling.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	EventProcessTerm

5.2.2.3.7. FaultTypeValue

FaultTypeValue	
Name:	Fault Type
Definition:	A codelist of terms describing the type of shear displacement structure.
Description:	EXAMPLE: thrust fault, normal fault, wrench fault.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/FaultTypeTerm

5.2.2.3.8. FoldProfileTypeValue

FoldProfileTypeValue	
Name:	Fold Profile Type
Definition:	A codelist of terms specifying the type of fold.
Description:	Folds are typed according to the concave/convex geometry of the fold relative to the earth surface, and the relationship to younging direction in folded strata if known. EXAMPLE: antiform, synform, anticline, syncline, etc.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/FoldProfileTypeTerm

5.2.2.3.9. GeneralTimeScaleValue

GeneralTimeScaleValue	
Name:	General Time Scale
Subtype of:	GeochronologicEraValue

GeneralTimeScaleValue	
Definition:	A codelist of recognised geological time units.
Description:	EXAMPLE: those shown on the International Commission on Stratigraphy (ICS) Stratigraphic Chart.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeneralTimeScale

5.2.2.3.10. GeochronologicEraValue

GeochronologicEraValue (abstract)	
Name:	Geochronologic Era
Definition:	A codelist of recognised geological time units.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	GeochronologicalEraTerm

5.2.2.3.11. GeologicUnitTypeValue

GeologicUnitTypeValue	
Name:	Geologic Unit Type
Definition:	A codelist of terms describing the type of geologic unit.
Description:	EXAMPLE: GeologicUnit, AllostratigraphicUnit etc
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeologicUnitTypeTerm

5.2.2.3.12. GeomorphologicActivityValue

GeomorphologicActivityValue	
Name:	Geomorphologic Activity
Definition:	A codelist of terms indicating the level of activity of a geomorphologic feature.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeomorphologicActivityTerm

5.2.2.3.13. LithologyValue

LithologyValue	
Name:	Lithology
Definition:	A codelist of terms describing the lithology.
Description:	EXAMPLE: granite, sandstone, schist.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/LithologyTerm

5.2.2.3.14. MappingFrameValue

MappingFrameValue	
Name:	Mapping Frame
Definition:	A codelist of terms to indicate the surface on which the MappedFeature is projected.
Status:	Proposed

MappingFrameValue	
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/MappingFrameTerm

5.2.2.3.15. NaturalGeomorphologicFeatureTypeValue

NaturalGeomorphologicFeatureTypeValue	
Name:	Natural Geomorphologic Feature Type
Definition:	A codelist of terms describing the type of natural geomorphologic feature.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/NaturalGeomorphologicalFeatureTypeTerm

5.2.2.3.16. QuaternaryTimeScaleValue

QuaternaryTimeScaleValue	
Name:	Quaternary Time Scale
Subtype of:	GeochronologicEraValue
Definition:	A codelist of recognised Quaternary units
Description:	EXAMPLE: those of the "Global chronostratigraphical correlation table for the last 2.7 million years" produced by the Subcommission on Quaternary Stratigraphy .
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/QuaternaryTimeScale

5.2.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.2.2.4.1. CharacterString

CharacterString	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103 Conceptual Schema Language::ISO 19103:2005 Schema Language::Basic Types::Primitive::Text [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.2. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103 Conceptual Schema Language::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.3. DirectPosition

DirectPosition	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Coordinate geometry [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.4. DocumentCitation

DocumentCitation	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types 2 [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Citation to unambiguously reference a document.

5.2.2.4.5. GM_Object

GM_Object (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometry root [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.6. GM_Point

GM_Point	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.7. GeophObject

GeophObject	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::Geophysics::GeophysicsCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.

5.2.2.4.8. GeophObjectSet

GeophObjectSet	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::Geophysics::GeophysicsCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Generic class for collections of geophysical objects
Description:	It is a set of geophysical objects that are grouped by some common property. p.e: created in the same measuring campaign. GeophObjectSets are used for spatial sampling either by means of data acquisition or data processing. The produced result of a geophObjectSet is always collective, e.g. a map constructed from the results of the individual member objects.

5.2.2.4.9. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.

Identifier	
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.2.2.4.10. Quantity

Quantity	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::OGC::SWE Common Data Model 2.0::Simple Components [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.11. QuantityRange

QuantityRange	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::OGC::SWE Common Data Model 2.0::Simple Components [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.12. SF_SamplingCurve

SF_SamplingCurve	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19156 Observations and Measurements::ISO 19156:2011 Observations and Measurements::Sampling Features::samplingCurve [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.2.2.4.13. codeList

codeList	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19118 Encoding::EncodingRules [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3 Application schema GeophysicsCore

5.3.1 Description

5.3.1.1. Narrative description and UML overview

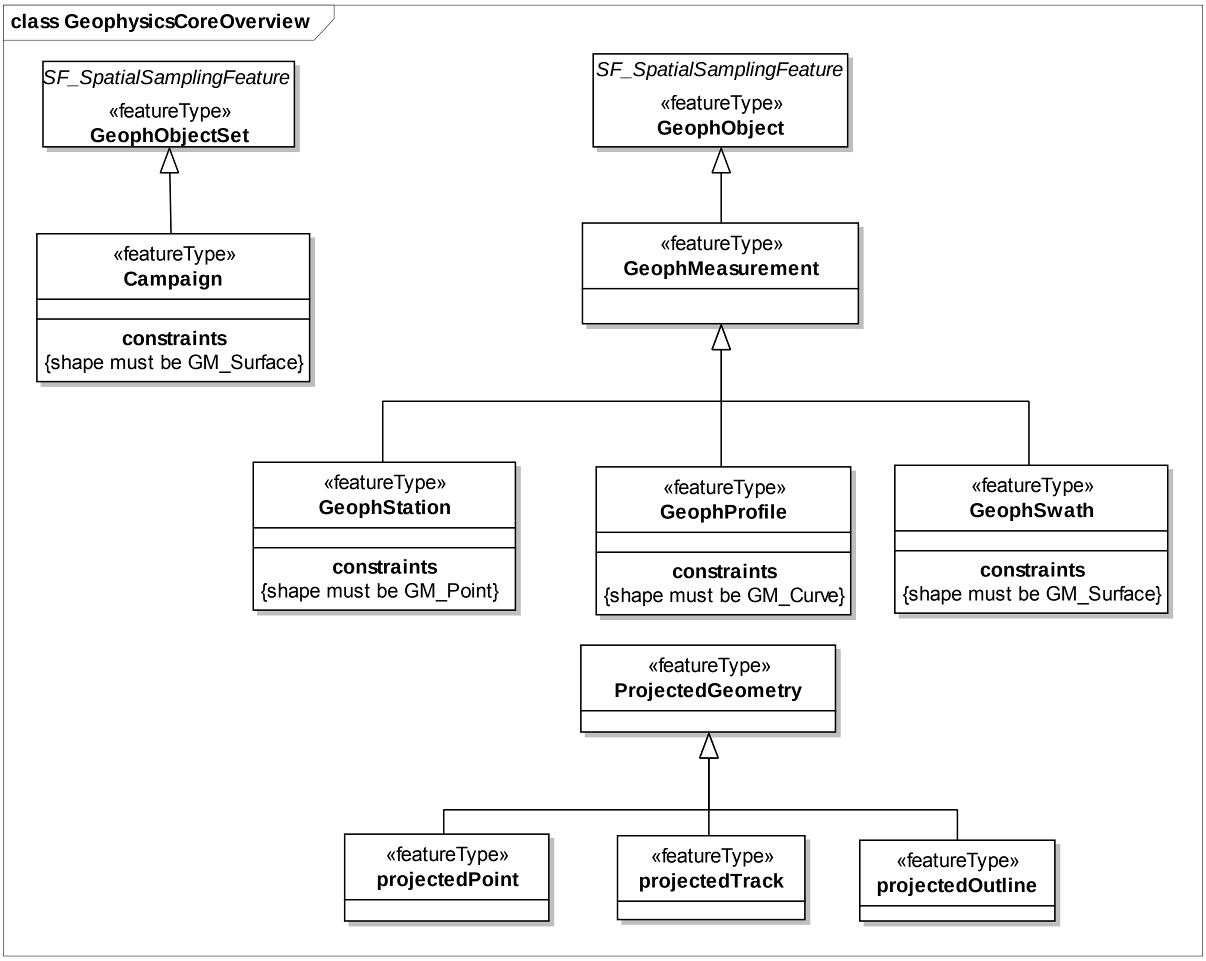

Figure 10 – UML class diagram: Overview of the Geophysics application schema

The core model is designed to fulfill the legal requirements of data provisioning by LMO-s, covering some of the common requirements mainly related to spatial locations and essential metadata of geophysical measurements. The extended model is to demonstrate the extensibility of the core model to address some more specific geophysical information and delivery of observation results.

Fundamental classes are defined in the core model. These are related to the well-known geophysical concepts measurement and survey:

- *GeophMeasurement* is a generic spatial object type that models the field observation procedure with its location, spatial characteristics and related metadata. The related projectedGeometry is necessary when measurement setup is 3 dimensional, to define a 2D geometry for displaying purposes
- *Campaign* is used to document geophysical surveys as measurement campaigns

Both are derived from SF_SpatialSamplingFeature that is a fundamental element of the ISO 19156 Observations and Measurements standard (O&M). Geophysical entities are always used for spatial sampling either by means of data acquisition (measurements) or data processing (models), therefore these are considered as sampling features. To encode the geophysical results of data acquisition and modeling procedures the O&M standard has to be used. At the minimum, in the Geophysics Core application schema, the sampling geometry (shape) shall always be provided. Recommendations and coding examples about the use of O&M, are provided in the guidelines.

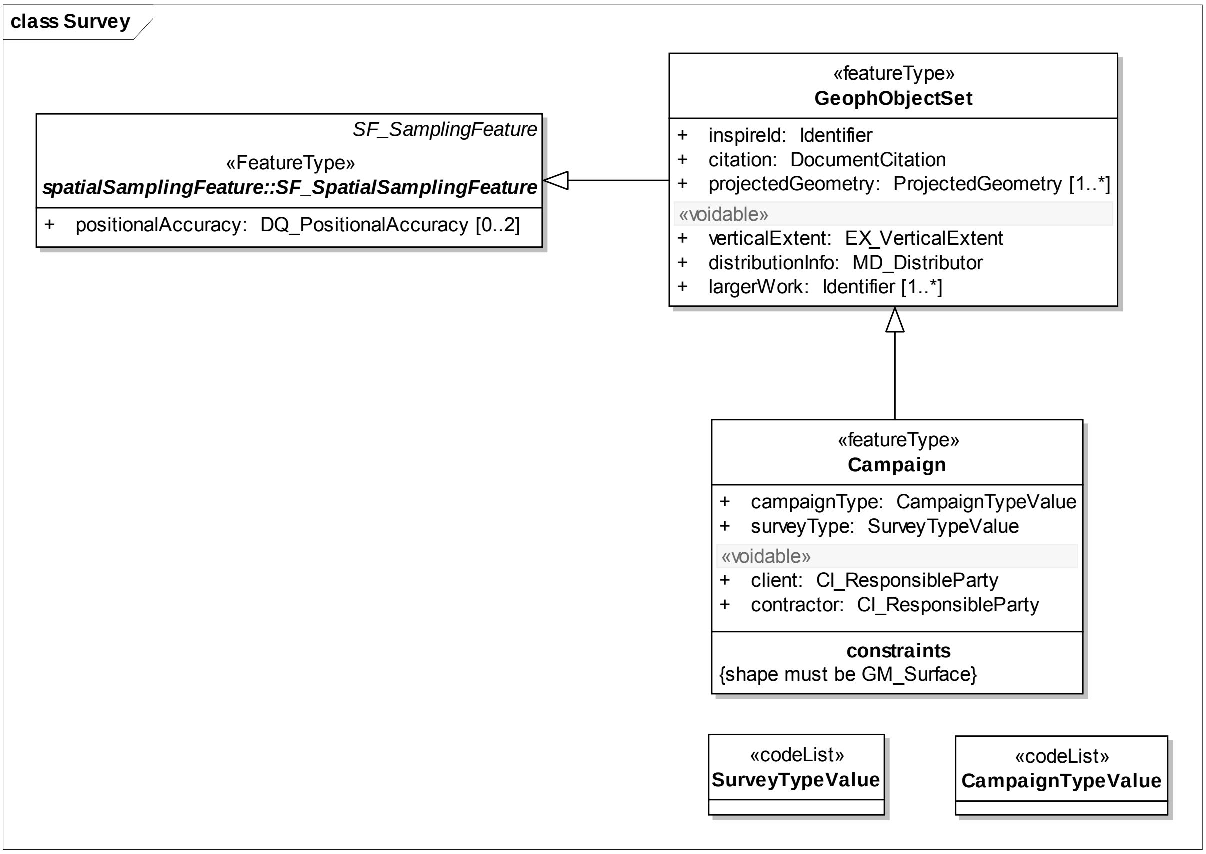

Figure 11 – UML class diagram: Geophysics - Campaign

GeophObjectSet is a generic spatial object type, subclass of SF_SamplingFeature that models geophysical entity collections like campaigns, or projects.

Note: In many cases it is useful to link observation results to collections, rather than to individual geophysical objects (e.g. a gravity map can be associated with a gravity survey and not with a single station). For encoding the O&M standard has to be used. As a minimum the sampling geometry shall always be provided. Recommendations for the use of O&M, and coding examples are provided in the guidelines (please reference D2.9 document).

Campaign is subtype of *GeophObjectSet*. Geophysical activity is usually organized into campaigns and projects. In the core model Campaign is a collective class to document such measuring activities. In the extension model another *GeophObjectSet* subtype, *Project* is also available.

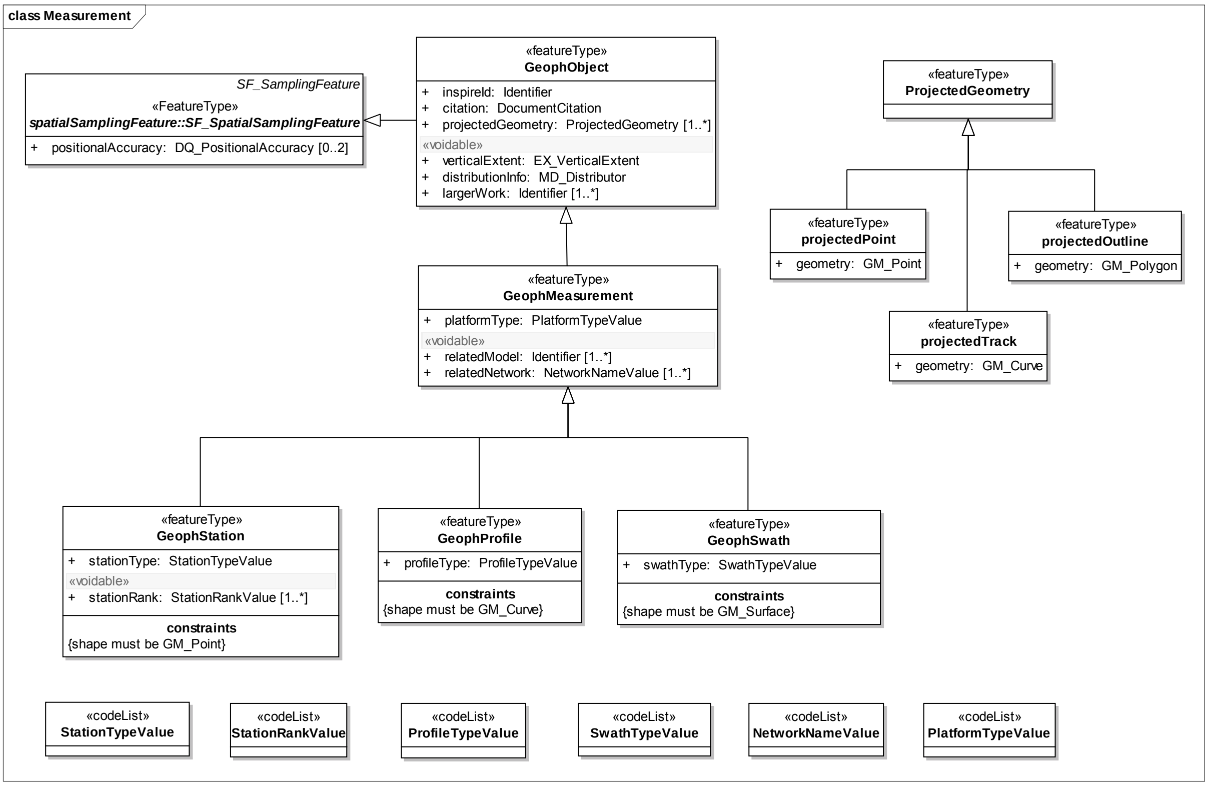

Figure 12 – UML class diagram: Geophysics - Measurement

GeophObject is a generic spatial object type that models single geophysical entities. It has two subtypes: *GeophMeasurement* and *GeophModel.* The later is only available in the GeopysicsExtension application schema.

GeophMeasurement is a generic spatial object type that models the field observation procedure with its location, spatial characteristics and related metadata. In contrast to Geophysical models geophysical measurements collect data outside or on the boundary of the observed spatial domain. In many cases observed data carries the characteristics of the internal organization of the observed domain as a function of some non spatial dimension (time, frequency, electrode distance etc.). It is a matter of processing to transform measured data so that the results overlap with the internal area of the observed domain. The observed property of a measurement is usually a geophysical property that can not be directly interpreted as a property of the observed domain.

In the core model *GeophMeasurement* has three subtypes: *GeophStation, GeophProfile*, and *GeophSwath.*

GeophStations are measurements spatially referenced to a point. They are used to collect data at a single location. The source – sensor setup may be elongated or two dimensional, but the observed data is either zero dimensional or a function of a non spatial parameter, for example time, frequency or electrode spacing. Processed results can be one dimensional (eg. a sounding curve) but it does not change the fact that the original sampling feature geometry is still a point. The type of *GeophStation* is restricted to gravityStation, magneticStation and seismologicalStation.

Note: Exclusion of ordinary survey stations prevents data providers from the obligation of reporting millions of ordinary stations. These shall be reported in a collective manner by using the *Campaign* class.

Constraint: shape must be point geometry. It is equivalent to the center or reference point of the measurement.

*GeophProfile*s are measurements spatially referenced to a curve. They are used to collect data along a curve or a series of points that can either be on the surface or in the 3D space. Observed data is a curve coverage. Range data may contain non dimensional parameters, for example time, frequency. Processed results can be two dimensional (eg. a depth section) but it does not change the fact that the original sampling feature geometry is still a curve. The type of *GeophProfile* is restricted to seismicLine, and boreholeLogging.

Constraint: shape must be curve geometry. It is equivalent to the reference curve of the measurement.

GeophSwath is a geophysical measurement spatially referenced to a surface. Range data may contain non dimensional parameters, for example time, frequency. Processed results are two or three dimensional. Type of *GeophSwath* is restricted to 3DSeismics.

Constraint: shape must be surface geometry. It is equivalent to the reference surface of the measurement.

5.3.1.2. Consistency between spatial data sets

The observation location is specified by its coordinates

5.3.1.3. Identifier management

All geophysical spatial object types shall be identified by an inspireId of type Identifier. It is composed of a local identification code, a codes pace that identifies the naming authority, and an optional version number. Features derived from *GeophMeasurement* usually don't get updated, and for this reason version number is not required. Features derived from *GeophModel* may have several versions as a result of reprocessing. Therefore, version number may be required.

5.3.1.4. Modelling of object references

Using geophysical features object referencing is often required. (eg. largerWork, relatedMeasurement, relatedModel) For internal referencing the Identifier class of the General Concept Model is used. For external referencing the usage of MD_Identifier embedded in citation records is recommended.

5.3.1.5. Geometry representation

IR Requirement 3	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.3.1.6. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanObject" and "endLifespanObject" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 3 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.3.2 Feature catalogue

Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue GeophysicsCore
Scope	GeophysicsCore
Version number	2.9
Version date	2012-04-04
Definition source	INSPIRE data specification GeophysicsCore

Types defined in the feature catalogue

Type	Package	Stereotypes	Section
Campaign	GeophysicsCore	«featureType»	5.3.2.1.1
CampaignTypeValue	GeophysicsCore	«codeList»	5.3.2.2.1
GeophMeasurement	GeophysicsCore	«featureType»	5.3.2.1.2
GeophObject	GeophysicsCore	«featureType»	5.3.2.1.3
GeophObjectSet	GeophysicsCore	«featureType»	5.3.2.1.4
GeophProfile	GeophysicsCore	«featureType»	5.3.2.1.5
GeophStation	GeophysicsCore	«featureType»	5.3.2.1.6
GeophSwath	GeophysicsCore	«featureType»	5.3.2.1.7
NetworkNameValue	GeophysicsCore	«codeList»	5.3.2.2.2
PlatformTypeValue	GeophysicsCore	«codeList»	5.3.2.2.3
ProfileTypeValue	GeophysicsCore	«codeList»	5.3.2.2.4
ProjectedGeometry	GeophysicsCore	«featureType»	5.3.2.1.8
StationRankValue	GeophysicsCore	«codeList»	5.3.2.2.5
StationTypeValue	GeophysicsCore	«codeList»	5.3.2.2.6
SurveyTypeValue	GeophysicsCore	«codeList»	5.3.2.2.7
SwathTypeValue	GeophysicsCore	«codeList»	5.3.2.2.8
projectedOutline	GeophysicsCore	«featureType»	5.3.2.1.9
projectedPoint	GeophysicsCore	«featureType»	5.3.2.1.10
projectedTrack	GeophysicsCore	«featureType»	5.3.2.1.11

5.3.2.1. Spatial object types

5.3.2.1.1. Campaign

Campaign	
Name:	Campaign
Subtype of:	GeophObjectSet
Definition:	Geophysical activity extending over a limited time range and limited area for producing similar geophysical measurements, processing results or models.
Description:	Campaigns can be considered as parents of geophysical measurements or models. Children may refer to parent campaigns through the largerWork identifier.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: campaignType	
Value type:	CampaignTypeValue
Definition:	Type of activity to produce data
Description:	Value shall be one of the items defined in codelist CampaignTypeValue
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: surveyType	
Value type:	SurveyTypeValue
Definition:	Type of geophysical survey
Description:	The geophysical method is specified by this attribute. Value shall be one of the items defined in codelist SurveyTypeValue.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: client	
Value type:	CI_ResponsibleParty
Definition:	Party to which data was created
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: contractor	
Value type:	CI_ResponsibleParty
Definition:	Party by which data was created
Description:	Party responsible for creating the data related to the campaign
Multiplicity:	1
Stereotypes:	«voidable»
Constraint: shape must be GM_Surface	
Natural language:	shape must be GM_Surface
OCL:	inv: shape.oclIsKindOf(GM_Surface)

5.3.2.1.2. GeophMeasurement

GeophMeasurement	
Name:	Geoph Measurement
Subtype of:	GeophObject
Definition:	Generic feature for geophysical measurements.
Description:	Geophysical measurements collect data outside or on the boundary of the observed spatial domain.

GeophMeasurement	
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: relatedModel	
Value type:	Identifier
Definition:	Identifier of the geophysical model that was created from the measurement
Description:	Results of the measurement can be referenced by these identifiers.
Multiplicity:	1..*
Stereotypes:	«voidable»
Attribute: platformType	
Value type:	PlatformTypeValue
Definition:	platform from which the measurement was carried out
Description:	Values to be used are defined in codelist PlatformTypeValue.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: relatedNetwork	
Value type:	NetworkNameValue
Definition:	Name of a national or international observation network to which the facility belongs, or to which measured data is reported.
Description:	Permanent measuring installations maz be part of larger observation networks. It means that observation data is regularly sent to the archives of the related network in an official way.
Multiplicity:	1..*
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

5.3.2.1.3. GeophObject

GeophObject	
Name:	Geoph Object
Subtype of:	SF_SpatialSamplingFeature
Definition:	Generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: inspireId	
Value type:	Identifier
Definition:	External object identifier of the measurement.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1
Attribute: citation	
Value type:	DocumentCitation
Definition:	Citation of geophysical documentation
Description:	Used for title, date of related documentation and URL for online access. At the minimum a short name (title) shall be given.

GeophObject

Multiplicity: 1

Attribute: projectedGeometry

Value type:	ProjectedGeometry
Definition:	2D projection of the feature to the ground surface. This is going to be used by WMS to display the feature location
Description:	When measurement setup is 3 dimensional, it is necessary to define a 2D geometry for displaying purposes. It shall be the 2D projection of the spatial object on the ground surface. Allowed types: point, track and outline. Examples: projected geometry of a borehole logging measurement is a point coincident with the borehole collar location. Projected geometry of a 3D multielectrode DC measurement is a polygon
Multiplicity:	1..*

Attribute: verticalExtent

Value type:	EX_VerticalExtent
Definition:	Vertical extent of the range of interest.
Description:	This parameter serves discovery purposes. It may refer both to the vertical extent of the measurement setup (p.e. borehole logging) or the extent of the range where processed data is spatially referenced to (Vertical Electric Sounding). The aim is to give an idea to the user about the estimated depth of investigation.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: distributionInfo

Value type:	MD_Distributor
Definition:	Distribution metadata
Description:	Data providers may use external services to provide information on a geophysical measurement. Links to the access points, description of ordering procedures or external services can be added in distributionInfo, that is an ISO MD_Distributor record.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: largerWork

Value type:	Identifier
Definition:	Identifier of a larger work dataset, tipically a campaign or project
Description:	Measurements are usually made in campaigns. The largerWork identifier points to the parent Campaign or Project
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.4. GeophObjectSet

GeophObjectSet

Name:	Geoph Object Set
Subtype of:	SF_SpatialSamplingFeature
Definition:	Generic class for collections of geophysical objects
Description:	It is a set of geophysical objects that are grouped by some common property. p.e: created in the same measuring campaign. GeophObjectSets are used for spatial sampling either by means of data acquisition or data processing. The produced result of a geophObjectSet is always collective, e.g. a map constructed from the results of the individual member objects.
Status:	Proposed
Stereotypes:	«featureType»

GeophObjectSet

Identifier: null

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the measurement.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: citation

Value type:	DocumentCitation
Definition:	Citation of geophysical documentation
Description:	Used for title, date of related documentation and URL for online access. At the minimum a short name (title) shall be given.
Multiplicity:	1

Attribute: verticalExtent

Value type:	EX_VerticalExtent
Definition:	Vertical extent of the range of interest.
Description:	This parameter serves discovery purposes. It may refer both to the vertical extent of the setup of measurements within the survey, or the extent of the range where processed data is spatially referenced to (estimated depth of investigation). The aim is to give an idea to the user about the estimated depth of investigation.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: distributionInfo

Value type:	MD_Distributor
Definition:	Distribution metadata
Description:	Data providers may use external services to provide access to data or information on a survey. Links to the access points, description of ordering procedures, fees can be added in distributionInfo that is an ISO MD_Distributor record.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: projectedGeometry

Value type:	ProjectedGeometry
Definition:	2D projection of the feature to the ground surface. This is going to be used by WMS to display the feature on a map
Description:	Projected geometry of the object set (survey), that is usually the bounding polygon of the working area.
Multiplicity:	1..*

Attribute: largerWork

Value type:	Identifier
Definition:	Identifier of a larger work dataset
Description:	The largerWork identifier points to the parent Campaign or Project
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.5. GeophProfile

GeophProfile

GeophProfile	
Name:	Geoph Profile
Subtype of:	GeophMeasurement
Definition:	Geophysical measurement spatially referenced to a curve
Description:	Used to collect data along a curve. Examples: 2D seismic line (field measurement), borehole logging, airborne geophysical flight line NOTE1. Processing results of geophProfiles are often vertical surface coverages
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: profileType	
Value type:	ProfileTypeValue
Definition:	Type of geophysical profile
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Constraint: shape must be GM_Curve	
Natural language:	shape must be GM_Curve
OCL:	inv: shape.oclIsKindOf(GM_Curve)

5.3.2.1.6. GeophStation

GeophStation	
Name:	Geoph Station
Subtype of:	GeophMeasurement
Definition:	Geophysical measurement spatially referenced to a single point location
Description:	Used to collect data at a single location. The source-sensor setup may be elongated or two dimensional, but the collected data is spatially referenced to a single point. Example: Gravity station, Magnetic station NOTE 1. Processing results of geophStations are often vertical curve coverages
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: stationType	
Value type:	StationTypeValue
Definition:	Type of geophysical station
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: stationRank	
Value type:	StationRankValue
Definition:	Geophysical stations may be part of a hierarchical system. Rank is proportional to the importance of a station
Description:	Significance of stations can be very different even for the same geophysical method. Rank maz take the following values: 1stOrderBase, 2ndOrderBase, secularStation, observatory. Base stations are used to tie local measurements to higher level networks. Secular stations are visited from time to time to detect long term temporal changes of physical parameters. Observatories are important facilities that collect data continuously, or on a regular basis.
Multiplicity:	1..*
Stereotypes:	«voidable»

GeophStation

Obligation: Implementing Rule (requirement)

Constraint: shape must be GM_Point

Natural language: shape must be GM_Point
OCL: inv: shape.oclIsKindOf(GM_Point)

5.3.2.1.7. GeophSwath

GeophSwath

Name: Geoph Swath
Subtype of: GeophMeasurement
Definition: Geophysical measurement spatially referenced to a surface
Description: Used to collect data over a surface. Example: 3D seismic swath

NOTE1. Processing results of geophSwaths can be both surface and solid coverages
Status: Proposed
Stereotypes: «featureType»
Identifier: null

Attribute: swathType

Value type: SwathTypeValue
Definition: Type of geophysical swath
Multiplicity: 1
Obligation: Implementing Rule (requirement)

Constraint: shape must be GM_Surface

Natural language: shape must be GM_Surface
OCL: inv: shape.oclIsKindOf(GM_Surface)

5.3.2.1.8. ProjectedGeometry

ProjectedGeometry

Name: Projected Geometry
Definition: 2D projection of the feature to the ground surface. This is going to be used by WMS to display the feature location
Status: Proposed
Stereotypes: «featureType»
Identifier: null

5.3.2.1.9. projectedOutline

projectedOutline

Name: projected Outline
Subtype of: ProjectedGeometry
Definition: Representative bounding polygon of the related geophysical object or object set.
Status: Proposed
Stereotypes: «featureType»
Identifier: null

Attribute: geometry

Value type: GM_Polygon
Definition: Polygon geometry to be displayed on a map
Multiplicity: 1

5.3.2.1.10. projectedPoint

projectedPoint	
Name:	projected Point
Subtype of:	ProjectedGeometry
Definition:	representative point of the related geophysical object
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: geometry	
Value type:	GM_Point
Definition:	Point geometry to be displayed on a map
Multiplicity:	1

5.3.2.1.11. projectedTrack

projectedTrack	
Name:	projected Track
Subtype of:	ProjectedGeometry
Definition:	Representative curve of the related geophysical object.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: geometry	
Value type:	GM_Curve
Definition:	Curve geometry to be displayed on a map.
Multiplicity:	1

5.3.2.2. Code lists

5.3.2.2.1. CampaignTypeValue

CampaignTypeValue	
Name:	Campaign Type
Definition:	Type of geophysical campaign
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/CampaignTypeValue

5.3.2.2.2. NetworkNameValue

NetworkNameValue	
Name:	Network Name
Definition:	Name of geophysical network
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/NetworkNameValue

5.3.2.2.3. PlatformTypeValue

PlatformTypeValue	
Name:	Platform Type
Definition:	Platform on which data acquisision was carried out
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/PlatformTypeValue

5.3.2.2.4. ProfileTypeValue

ProfileTypeValue	
Name:	Profile Type
Definition:	Type of geophysical profile
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/ProfileTypeValue

5.3.2.2.5. StationRankValue

StationRankValue	
Name:	Station Rank
Definition:	Rank of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/StationRankValue

5.3.2.2.6. StationTypeValue

StationTypeValue	
Name:	Station Type
Definition:	Type of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/StationTypeValue

5.3.2.2.7. SurveyTypeValue

SurveyTypeValue	
Name:	Survey Type
Definition:	Type of geophysical survey or dataset

SurveyTypeValue	
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/SurveyTypeValue

5.3.2.2.8. SwathTypeValue

SwathTypeValue	
Name:	Swath Type
Definition:	Type of geophysical swath
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/SwathTypeValue

5.3.2.3. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.3.2.3.1. CI_ResponsibleParty

CI_ResponsibleParty	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115-All Metadata::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.2. DocumentCitation

DocumentCitation	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types 2 [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Citation to unambiguously reference a document.

5.3.2.3.3. EX_VerticalExtent

EX_VerticalExtent	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115-All Metadata::ISO 19115:2006 Metadata (Corrigendum)::Extent information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.4. GM_Curve

GM_Curve	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.5. GM_Point

GM_Point	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.6. GM_Polygon

GM_Polygon	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Coordinate geometry [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.7. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.3.2.3.8. MD_Distributor

MD_Distributor	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115-All Metadata::ISO 19115:2006 Metadata (Corrigendum)::Distribution information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.3.2.3.9. SF_SpatialSamplingFeature

SF_SpatialSamplingFeature (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19156 Observations and Measurements::ISO 19156:2011 Observations and Measurements::Sampling Features::spatialSamplingFeature [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4 Application schema HydrogeologyCore

5.4.1 Description

5.4.1.1. Narrative description and UML overview

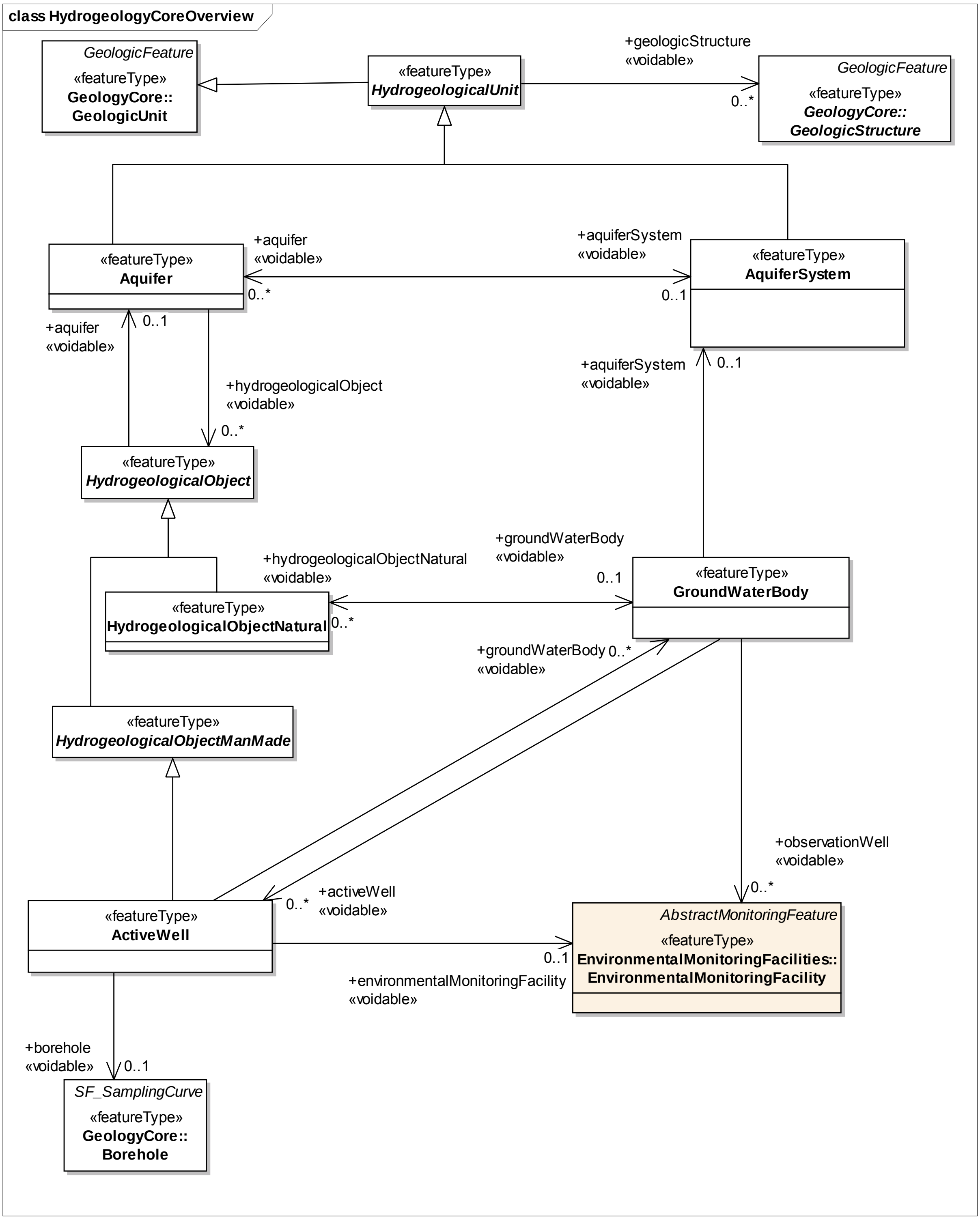

Figure 13 – UML class diagram: Overview of the HydrogeologicalCore application schema

The INSPIRE model for groundwater identifies two basic elements: the **'rock' system** or aquifer system (invariable in time) containing hydrogeological units, classified as aquifers, aquitards and aquicludes and the **'groundwater' system** with groundwater bodies (variable in time). Hydrogeological objects (man-made and natural objects such as groundwater wells and springs) interact with these domains of the 'rock' system and the 'groundwater' system. The 'rock' system and the 'groundwater' system and the interaction between them create a hydrogeological system. The principal aim of the core model is to capture the main classes of these systems and to provide the logical links between them. The **'groundwater' system** is created by groundwater flow in aquifers of the **'rock' system**, which have the right porosity and permeability to conduct groundwater. The **'groundwater' system** has distinct groundwater flow properties and a distinct pressure regime and is confined by permeability, groundwater surface or other barriers in the subsurface.

The hydrogeology core model provides the classes of the 'rock' system and the 'groundwater' system and the links between them and also the interaction of these systems with man-made facilities and natural features. Like the Geology core model the suggested Hydrogeology core model represents a more static approach aimed at providing hydrogeological maps on a regional or national scale (1 : 50.000 or smaller). Dynamic groundwater models and the dynamic flow of groundwater are out of scope of the core model, as these are mostly available only for large scales (maybe up to 1:10.000) through more detailed groundwater modelling approaches.

Also out of scope are detailed measurements on the quality and chemical composition of groundwater and time series measurements of groundwater level within groundwater wells. For these types of measurements the use of the WaterML 2.0 specification is recommended. WaterML2.0 is an open standard for exchanging in-situ water observations data. It is based on Observations and Measurements version 2.0 (O&M) and implemented as an application schema according to the rules of Geography Markup Language version 3.2 (GML). The core aspect of the model is in the correct, precise description of time series.

The 'Rock' system

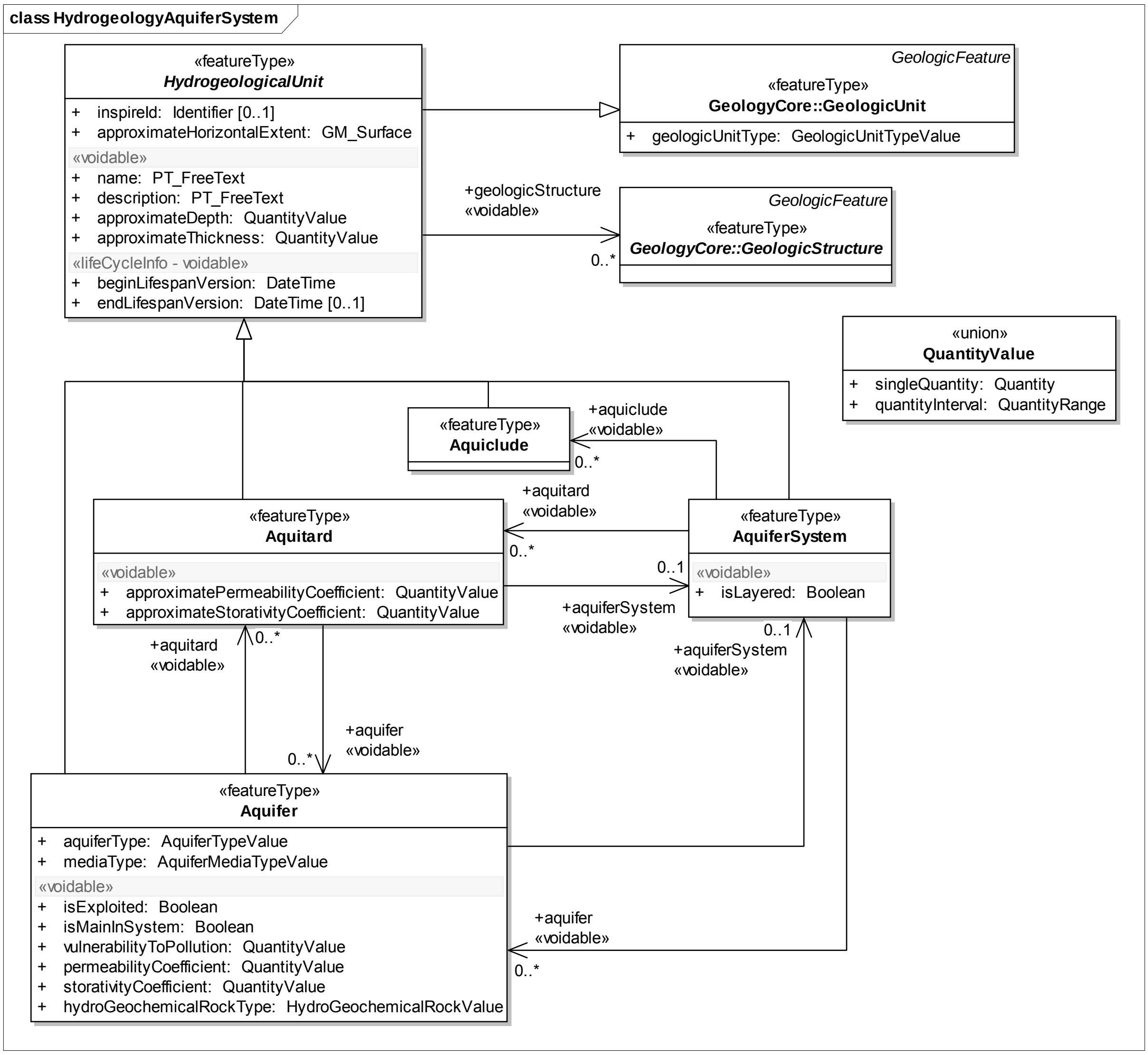

Figure 14 – UML class diagram: HydrogeologicalCore – the Aquifer System

The 'Rock' system has 1 main class, *HydrogeologicalUnit,* with a number of important subclasses. A *HydrogeologicalUnit* is a part of the lithosphere with distinctive parameters for water storage and conduction, and is a specialisation of GeologicUnit.

There are four important subclasses of *HydrogeologicalUnit*: *Aquifer*, *Aquitard, Aquiclude and AquiferSystem*. An *Aquifer* is a wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted by a groundwater well.

An *Aquitard* is a saturated, but poorly permeable bed that impedes groundwater movement and does not yield water freely to wells, but which may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important groundwater storage unit.

An *Aquiclude* is a *HydrogeologicalUnit* that due to its low permeability can act as a barrier to groundwater flow and as such often confines aquifers or aquifer systems.

An *AquiferSystem* is a collection of Aquifers and/or Aquitards which together constitute the environment of groundwater - "communicating vessels" that are filled or can be filled with groundwater i.e. a GroundWaterBody.

An *AquiferSystem* may contain one or more *Aquifers, Aquitards* and *Aquicludes .*

The 'Hydrogeology' system

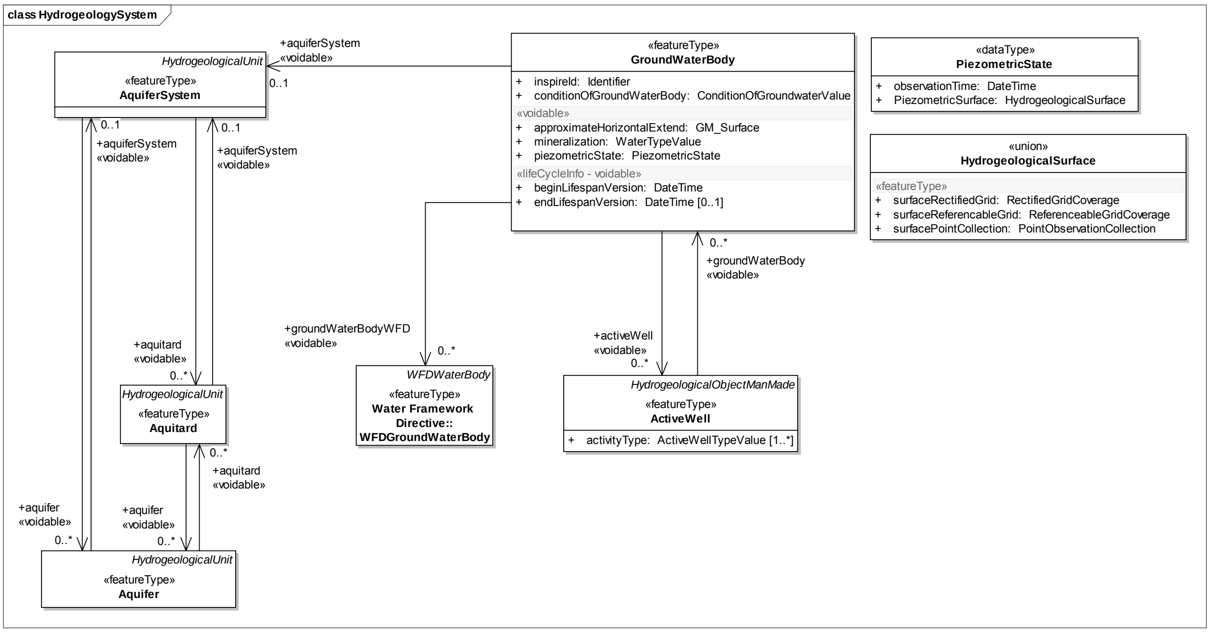

Figure 15 – UML class diagram: HydrogeologicalCore – the Groundwater system

The hydrogeological system is formed by the interaction of the groundwater system and the rock system.
The main class of the the groundwater system is *GroundWaterBody.*
A *GroundWaterBody* is a distinct volume of groundwater within an aquifer or system of aquifers, which is hydraulically isolated from nearby groundwater bodies. The *piezometricState* property of a *GroundWaterBody,* which specifies the piezometric state of the groundwater body water table, is modelled in a separate class *PiezometricState.*

WFD_GroundWaterBody is a distinct volume of groundwater within a groundwater flow system, which is used as a reporting or management unit within the Water Framework Directive (WFD). This class is is a special case of a WFDWaterBody, which is imported from the Area Management (AM) application schema. The relationship to the GroundWaterBody is modeled through two associations (i.e. every WFDGroundWaterBody may be based on mulitiple GroundWaterBodies and the other way around).

GroundWaterBody interacts with the 'rock' system through an association with *AquiferSystem.*

Hydrogeological objects

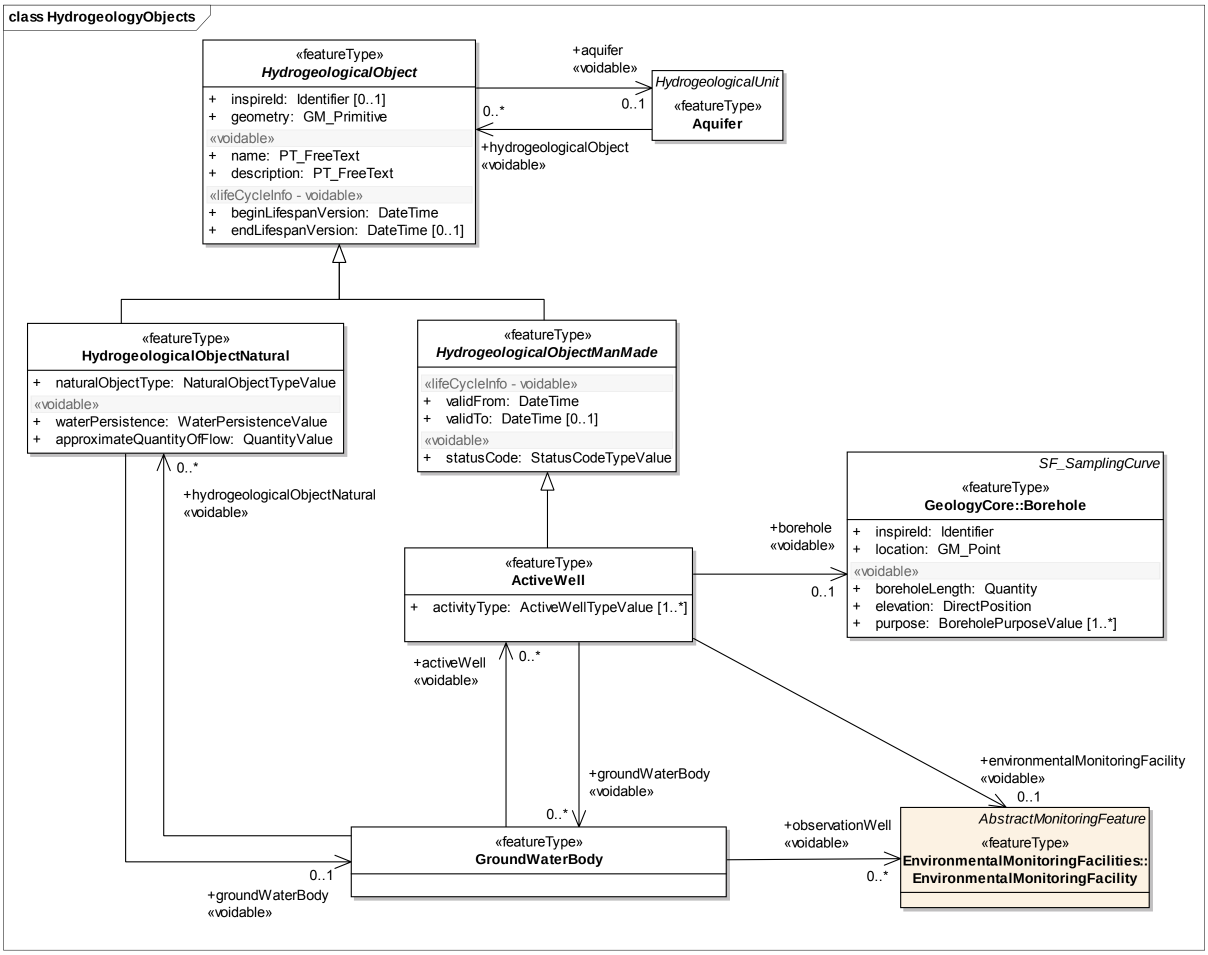

Figure 16 – UML class diagram: HydrogeologicalCore – the Hydrogeological Objects

HydrogeologicalObject is an abstract class for man-made or natural objects where interaction occurs with the hydrogeological system. *HydrogeologicalObject* has two subclasses *HydrogeologicalObjectManMade and HydrogeologicalObjectNatural*

HydrogeologicalObjectManMade is an abstract class for a manmade facility, where interaction occurs with the hydrogeological system.

An *ActiveWell* is the only type of *HydrogeologicalObjectManMade* defined in the application schema. It is an excavation or opening into the ground where the intended use is for location, acquisition, development, or artificial recharge of ground water. The association from *GroundwaterWell* to *Borehole* allows the *GroundwaterWell* to be associated with a particular Borehole. Where there is an associated *Borehole* the geometry should be taken from *Borehole* rather than from *HydrogeologicalObject*.

ActiveWell has a bidirectional associations to a *GroundWaterBody* to describe the interaction between these wells and a groundwater body.

HydrogeologicalObjectNatural is the type of *HydrogeologicalObject* for natural objects where interaction (inflow or outflow) occurs with the hydrogeological system.

Like *ActiveWell* and *ObservationWell, HydrogeologicalObjectNatural* has bidirectional associations to a *GroundWaterBody* to describe the interaction between a type of natural hydrogeological object and a groundwater body.

5.4.1.2. Consistency between spatial data sets

The observation location is specified by its coordinates.

5.4.1.3. Identifier management

There is no specific requirement to manage identifiers.

5.4.1.4. Geometry representation

IR Requirement 4	The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.4.1.5. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attribute "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 4	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.4.2 Feature catalogue

Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue HydrogeologyCore
Scope	HydrogeologyCore
Version number	2.9
Version date	2012-06-29
Definition source	INSPIRE data specification HydrogeologyCore

Types defined in the feature catalogue

Type	Package	Stereotypes	Section
ActiveWell	HydrogeologyCore	«featureType»	5.2.2.1.1
ActiveWellTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.1
Aquiclude	HydrogeologyCore	«featureType»	5.2.2.1.2
Aquifer	HydrogeologyCore	«featureType»	5.2.2.1.3
AquiferMediaTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.2
AquiferSystem	HydrogeologyCore	«featureType»	5.2.2.1.4
AquiferTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.3
Aquitard	HydrogeologyCore	«featureType»	5.2.2.1.5
ConditionOfGroundwaterValue	HydrogeologyCore	«codeList»	5.2.2.3.4
GroundWaterBody	HydrogeologyCore	«featureType»	5.2.2.1.6
HydroGeochemicalRockValue	HydrogeologyCore	«codeList»	5.2.2.3.5
HydrogeologicalObject	HydrogeologyCore	«featureType»	5.2.2.1.7
HydrogeologicalObjectManMade	HydrogeologyCore	«featureType»	5.2.2.1.8
HydrogeologicalObjectNatural	HydrogeologyCore	«featureType»	5.2.2.1.9
HydrogeologicalSurface	HydrogeologyCore	«union»	5.2.2.2.1
HydrogeologicalUnit	HydrogeologyCore	«featureType»	5.2.2.1.10
NaturalObjectTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.6
PiezometricState	HydrogeologyCore	«dataType»	5.2.2.2.2
QuantityValue	HydrogeologyCore	«union»	5.2.2.2.3
StatusCodeTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.7
WaterPersistenceValue	HydrogeologyCore	«codeList»	5.2.2.3.8
WaterTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.9
WellObservationTypeValue	HydrogeologyCore	«codeList»	5.2.2.3.10

5.4.2.1. Spatial object types

5.4.2.1.1. ActiveWell

ActiveWell	
Name:	Active Well
Subtype of:	HydrogeologicalObjectManMade
Definition:	A well influencing the groundwater resources of the aquifer.
Description:	The most common examples of Active Well are: extracting, artificial recharging, or dewatering wells. NOTE: ActiveWell by extracting, recharging or dewatering influences and changes the state of groundwater resources.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: activityType	
Name	Active Well Type
Value type:	ActiveWellTypeValue
Definition:	The type of activity carried out by the well.

ActiveWell

Description:	Indicates if the well is used for extracting, recharging, dewatering etc of the groundwater resources.
Multiplicity:	1..*
Obligation:	Implementing Rule (requirement)

Association role: borehole

Value type:	Borehole
Definition:	The Borehole upon which the GroundWaterWell is based.
Multiplicity:	0..1
Stereotypes:	«voidable»

Association role: groundWaterBody

Value type:	GroundWaterBody
Definition:	The GroundWaterBody the ActiveWell extracts groundwater resources from.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: environmentalMonitoringFacility

Value type:	EnvironmentalMonitoringFacility
Definition:	The related EnvironmentalMonitoringFacility.
Description:	Groundwater ObservationWell is a monitoring object.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.2. Aquiclude

Aquiclude

Name:	Aquiclude
Subtype of:	HydrogeologicalUnit
Definition:	An impermeable body of rock or stratum of sediment that acts as a barrier to the flow of groundwater.
Description:	A formation which, although porous and capable of absorbing water slowly, will not transmit water fast enough to furnish an appreciable supply for a well or spring. Aquicludes are characterized by very low values of "leakage" (the ratio of vertical *Hydraulic Conductivity* to thickness), so that they transmit only minor inter-aquifer flow and also have very low rates of yield from compressible storage. Therefore, they constitute boundaries of aquifer flow systems.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

5.4.2.1.3. Aquifer

Aquifer

Name:	Aquifer
Subtype of:	HydrogeologicalUnit
Definition:	A wet underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well.
Description:	An underground geological formation able to store and yield water.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: aquiferType

Name	Type of Aquifer

Aquifer

Value type:	AquiferTypeValue
Definition:	The type of aquifer.
Description:	Water in an Aquifer is, or is not, under pressure. Based on that unconfined, confined, artesian, or subartesian types are distinguished.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

Attribute: hydroGeochemicalRockType

Name	Hydrogeochemical Type of Rock
Value type:	HydroGeochemicalRockValue
Definition:	The rock type with respect to the soluble rock components and their hydrogeochemical influence of groundwater.
Description:	Defines the prevailing geochemical character of natural groundwater within the Aquifer.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: isExploited

Name	Is Exploited
Value type:	Boolean
Definition:	Indicates if groundwater from aquifer is exploited by wells or intakes
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: isMainInSystem

Name	Is Main In System
Value type:	Boolean
Definition:	Indicates if aquifer is the main useful aquifer in the aquifer system
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: mediaType

Name	Type of Media
Value type:	AquiferMediaTypeValue
Definition:	The classification of the medium in which the groundwater flow occurs..
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

Attribute: permeabilityCoefficient

Name	Permeability Coefficient
Value type:	QuantityValue
Definition:	The volume of an incompressible fluid that will flow in unit time through a unit cube of a porous substance across which a unit pressure difference is maintained.
Description:	The parameter represents the hydraulic conductivity of a rock container. Describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation. NOTE: Because of their high porosity and permeability, sand and gravel have higher hydraulic conductivity than clay or unfractured granite aquifers.
Multiplicity:	1
Stereotypes:	«voidable»

Aquifer

Attribute: storativityCoefficient

Name	Storativity Coefficient
Value type:	QuantityValue
Definition:	The ability of an aquifer to store water.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: vulnerabilityToPollution

Name	Vulnerability To Pollution
Value type:	QuantityValue
Definition:	DRASTIC index value or interval of values determining the potential degree of aquifer risk arising from the geological structure, hydrogeological conditions and the existence of real or potential source of contamination.
Description:	A single value should be used if it is determined directly from the DRASTIC method. If attribute data comes from another data source which is expressed by categorized items, for example: low, moderate or high, interval should be used expressed by lowest and highest value of category. EXAMPLE: 'Moderate' means interval from 101 to 140.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: aquitard

Value type:	Aquitard
Definition:	The Aquitard(s) that separates the Aquifer.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: hydrogeologicalObject

Value type:	HydrogeologicalObject
Definition:	The HydrogeologicalObject(s) related to the aquifer.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: aquiferSystem

Value type:	AquiferSystem
Definition:	The specific AquiferSystem where the Aquitard occurs.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.4. AquiferSystem

AquiferSystem

Name:	Aquifer System
Subtype of:	HydrogeologicalUnit
Definition:	A collection of aquifers and aquitards, which together constitute the environment of groundwater - "communicating vessels", that are filled or can be filled with water.
Description:	Attributes of Aquifer System and its components determine the feasibility of water collection, its movement, as well as the impact on its chemical state. NOTE: The Aquifer System components and their attributes (including geometry) are relatively stable over time except in special cases.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

AquiferSystem

Attribute: isLayered

Name	Is Layered
Value type:	Boolean
Definition:	Indicates if the AquiferSystem consists of more than one layer.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: aquitard

Value type:	Aquitard
Definition:	The Aquitard(s) contained within the AquiferSystem.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: aquiclude

Value type:	Aquiclude
Definition:	An Aquiclude enclosing the AquiferSystem.
Description:	This acts as a barrier for groundwater flow.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: aquifer

Value type:	Aquifer
Definition:	The Aquifer(s) contained in the AquiferSystem.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.1.5. Aquitard

Aquitard

Name:	Aquitard
Subtype of:	HydrogeologicalUnit
Definition:	A saturated, but poorly permeable bed that impedes ground-water movement.
Description:	It does not yield water freely to wells, but may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important ground-water storage unit. Aquitards are characterized by values of leakance that may range from relatively low to relatively high. A really extensive aquitard of relatively low leakance may function regionally as boundaries of aquifer flow systems.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: approximatePermeabilityCoefficient

Name	Approximate Permeability Coefficient
Value type:	QuantityValue
Definition:	The volume of an incompressible fluid that will flow in unit time through a unit cube of a porous substance across which a unit pressure difference is maintained.
Description:	The parameter represents the hydraulic conductivity of a rock container. Describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation. NOTE: Because of their high porosity and permeability, sand and gravel have higher hydraulic conductivity than clay or unfractured granite aquifers.

Aquitard

Multiplicity:	1
Stereotypes:	«voidable»

Attribute: approximateStorativityCoefficient

Name	Approximate Storativity Coefficient
Value type:	QuantityValue
Definition:	The ability of an aquifer to store water.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: aquiferSystem

Value type:	AquiferSystem
Definition:	The AquiferSystem the Aquitard is part of.
Multiplicity:	0..1
Stereotypes:	«voidable»

Association role: aquifer

Value type:	Aquifer
Definition:	The Aquifers separated by the Aquitard.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.1.6. GroundWaterBody

GroundWaterBody

Name:	Groundwater Body
Definition:	A distinct volume of groundwater within an aquifer or system of aquifers, which is hydraulically isolated from nearby groundwater bodies.
Description:	Groundwater bodies form the principal management units under the European Water Framework Directive (2000/60/CE, 2000). They should be hydraulically continuous entities, and must be defined on the basis of flow or abstraction, and are inextricably linked to surface water bodies.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: approximateHorizontalExtend

Name	Approximate Horizontal Extend
Value type:	GM_Surface
Definition:	The geometry defining the boundary of the GroundWaterBody.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: beginLifespanVersion

Name	Begin Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»

Attribute: conditionOfGroundWaterBody

Name	Condition of Groundwater Body
Value type:	ConditionOfGroundwaterValue

GroundWaterBody

Definition:	The approximate degree of change to groundwater as a result of human activity.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)

Attribute: endLifespanVersion

Name	End Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»

Attribute: inspireId

Name	INSPIRE Identifier
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE: An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: mineralization

Name	Water Type
Value type:	WaterTypeValue
Definition:	One of the main chemical characteristics of water. A value is a sum of all water chemical concentration components.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: piezometricState

Name	Piezometric State
Value type:	PiezometricState
Definition:	Specifies the piezometric state of the GroundwaterBody water table
Multiplicity:	1
Stereotypes:	«voidable»

Association role: groundWaterBodyWFD

Value type:	WFDGroundWaterBody
Definition:	The WFDGroundWaterBody to which the natural GroundWaterBody is related.
Description:	Based on the different assumptions established in Member States the delineation of a WFDGroundWaterBody boundary can differ from the natural GroundWaterBody extent.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: activeWell

Value type:	ActiveWell
Definition:	The ActiveWell changing the state of the GroundwaterBody through extracting groundwater resources.
Description:	ActiveWell by extracting groundwater resources influences the state of GroundWaterBody resources it is installed in.
Multiplicity:	0..*

GroundWaterBody

Stereotypes: «voidable»

Association role: aquiferSystem

Value type: AquiferSystem
Definition: The AquiferSystem the GroundWaterBody is contained within.
Multiplicity: 0..1
Stereotypes: «voidable»

Association role: hydrogeologicalObjectNatural

Value type: HydrogeologicalObjectNatural
Definition: A HydrogeologicalObjectNatural with which the GroundwaterBody is associated.
Multiplicity: 0..*
Stereotypes: «voidable»

Association role: observationWell

Value type: EnvironmentalMonitoringFacility
Definition: The observation wells which monitor the GroundWaterBody
Multiplicity: 0..*
Stereotypes: «voidable»

5.4.2.1.7. HydrogeologicalObject

HydrogeologicalObject (abstract)

Name: Hydrogeological Object
Definition: An abstract class for man-made facilities or natural features that have an interaction with the hydrogeological system.
Description: Hydrogeological objects may be natural (eg. spring) or the manmade (eg. wells). The vast majority of hydrogeological objects are manmade.
Status: Proposed
Stereotypes: «featureType»
Identifier: null

Attribute: beginLifespanVersion

Name Begin Life Span Version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «lifeCycleInfo - voidable»

Attribute: description

Name Description
Value type: PT_FreeText
Definition: The description of the HydrogeologicalObject.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: endLifespanVersion

Name End Life Span Version
Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «lifeCycleInfo - voidable»

HydrogeologicalObject (abstract)

Attribute: geometry

Name	Geometry
Value type:	GM_Primitive
Definition:	The geometry defining the spatial location of the HydrogeologicalObject.
Multiplicity:	1

Attribute: inspireId

Name	INSPIRE Identifier
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	0..1

Attribute: name

Name	Name
Value type:	PT_FreeText
Definition:	The name or code of the HydrogeologicalObject.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: aquifer

Value type:	Aquifer
Definition:	The Aquifer within which the HydrogeologicalObject occurs.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.8. HydrogeologicalObjectManMade

HydrogeologicalObjectManMade (abstract)

Name:	Hydrogeological Object Man-made
Subtype of:	HydrogeologicalObject
Definition:	A man-made hydrogeological object.
Description:	Examples of manmade hydrogeological objects are: well, groundwater intake, groundwater monitoring station or monitoring well.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null

Attribute: statusCode

Name	Status Code
Value type:	StatusCodeTypeValue
Definition:	A code defining the formal status of a HydrogeologicalObjectManMade.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)

Attribute: validFrom

Name	Valid From
Value type:	DateTime
Definition:	Official date and time the hydrogeological object was/will be legally established.
Description:	NOTE This is the date and time the register reference can be used in legal acts.

HydrogeologicalObjectManMade (abstract)	
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: validTo	
Name	Valid To
Value type:	DateTime
Definition:	Date and time at which the hydrogeological object legally ceased/will cease to be used.
Description:	NOTE This is the date and time the register reference can no longer be used in legal acts.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»

5.4.2.1.9. HydrogeologicalObjectNatural

HydrogeologicalObjectNatural	
Name:	Hydrogeological Object Natural
Subtype of:	HydrogeologicalObject
Definition:	HydrogeologicalObject which was created by natural processes.
Description:	Examples of natural hydrogeological objects are: a source, vanishing point and geyser.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: approximateQuantityOfFlow	
Name	Approximate Quantity of Flow
Value type:	QuantityValue
Definition:	An approximate value defining the water yield in a natural object.
Description:	The discharge of water flow for a certain cross-section per time unit.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: naturalObjectType	
Name	Natural Object Type
Value type:	NaturalObjectTypeValue
Definition:	The type of natural hydrogeological object.
Multiplicity:	1
Obligation:	Implementing Rule (requirement)
Attribute: waterPersistence	
Name	Water Persistence
Value type:	WaterPersistenceValue
Definition:	The degree of persistence of water flow.
Multiplicity:	1
Stereotypes:	«voidable»
Obligation:	Implementing Rule (requirement)
Association role: groundWaterBody	
Value type:	GroundWaterBody
Definition:	The GroundWateBody associated with the HydrogeologicalObjectNatural.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.10. HydrogeologicalUnit

HydrogeologicalUnit (abstract)	
Name:	Hydrogeological Unit
Subtype of:	GeologicUnit
Definition:	A part of the lithosphere with distinctive parameters for water storage and conduction.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: approximateDepth	
Name	Approximate Depth
Value type:	QuantityValue
Definition:	The approximate depth of the HydrogeologicalUnit occurrence.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: approximateHorizontalExtent	
Name	Approximate Horizontal Extent
Value type:	GM_Surface
Definition:	The geometry defining the boundary of the HydrogeologicalUnit.
Multiplicity:	1
Attribute: approximateThickness	
Name	Approximate Thickness
Value type:	QuantityValue
Definition:	The approximate thickness of the HydrogeologicalUnit.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: beginLifespanVersion	
Name	Begin Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: description	
Name	Description
Value type:	PT_FreeText
Definition:	The description of the HydrogeologicalUnit
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: endLifespanVersion	
Name	End Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: inspireId	

HydrogeologicalUnit (abstract)	
Name	INSPIRE identifier
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	0..1
Attribute: name	
Name	Name
Value type:	PT_FreeText
Definition:	The name or code of the HydrogeologicalUnit.
Multiplicity:	1
Stereotypes:	«voidable»
Association role: geologicStructure	
Value type:	GeologicStructure
Definition:	Relates one or many HydrogeologicalUnit(s) to a GeologicStructure.
Description:	Allows the description of groundwater occurrence in geological structures.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.2. Data types

5.4.2.2.1. HydrogeologicalSurface

HydrogeologicalSurface	
Name:	Hydrogeological Surface
Definition:	A surface that represents the interpolated groundwater table, or other surface, for a local or regional area.
Description:	This is the 2.5D geometry for hydrogeological surfaces and is based on hydrogeological measurements in a group of wells or other sources of data.
Status:	Proposed
Stereotypes:	«union»
Identifier:	null
Attribute: surfacePointCollection	
Name	Surface Point Collection
Value type:	PointObservationCollection
Definition:	Hydrogeological surface represented by collection of observations in points.
Multiplicity:	1
Stereotypes:	«featureType»
Attribute: surfaceRectifiedGrid	
Name	Surface as Rectified Grid
Value type:	RectifiedGridCoverage
Definition:	A surface whose domain is a rectified grid.
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate system. It can be used for both discrete and continuous coverages.
Multiplicity:	1
Stereotypes:	«featureType»
Attribute: surfaceReferencableGrid	

HydrogeologicalSurface	
Name	Surface as Referenceable Grid.
Value type:	ReferenceableGridCoverage
Definition:	Surface whose domain consists of a referenceable grid.
Description:	A referenceable grid is a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system. It can be used for both discrete and continuous coverages.
Multiplicity:	1
Stereotypes:	«featureType»

5.4.2.2.2. PiezometricState

PiezometricState	
Name:	Piezometric State
Definition:	The piezometric state of a GroundWaterBody
Description:	Groundwater state (level) as a surface. It can be a set of point observations or interpolated to form a coverage.
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: observationTime	
Name	Observation Time
Value type:	DateTime
Definition:	Date and time of groundwater state observation.
Multiplicity:	1
Attribute: PiezometricSurface	
Name	Piezometric Surface
Value type:	HydrogeologicalSurface
Definition:	A surface that represents the level to which water will rise in tightly cased wells.
Description:	If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table is a particular potentiometric surface for an unconfined aquifer.
Multiplicity:	1

5.4.2.2.3. QuantityValue

QuantityValue	
Name:	QuantityValue
Definition:	Data container with a single or range of quantity values .
Status:	Proposed
Stereotypes:	«union»
Identifier:	null
Attribute: quantityInterval	
Name	Quantity Interval
Value type:	QuantityRange
Definition:	Decimal pair for specifying a quantity range with a unit of measure.
Multiplicity:	1
Attribute: singleQuantity	
Name	Single Quantity
Value type:	Quantity

QuantityValue	
Definition:	Scalar component with decimal representation and a unit of measure used to store value of a continuous quantity.
Multiplicity:	1

5.4.2.3. Code lists

5.4.2.3.1. ActiveWellTypeValue

ActiveWellTypeValue	
Name:	Active Well Type
Definition:	The type of active well.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/ActiveWellType

5.4.2.3.2. AquiferMediaTypeValue

AquiferMediaTypeValue	
Name:	Aquifer Media Type
Definition:	A type for describing the characteristics of the aquifer medium.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.4.2.3.3. AquiferTypeValue

AquiferTypeValue	
Name:	Aquifer Type
Definition:	A type for describing the type of aquifer.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.4.2.3.4. ConditionOfGroundwaterValue

ConditionOfGroundwaterValue	
Name:	Condition Of Groundwater
Definition:	A type for indicating the approximate degree of change which has taken place on the natural state of groundwater.
Description:	The groundwater in a GroundWaterFlowSystem is in a variable condition, dependent on external factors, among which are diverse human activities.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.4.2.3.5. HydroGeochemicalRockValue

HydroGeochemicalRockValue	
Name:	Hydrogeochemical Rock Value
Definition:	Code for defining the hydrogeochemical condition of the groundwater environment.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any

HydroGeochemicalRockValue	
Identifier:	http://inspire.ec.europa.eu/codeList/HydroGeochemicalRockType

5.4.2.3.6. NaturalObjectTypeValue

NaturalObjectTypeValue	
Name:	Natural Object Type
Definition:	The type of natural hydrogeological object.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/NaturalObjectType

5.4.2.3.7. StatusCodeTypeValue

StatusCodeTypeValue	
Name:	Status Code Type
Definition:	A code list for defining the status of a HydrogeologicalObjectManMade.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/StatusCodeType

5.4.2.3.8. WaterPersistenceValue

WaterPersistenceValue	
Name:	Water Persistence Value
Definition:	The type of hydrological persistence of water.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/WaterPersistenceValue

5.4.2.3.9. WaterTypeValue

WaterTypeValue	
Name:	Water Type
Definition:	A type for indicating salinity classes in water.
Description:	Salinity is the saltiness or dissolved salt content of a body of water. Generally, it is the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater salinity often refers to the concentration of chlorides in the water. See also total dissolved solids.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.4.2.3.10. WellObservationTypeValue

WellObservationTypeValue	
Name:	Well Observation Type
Definition:	The type of observation made on the feature of interest.
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	

5.4.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.4.2.4.1. Boolean

Boolean	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103 Conceptual Schema Language::ISO 19103:2005 Schema Language::Basic Types::Primitive::Truth [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.2. Borehole

Borehole	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::GeologyMain::GeologyCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A borehole is the generalized term for any narrow shaft drilled in the ground.

5.4.2.4.3. DateTime

DateTime	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19103 Conceptual Schema Language::ISO 19103:2005 Schema Language::Basic Types::Primitive::Date and Time [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.4. EnvironmentalMonitoringFacility

EnvironmentalMonitoringFacility	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Environmental Monitoring Facilities::EnvironmentalMonitoringFacilities [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A georeferenced object directly collecting and/or processing data, or hosting other EnvironmentalMonitoringFacility objects collecting data about features whose properties (e.g. physical, chemical, biological or other aspects of environmental conditions) are repeatedly observed/measured.
Description:	NOTE 1: An EnvironmentalMonitoringFacility is not a facility in the common INSPIRE sense realised by the Generic Conceptual Model class ActivtiyComplex. NOTE 2: Laboratories are not EnvironmentalMonitoringFacilities from an INSPIRE perspective as the exact location of the laboratory does not add further information to the measurement. The methodology used in the laboratory should be provided with observational data.

5.4.2.4.5. GM_Primitive

GM_Primitive (abstract)	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.6. GM_Surface

GM_Surface	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19107 Spatial Schema::ISO 19107:2003 Spatial Schema:: Geometry::Geometric primitive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.7. GeologicStructure

GeologicStructure (abstract)	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::GeologyMain::GeologyCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an earth material.
Description:	The identity of a GeologicStructure is independent of the material that is the substrate for the structure.

5.4.2.4.8. GeologicUnit

GeologicUnit	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::GeologyMain::GeologyCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A volume of rock with distinct characteristics.
Description:	Includes both formal units (i.e. formally adopted and named in an official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised). Spatial properties are only available through association with a MappedFeature.

5.4.2.4.9. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.4.2.4.10. PT_FreeText

PT_FreeText	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19139 Metadata - XML Implementation::Cultural and linguistic adapdability [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.11. PointObservationCollection

PointObservationCollection

PointObservationCollection	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Observations::Specialised Observations::Point Observations [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A collection of PointObservations.
Description:	The PointObservationCollection is a collection of separate PointObservations. In the case where it is useful to group together a set of otherwise independent PointObservations the PointObservationCollection should be used to make this grouping. The grouping may be made on any basis e.g. it may be useful to group together PointObservations made by the same instrument or Environmental Facility, or in a particular measurement campaign. Each member of the PointObservationCollection must be a single PointObservation.

5.4.2.4.12. Quantity

Quantity	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19136 GML::valueObjects [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.13. QuantityRange

QuantityRange	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::OGC::SWE Common Data Model 2.0::Simple Components [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

5.4.2.4.14. RectifiedGridCoverage

RectifiedGridCoverage	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Coverages::Coverages (Domain and Range) [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	coverage whose domain consists of a rectified grid
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.4.2.4.15. ReferenceableGridCoverage

ReferenceableGridCoverage	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Coverages::Coverages (Domain and Range) [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	coverage whose domain consists of a referencable grid
Description:	A referencable grid is a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.4.2.4.16. WFDGroundWaterBody

WFDGroundWaterBody

WFDGroundWaterBody	
Package:	INSPIRE Consolidated UML Model::Themes::Annex III::Area Management Restriction Regulation Zones and Reporting units::Water Framework Directive [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A distinct volume of groundwater within an aquifer or aquifers.
Description:	SOURCE [2000/60/EC Art. 2(12)]. NOTE All WFD spatial object types are regarded as candidate spatial objects in Annex III theme 'Area management/restriction/regulation zones and reporting units' due to their primary function for reporting under Directive 2000/60/EC.

5.4.3

6 Reference systems, units of measure and grids

6.1 Default reference systems, units of measure and grid

6.1.1

6.1.2 The reference systems, units of measure and grid included in this sub-section are the defaults to be used for all INSPIRE data sets, unless theme-specific exceptions and/or additional requirements are defined in section 6.2.

Coordinate reference systems

IR Requirement 5 **IR Requirement 6** **IR Requirement 7**	Datum For the coordinate reference systems used for making available the INSPIRE spatial data sets, the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, and the datum of the International Terrestrial Reference System (ITRS) or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well-established and described relationship between both systems, according to EN ISO 19111.

6.1.3 Coordinate reference systems

IR Requirement 8 INSPIRE spatial data sets shall be made available using one of the three-dimensional, two-dimensional or compound coordinate reference systems specified below.

IR Requirement 9

IR Requirement 10 1. Three-dimensional Coordinate Reference Systems

– Three-dimensional Cartesian coordinates

– Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height), using the parameters of the GRS80 ellipsoid

2. Two-dimensional Coordinate Reference Systems

– Two-dimensional geodetic coordinates, using the parameters of the GRS80 ellipsoid

– Plane coordinates using the Lambert Azimuthal Equal Area projection and the parameters of the GRS80 ellipsoid (ETRS89-LAEA)

– Plane coordinates using the Lambert Conformal Conic projection and the parameters of the GRS80 ellipsoid (ETRS89-LCC)

1. – Plane coordinates using the Transverse Mercator projection and the parameters of the GRS80 ellipsoid (ETRS89-TMzn)

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– 3. Compound Coordinate Reference Systems

– – For the horizontal component of the compound coordinate reference system, one of the two-dimensional coordinate reference systems specified above shall be used.

– For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope. Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS. The geodetic codes and parameters for these vertical reference systems shall be documented and an identifier shall be created, according to EN ISO 19111 and ISO 19127.

2. – For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere, or other linear or parametric reference systems shall be used. Where other parametric reference systems are used, these shall be described in an accessible reference using EN ISO 19111-2:2012.

– – For the vertical component in marine areas where there is an appreciable tidal range (tidal waters), the Lowest Astronomical Tide (LAT) shall be used as the reference surface.

– – For the vertical component in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200 meters, the Mean Sea Level (MSL) or a well-defined reference level close to the MSL shall be used as the reference surface.

–

– Other coordinate reference systems than those listed below may only be used if specified for a specific spatial data theme and for regions outside of continental Europe. The geodetic codes and parameters for these coordinate reference systems shall be documented, and an identifier shall be created, according to EN ISO 19111 and ISO 19127.

–

– Display

–

– For the display of the INSPIRE spatial data sets with the View Service specified in Commission Regulation (EC) No 976/2009 as regards the Network Services, at least the two dimensional geodetic coordinate system shall be made available.

3. Identifiers for coordinate reference systems

–

– Coordinate reference system parameters and identifiers shall be managed in one or several common registers for coordinate reference systems. Only identifiers contained in a common register shall be used for referring to the coordinate reference systems listed in this section.

–

– It is recommended to use the http URIs provided by the Open Geospatial Consortium as coordinate reference system identifiers (see identifiers for the default CRSs below). These are based on and redirect to the definition in the EPSG Geodetic Parameter Registry (*http://www.epsg-registry.org/*).

–

– Table 2. Recommended http URIs for the default coordinate reference systems

– **Coordinate reference system**	**Short name**	**http URI identifier**
3D Cartesian in ETRS89	ETRS89-XYZ	*http://www.opengis.net/def/crs/EPSG/0/4936*
3D geodetic in ETRS89 on GRS80	ETRS89-GRS80h	*http://www.opengis.net/def/crs/EPSG/0/4937*
2D geodetic in ETRS89 on GRS80	ETRS89-GRS80	*http://www.opengis.net/def/crs/EPSG/0/4258*
2D LAEA projection in ETRS89 on GRS80	ETRS89-LAEA	*http://www.opengis.net/def/crs/EPSG/0/3035*
2D LCC projection in ETRS89 on GRS80	ETRS89-LCC	*http://www.opengis.net/def/crs/EPSG/0/3034*
2D TM projection in ETRS89 on GRS80, zone 26N (30°W to 24°W)	ETRS89-TM26N	*http://www.opengis.net/def/crs/EPSG/0/3038*
2D TM projection in ETRS89 on GRS80, zone 27N (24°W to 18°W)	ETRS89-TM27N	*http://www.opengis.net/def/crs/EPSG/0/3039*
2D TM projection in ETRS89 on GRS80, zone 28N (18°W to 12°W)	ETRS89-TM28N	*http://www.opengis.net/def/crs/EPSG/0/3040*
2D TM projection in ETRS89 on GRS80, zone 29N (12°W to 6°W)	ETRS89-TM29N	*http://www.opengis.net/def/crs/EPSG/0/3041*
2D TM projection in ETRS89 on GRS80, zone 30N (6°W to 0°)	ETRS89-TM30N	*http://www.opengis.net/def/crs/EPSG/0/3042*
2D TM projection in ETRS89 on GRS80, zone 31N (0° to 6°E)	ETRS89-TM31N	*http://www.opengis.net/def/crs/EPSG/0/3043*
2D TM projection in ETRS89 on GRS80, zone 32N (6°E to 12°E)	ETRS89-TM32N	*http://www.opengis.net/def/crs/EPSG/0/3044*
2D TM projection in ETRS89 on GRS80, zone 33N (12°E to 18°E)	ETRS89-TM33N	*http://www.opengis.net/def/crs/EPSG/0/3045*
2D TM projection in ETRS89 on GRS80, zone 34N (18°E to 24°E)	ETRS89-TM34N	*http://www.opengis.net/def/crs/EPSG/0/3046*
2D TM projection in ETRS89 on GRS80, zone 35N (24°E to 30°E)	ETRS89-TM35N	*http://www.opengis.net/def/crs/EPSG/0/3047*
2D TM projection in ETRS89 on GRS80, zone 36N (30°E to 36°E)	ETRS89-TM36N	*http://www.opengis.net/def/crs/EPSG/0/3048*
2D TM projection in ETRS89 on GRS80, zone 37N (36°E to 42°E)	ETRS89-TM37N	*http://www.opengis.net/def/crs/EPSG/0/3049*
2D TM projection in ETRS89 on GRS80, zone 38N (42°E to 48°E)	ETRS89-TM38N	*http://www.opengis.net/def/crs/EPSG/0/3050*
2D TM projection in ETRS89 on GRS80, zone 39N (48°E to 54°E)	ETRS89-TM39N	*http://www.opengis.net/def/crs/EPSG/0/3051*
Height in EVRS	EVRS	*http://www.opengis.net/def/crs/EPSG/0/5730*
3D compound: 2D geodetic in ETRS89 on GRS80, and EVRS height	ETRS89-GRS80-EVRS	*http://www.opengis.net/def/crs/EPSG/0/7409*

6.1.4 Temporal reference system

Test 3	The Gregorian calendar shall be used as a reference system for date values, and the Universal Time Coordinated (UTC) or the local time including the time zone as an offset from UTC shall be used as a reference system for time values.

6.1.5 Units of measure

Test 4	All measurement values shall be expressed using SI units, unless specified otherwise for a specific spatial data theme or type.

6.1.6 Equal area grid

Test 5	The grid with fixed and unambiguously defined locations of equal-area grid cells defined below shall be used as a geo-referencing framework to make gridded data available in INSPIRE. Exceptions, where other grids may be used, are: 1. Other grids may be specified for specific spatial data themes. In this case, data exchanged using such a theme-specific grid shall use standards in which the grid definition is either included with the data, or linked by reference. 2. For grid referencing in regions outside of continental Europe Member States may define their own grid based on a geodetic coordinate reference system compliant with ITRS and a Lambert Azimuthal Equal Area projection, following the same principles as laid down for the grid specified below. In this case, an identifier for the coordinate reference system shall be created.

The grid is based on the ETRS89 Lambert Azimuthal Equal Area (ETRS89-LAEA) coordinate reference system with the centre of the projection at the point 52^o N, 10^o E and false easting: x_0 = 4321000 m, false northing: y_0 = 3210000 m.

The origin of the grid coincides with the false origin of the ETRS89-LAEA coordinate reference system (x=0, y=0).

Grid points of grids based on ETRS89-LAEA shall coincide with grid points of the grid.

The grid is hierarchical, with resolutions of 1m, 10m, 100m, 1000m, 10000m and 100000m.

The grid orientation is south-north, west-east.

The grid is designated as Grid_ETRS89-LAEA. For identification of an individual resolution level the cell size in metres is appended.

The reference point of a grid cell shall be the lower left corner of the grid cell.

For the unambiguous referencing and identification of a grid cell, the cell code composed of the size of the cell and the coordinates of the lower left cell corner in ETRS89-LAEA shall be used. The cell size shall be denoted in metres (“m”) for cell sizes up to 100m or kilometres (“km”) for cell sizes of 1000m and above. Values for northing and easting shall be divided by 10^n, where *n* is the number of trailing zeros in the cell size value.

6.2 Theme-specific requirements and recommendations on reference systems

There are no theme-specific requirements or recommendations on reference systems.

7 Data quality

This chapter includes a description of the data quality elements and sub-elements as well as the corresponding data quality measures that should be used to evaluate and document data quality for data sets related to the spatial data theme *Geology* (section 7.1).

It may also define requirements or recommendations about the targeted data quality results applicable for data sets related to the spatial data theme *Geology* (sections 7.2 and 7.3).

In particular, the data quality elements, sub-elements and measures specified in section 7.1 should be used for

- evaluating and documenting data quality properties and constraints of spatial objects, where such properties or constraints are defined as part of the application schema(s) (see section 5);
- evaluating and documenting data quality metadata elements of spatial data sets (see section 8); and/or
- specifying requirements or recommendations about the targeted data quality results applicable for data sets related to the spatial data theme *Geology* (see sections 7.2 and 7.3).

The descriptions of the elements and measures are based on Annex D of ISO/DIS 19157 Geographic information – Data quality.

7.1 Data quality elements

Table 3 lists all data quality elements and sub-elements that are being used in this specification. Data quality information can be evaluated at level of spatial object, spatial object type, dataset or dataset series. The level at which the evaluation is performed is given in the "Evaluation Scope" column.

The measures to be used for each of the listed data quality sub-elements are defined in the following sub-sections.

Table 3 – Data quality elements used in the spatial data theme *Geology*

Section	Data quality element	Data quality sub-element	Definition	Evaluation Scope
7.1.2	Completeness	Omission	data absent from the dataset, as described by the scope	dataset series; dataset; spatial object type
7.1.7	Positional accuracy	Absolute or external accuracy	closeness of reported coordinate values to values accepted as or being true	spatial object

Recommendation 4	Where it is impossible to express the evaluation of a data quality element in a quantitative way, the evaluation of the element should be expressed with a textual statement as a data quality descriptive result.

7.1.1 Completeness – Commission

Recommendation 5	Commission should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.2 Completeness – Omission

Recommendation 6	Omission should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.3 Logical consistency – Conceptual consistency

Recommendation 7	Conceptual consistency should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.4 Logical consistency – Domain consistency

Recommendation 8	Domain consistency should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.5 Logical Consistency – Format consistency

Recommendation 9	Format consistency should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.6 Logical Consistency – Topological consistency

Recommendation 10	Topological consistency should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.7 Positional accuracy – Absolute or external accuracy

Recommendation 11 Absolute or external accuracy should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

Name	**Positional accuracy – Absolute or external accuracy**
Alternative name	
Data quality element	Positional accuracy
Data quality sub-element	Absolute or external accuracy
Data quality basic measure	Two-dimensional random variable X and Y
Definition	Value of the positional uncertainty of a borehole collar location.
Description	
Evaluation scope	spatial object type: Borehole
Reporting scope	spatial object type: Borehole
Parameter	
Data quality value type	
Data quality value structure	Single value
Source reference	ISO/DIS 19157 Geographic information – Data quality
Example	
Measure identifier	19

7.1.8 Positional accuracy – Relative or internal accuracy

Recommendation 13 Relative or internal accuracy should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.9 Positional accuracy – Gridded data position accuracy

Recommendation 14 Gridded data position accuracy should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.10 Thematic accuracy – Classification correctness

Recommendation 15 Classification correctness should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.11 Thematic accuracy – Non-quantitative attribute correctness

Recommendation 16 Non-quantitative attribute correctness should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.12 Thematic accuracy – Quantitative attribute accuracy

Recommendation 17 Quantitative attribute accuracy should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.13 Temporal quality – Accuracy of a time measurement

Recommendation 18 Accuracy of a time measurement should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.14 Temporal quality – Temporal consistency

Recommendation 19 Temporal consistency should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.15 Temporal quality – Temporal validity

Recommendation 20 Temporal validity should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.1.16 Usability

Recommendation 21 Usability should be evaluated and documented using <Name of the measure(s), from ISO/DIS 19157> as specified in the tables below.

7.2 Minimum data quality requirements

No minimum data quality requirements are defined for the spatial data theme Geology.

IR Requirement 11 For the data quality elements listed in **Erreur ! Source du renvoi introuvable.**, all data sets related to the spatial data theme Geology shall meet the specified target results.

Table 4 – Minimum data quality requirements for spatial data theme Geology

Section	Data quality element and sub-element	Measure name(s)	Target result(s)	Condition

Insert more rows when additional requirements have been defined!

7.3 Recommendation on data quality

No minimum data quality recommendations are defined.

Recommendation 22 For the data quality elements listed in **Erreur ! Source du renvoi introuvable.**, all data sets related to the spatial data theme *Geology* should meet the specified target results.

Table 5 – Recommended minimum data quality results for spatial data theme Geology

Section	Data quality element and sub-element	Measure name(s)	Target result(s)	Condition
7.XX	Absolute or external accuracy			

8 Dataset-level metadata

Error! Not a valid filename.

8.1 Metadata elements for reporting data quality

Recommendation 23 For reporting the results of the data quality evaluation, the data quality elements, sub-elements and (for quantitative evaluation) measures defined in chapter 7 should be used.

The scope for reporting may be different from the scope for evaluating data quality (see section 7). If data quality is reported at the data set or spatial object type level, the results are usually derived or aggregated.

Recommendation 5 The metadata elements specified in the following tables should be used to report the results of the data quality evaluation. At least the information included in the row "Implementation instructions" should be provided.

The first table applies to reporting quantitative results (using the element DQ_QuantitativeResult), while the second table applies to reporting non-quantitative results (using the element DQ_DescriptiveResult).

NOTE These tables may need to be updated once the XML schemas for ISO 19157 have been finalised.

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission
Domain	Lines 7-9 from ISO/DIS 19157 7. DQ_MeasureReference (C.2.1.3) 8. DQ_EvaluationMethod (C.2.1.4.) 9. DQ_Result (C2.1.5.)

Implementing instructions	39. nameOfMeasure NOTE This should be the name as defined in Chapter 7. 42. evaluationMethodType 43. evaluationMethodDescription NOTE If the reported data quality results are derived or aggregated (i.e. the scope levels for evaluation and reporting are different), the derivation or aggregation should also be specified using this property. 46. dateTime NOTE This should be data or range of dates on which the data quality measure was applied. 63. DQ_QuantitativeResult / 64. value NOTE The DQ_Result type should be DQ_QuantitativeResult and the value(s) represent(s) the application of the data quality measure (39.) using the specified evaluation method (42-43.)
Example	See Table E.12 — Reporting commission as metadata (ISO/DIS 19157)
Example XML encoding	

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission
Domain	Line 9 from ISO/DIS 19157 9. DQ_Result (C2.1.5.)
Implementing instructions	67. DQ_DescripitveResult / 68. statement NOTE The DQ_Result type should be DQ_DescriptiveResult and in the statement (68.) the evaluation of the selected DQ sub-element should be expressed in a narrative way.
Example	See Table E.15 — Reporting descriptive result as metadata (ISO/DIS 19157)
Example XML encoding	

Open issue 1: For reporting compliance with minimum data quality requirements and recommendations specified in section 7, the INSPIRE conformity metadata element should be used. However, since this issue is part of the larger discussion on the Abstract Test Suite and the definition of conformance classes for the data specification, detailed instructions on how to provide metadata on compliance with minimum data quality requirements and recommendations will only be provided for v3.0.

8.2 Theme-specific metadata elements

If no mandatory theme-specific metadata elements are included, include the following sentence and remove the IR Requirement and the table. Otherwise delete the sentence.

No mandatory theme-specific metadata elements are defined for this theme.

IR Requirement 12 The metadata describing a spatial data set or a spatial data set series related to the theme <*Theme Name*> shall also comprise the theme-specific metadata elements specified in Table 6.

Table 6 – Mandatory and conditional theme-specific metadata elements for the theme <*Theme Name*>

List all metadata elements here that have a multiplicity of 1 or 1... Delete the entries that are not applicable for this data specification.*

Section	Metadata element	Multiplicity	Condition
Erreur ! Source du renvoi introuvable.	**Erreur ! Source du renvoi introuvable.**	<multiplicity> *at least 1 unless conditional*	*To be filled if the minimum cardinality is 0*

If no mandatory theme-specific metadata elements are included, include the following sentence and remove the IR Requirement and the table. Otherwise delete the sentence.

No optional theme-specific metadata elements are defined for this theme.

Recommendation 6 The metadata describing a spatial data set or a spatial data set series related to the theme <*Theme Name*> should comprise the theme-specific metadata elements specified in Table 7.

Table 7 – Optional theme-specific metadata elements for the theme <*Theme Name*>

List all metadata elements here that have a multiplicity of 0..1 or 0... Delete the entries that are not applicable for this data specification.*

Section	Metadata element	Multiplicity
8.2.2	Maintenance Information	0..1
Erreur ! Source du renvoi introuvable.	Positional accuracy – Absolute or external accuracy	0..1

Specify the theme-specific metadata elements listed in Table 6 and Table 7 using thetable template below. Include one section for each element.

8.2.1 Positional accuracy – Absolute or external accuracy

Open issue: It is not yet defined how to aggregate information about positional accuracy at the dataset level (positional accuracy is described at the feature level for Boreholes location).

Metadata element name	**Data Quality – Positional accuracy – Absolute or external accuracy**
Definition	closeness of reported coordinate values to values accepted as or being true

ISO 19115 number and name	18. dataQualityInfo
ISO/TS 19139 path	dataQualityInfo
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..1
Data type (and ISO 19115 no.)	117. DQ_AbsoluteExternalPositionalAccuracy
Domain	See section 7.1.2 of Data Quality.
Implementing instructions (optional)	
Example (optional)	
Example XML encoding (optional)	
Comments (optional)	

Include mandatory and/or conditional elements here.

8.2.2 Maintenance Information

Metadata element name	**Maintenance information**
Definition	Information about the scope and frequency of updating
ISO 19115 number and name	30. resourceMaintenance
ISO/TS 19139 path	identificationInfo/MD_Identification/resourceMaintenance
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..1
Data type(and ISO 19115 no.)	142. MD_MaintenanceInformation
Domain	This is a complex type (lines 143-148 from ISO 19115). At least the following elements should be used (the multiplicity according to ISO 19115 is shown in parentheses): – maintenanceAndUpdateFrequency [1]: frequency with which changes and additions are made to the resource after the initial resource is completed / domain value: MD_MaintenanceFrequencyCode: – updateScope [0..*]: scope of data to which maintenance is applied / domain value: MD_ScopeCode – maintenanceNote [0..*]: information regarding specific requirements for maintaining the resource / domain value: free text
Implementing instructions	
Example	
Example XML encoding	
Comments	

8.2.3 Conformity

The *Conformity* metadata element defined in Regulation 1205/2008/EC requires to report the conformance with the Implementing Rule for interoperability of spatial data sets and services. In addition, it may be used also to document the conformance to another specification.

Recommendation 7	The *Conformity* metadata element should be used to document conformance with this data specification (as a whole), a specific conformance class defined in the Abstract Test Suite in Annex A and/or another specification.

The *Conformity* element includes two sub-elements, the *Specification* (a citation of the Implementing Rule for interoperability of spatial data sets and services or other specification), and the *Degree* of conformity. The *Degree* can be *Conformant* (if the dataset is fully conformant with the cited specification), *Not Conformant* (if the dataset does not conform to the cited specification) or *Not Evaluated* (if the conformance has not been evaluated).

DS Requirement 3 Dataset metadata shall include a statement on the overall conformance of the dataset with this data specification (i.e. conformance with all requirements).

Recommendation 8 If a dataset is not yet conformant with all requirements of this data specification, it is recommended to include information on the conformance with the individual conformance classes specified in the Abstract Test Suite in Annex A.

Recommendation 9 If a dataset is produced or transformed according to an external specification that includes specific quality assurance procedures, the conformity with this specification should be documented using the *Conformity* metadata element.

DS Requirement 4 If minimum data quality requirements are defined then the statement on the conformity with these requirements shall be included using the *Conformity* metadata element and referring to the relevant data quality conformance class in the Abstract Test Suite.

Recommendation 10 When documenting conformance with this data specification or one of the conformance classes defined in the Abstract Test Suite, the *Specification* sub-element should be given using the http URI identifier of the conformance class or using a citation including the following elements:
- title: "INSPIRE Data Specification on Geology – Draft Guidelines – <name of the conformance class>"
- date:
    - dateType: publication
    - date: 2012-06-29

EXAMPLE 1: The XML snippets below show how to fill the *Specification* sub-element for documenting conformance with the whole data specification on Addresses v3.0.1.

```
<gmd:DQ_ConformanceResult>
   <gmd:specification href="http://inspire.ec.europa.eu/conformanceClass/ad/3.0.1/tg" />
   <gmd:explanation> (...) </gmd:explanation>
   <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

or (using a citation):

```
<gmd:DQ_ConformanceResult>
   <gmd:specification>
      <gmd:CI_Citation>
         <gmd:title>
            <gco:CharacterString>INSPIRE Data Specification on Geology – Draft
Guidelines</gco:CharacterString>
         </gmd:title>
         <gmd:date>
            <gmd:date>
               <gco:Date>2012-06-29</gco:Date>
            </gmd:date>
            <gmd:dateType>
               <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resou
```

```
rces/Codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">publication</gmd:CI_DateTypeCode>
                </gmd:dateType>
            </gmd:date>
        </gmd:CI_Citation>
    </gmd:specification>
    <gmd:explanation> (...) </gmd:explanation>
    <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

EXAMPLE 2: The XML snippets below show how to fill the *Specification* sub-element for documenting conformance with the CRS conformance class of the data specification on Addresses v3.0.1.

```
<gmd:DQ_ConformanceResult>
    <gmd:specification href="http://inspire.ec.europa.eu/conformanceClass/ad/3.0.1/crs" />
    <gmd:explanation> (...) </gmd:explanation>
    <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

or (using a citation):

```
<gmd:DQ_ConformanceResult>
    <gmd:specification>
        <gmd:CI_Citation>
            <gmd:title>
                <gco:CharacterString>INSPIRE Data Specification on Geology – Draft Guidelines –
CRS</gco:CharacterString>
            </gmd:title>
            <gmd:date>
                <gmd:date>
                    <gco:Date>2012-06-29</gco:Date>
                </gmd:date>
                <gmd:dateType>
                    <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resou
rces/Codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">publication</gmd:CI_DateTypeCode>
                </gmd:dateType>
            </gmd:date>
        </gmd:CI_Citation>
    </gmd:specification>
    <gmd:explanation> (...) </gmd:explanation>
    <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

8.2.4 Lineage

Recommendation 24	Following the ISO/DIS 19157 Quality principles, if a data provider has a procedure for the quality management of their spatial data sets then the appropriate data quality elements and measures defined in ISO/DIS 19157 should be used to evaluate and report (in the metadata) the results. If not, the *Lineage* metadata element (defined in Regulation 1205/2008/EC) should be used to describe the overall quality of a spatial data set.

According to Regulation 1205/2008/EC, lineage "is a statement on process history and/or overall quality of the spatial data set. Where appropriate it may include a statement whether the data set has been validated or quality assured, whether it is the official version (if multiple versions exist), and whether it has legal validity. The value domain of this metadata element is free text".

The Metadata Technical Guidelines based on EN ISO 19115 and EN ISO 19119 specifies that the statement sub-element of LI_Lineage (EN ISO 19115) should be used to implement the lineage metadata element.

Recommendation 25 To describe the transformation steps and related source data, it is recommended to use the following sub-elements of LI_Lineage:
- For the description of the transformation process of the local to the common INSPIRE data structures, the LI_ProcessStep sub-element should be used.
- For the description of the source data the LI_Source sub-element should be used.

NOTE 1 In order to improve the interoperability, domain templates and instructions for using these free text elements (descriptive statements) may be specified here and/or in an Annex of this data specification.

8.2.5 Temporal reference

According to Regulation 1205/2008/EC, at least one of the following temporal reference metadata sub-elements shall be provided: temporal extent, date of publication, date of last revision, date of creation.

Recommendation 26 It is recommended that at least the date of the last revision of a spatial data set should be reported using the *Date of last revision* metadata sub-element.

8.2.6 Recommendations for Lineage

To provide the user with a valuable information about the quality (thematic, geometric) and usability of geological map data, the metadata should include information about the original data sources (geological and topographic sources, digitizing and mapping processes) for the final digital dataset.

Geological units and structures are the result of an interpretation and their geometry is drawn on a topographic map. The digitizing method and the topographic map used are then very important for the data quality. To create all geological maps of a country needs several decades of work. So the data are very heterogeneous for many reasons, and harmonizing these data is a well-known issue and needs a huge work, but the user would like to know if the thematic and the geometric harmonisation are done or not.

Metadata elements to describe the dataset
- Digitizing method
- Internal thematic harmonization
- Internal geometric harmonization

Metadata elements to describe Geological and Topographic Sources:
- Title
- Description
- Date
- Mapping method (only for geological source)
- Temporal extent
- Scale
- Reference system

The following paragraphs describe which Lineage metadata elements should be used:

Digitizing method:

ISO Number	87
Name	description
Definition	description of the event, including related parameters or tolerances
XPath	dataQualityInfo/*/lineage/*/ processStep/*/description
Data type	CharacterString
Domain	Free text
Example	Digitized on screen from scanned geological or applied map

Internal thematic harmonization

ISO Number	83
Name	statement
Definition	general explanation of the data producer's knowledge about the lineage of a dataset
XPath	dataQualityInfo/*/lineage/*/statement
Data type	CharacterString
Domain	Free text
Example	thematicHarmonizationDescription=Yes, thematicHarmonizationDescription: unified structured legend

Internal geometric harmonization

ISO Number	83
Name	statement
Definition	general explanation of the data producer's knowledge about the lineage of a dataset
XPath	dataQualityInfo/*/lineage/*/statement
Data type	CharacterString
Domain	Free text
Example	geometricHarmonization= yes; geometricHarmonizationDescription: seamless map

Source title:

ISO Number	360
Name	sourceCitation
Definition	recommended reference to be used for the source data
XPath	dataQualityInfo/*/lineage/*/processStep/*/source/*/ sourceCitation/*/title
Data type	CharacterString
Domain	Free text
Example	

Source description:

ISO Number	93
Name	description
Definition	detailed description of the level of the source data
XPath	dataQualityInfo/*/lineage/*/processStep/*/source/*/ description
Data type	CharacterString
Domain	Free text
Example	

Source Date:

ISO Number	362
Name	date
Definition	Reference date for the cited resource
XPath	dataQualityInfo/*/lineage/*/processStep/*/source/*/ sourceCitation/*/date
Data type	Class
Domain	Date (B.4.2)
Example	

Source Mapping method (only for geological source):

ISO Number	87
Name	description
Definition	description of the event, including related parameters or tolerances
XPath	dataQualityInfo/*/lineage/*/ processStep/*/description
Data type	CharacterString
Domain	Free text
Example	Field survey *(A predefined code list is available for specifying the source mapping method)*

Source Scale:

ISO Number	94
Name	scaleDenominator
Definition	denominator of the representative fraction on a source map
XPath	dataQualityInfo/*/lineage/*/processStep/*/source/*/ scaleDenominator
Data type	Class
Domain	MD_RepresentativeFraction (B.2.2.4)
Example	25000

Source Reference system:

ISO Number	95
Name	sourceReferenceSystem
Definition	spatial reference system used by the source data
XPath	dataQualityInfo/*/lineage/*/processStep/*/source/*/referenceSystem
Data type	Class
Domain	MD_ReferenceSystem (B.2.7)
Example	

Suggested list of Digitizing methods:

code	method
directGIS	Direct input in GIS software
directGPS	Direct input – GPS measurement
interpolationPoint	Generated data (interpolation from point data)
	Digitized on digitizing tablet:
digitizedTabletLineMap	• from line-map
digitizedTabletPenciledOriginal	• from penciled original
digitizedTabletScribingFolio	• from scribing folio
digitizedTabletFilm	• from transparency film
digitizedTabletPaperCopy	• from paper copy
	Digitized on screen from scanned geological or applied map:
digitizedScannedMapManual	• Interactive manually
digitizedScannedMapSemiAutomated	• semi-automated
digitizedScannedMapAutomated	• automated
	Digitized on screen from other digital raster data:
digitizedScannedOtherManual	• Interactive manually
digitizedScannedOtherSemiAutomated	• semi-automated
digitizedScannedOtherAutomated	• automated
generalized	Generalized
unknown	Unknown digitizing method

Suggested list of Mapping methods:

code	method
fieldSurvey	Field survey
assemblyOfPublishedMaps	Synthesis of published descriptions/maps
generalization	Generalization from larger scale
	Interpretation:
intepretationGeophysical	• geophysical methods
intepretationAerial	• aerial imagery
intepretationSatellite	• satellite imagery
unknown	Unknown mapping method

9 Delivery

9.1 Delivery medium

DS Requirement 5 Data conformant to this INSPIRE data specification shall be made available through an INSPIRE network service.

DS Requirement 6 All information that is required by a calling application to be able to retrieve the data through the used network service shall be made available in accordance with the requirements defined in the Implementing Rules on Network Services.

EXAMPLE 1 Through the Get Spatial Objects function, a download service can either download a pre-defined data set or pre-defined part of a data set (non-direct access download service), or give direct access to the spatial objects contained in the data set, and download selections of spatial objects based upon a query (direct access download service). To execute such a request, some of the following information might be required:

– the list of spatial object types and/or predefined data sets that are offered by the download service (to be provided through the Get Download Service Metadata operation),
– and the query capabilities section advertising the types of predicates that may be used to form a query expression (to be provided through the Get Download Service Metadata operation, where applicable),
– a description of spatial object types offered by a download service instance (to be provided through the Describe Spatial Object Types operation).

EXAMPLE 2 Through the Transform function, a transformation service carries out data content transformations from native data forms to the INSPIRE-compliant form and vice versa. If this operation is directly called by an application to transform source data (e.g. obtained through a download service) that is not yet conformant with this data specification, the following parameters are required:
Input data (mandatory). The data set to be transformed.

– Source model (mandatory, if cannot be determined from the input data). The model in which the input data is provided.
– Target model (mandatory). The model in which the results are expected.
– Model mapping (mandatory, unless a default exists). Detailed description of how the transformation is to be carried out.

9.2 Encodings

9.2.1 Default Encoding(s)

DS Requirement 7	Data conformant to the application schema(s) defined in section 5 shall be encoded using the encoding(s) specified in this section.

9.2.1.1. Default encoding for application schema GeologyCore

Name: GeologyCore GML Application Schema
Version: version <version of the GML Application Schema>, GML, version 3.2.1
Specification: D2.8.**II/III.4** Data Specification on **Geology** – Draft Guidelines
Character set: UTF-8

The GML Application Schema is distributed in a zip-file separately from the data specification document.

10 Data Capture

There is no specific guidance required with respect to data capture.

11 Portrayal

This clause defines the rules for layers and styles to be used for portrayal of the spatial object types defined for this theme.

In section 11.1, the *types* of layers are defined that are to be used for the portrayal of the spatial object types defined in this specification. A view service may offer several layers of the same type, one for each dataset that it offers on a specific topic.

Section 11.2 specifies the styles that shall be supported by INSPIRE view services for each of these layer types.

In section **Erreur ! Source du renvoi introuvable.**, further styles can be specified that represent examples of styles typically used in a thematic domain. It is recommended that also these styles should be supported by INSPIRE view services, where applicable.

Where XML fragments are used in these sections, the following namespace prefixes apply:

- sld="http://www.opengis.net/sld" (WMS/SLD 1.1)
- se="http://www.opengis.net/se" (SE 1.1)
- ogc="http://www.opengis.net/ogc" (FE 1.1)

IR Requirement 13 For the portrayal of spatial data sets related to the theme *Geology* using a view network service as specified in Commission Regulation No 976/2009, the layers specified in section **Erreur ! Source du renvoi introuvable.** shall be available.

DS Requirement 8 For each layer specified in this section, the styles defined in section 11.2 shall be available.

NOTE One of the required styles may be defined as the default style. This style should be used for portrayal by the view network service if no user-defined style is specified in a portrayal request for a specific layer.

Recommendation 27 In addition, it is recommended that, where applicable, INSPIRE view services also support the styles defined in section **Erreur ! Source du renvoi introuvable.**.

11.1 Layers to be provided by INSPIRE view services

Layer Type	Layer Title	Spatial object type(s)
GE.GeologicUnitsLithology	Geologic Units	GeologicUnit
GE.GeologicFaults	Geologic Faults	GeologicStructure/ShearDisplacementStructure
GE.GeologicFolds	Geologic Folds	GeologicStructure/Fold
GE.GeomorphologicFeatureType	Geomorphologic Features	GeomorphologicFeature
GE.Boreholes	Boreholes	Boreholes
GE.Aquifers	Aquifers	Aquifer
GE.Groundwaterbodies	Groundwaterbodies	Groundwaterbody
GE.Wells	Wells	Wells

GeophysicsCore application schema

Layer type	Layer title	Spatial object type
GE.Geophysics.gravityStation	gravityStation	GeophStation
GE.Geophysics.magneticStation	magneticStation	GeophStation
GE.Geophysics.seismologicalStation	seismologicalStation	GeophStation
GE.Geophysics.magnetotelluricSounding	magnetotelluricSounding	GeophStation
GE.Geophysics.verticalElectricSounding	verticalElectricSounding	GeophStation
GE.Geophysics.boreholeLogging	boreholeLogging	GeophProfile
GE.Geophysics.seismicLine	seismicLine	GeophProfile
GE.Geophysics.multielectrodeDCProfile	multielectrodeDCProfile	GeophProfile
GE.Geophysics.3DSeismics	3DSeismics	GeophSwath
GE.Geophysics.groundGravitySurvey	groundGravitySurvey	Campaign
GE.Geophysics.groundMagneticSurvey	groundMagneticSurvey	Campaign
GE.Geophysics.airborneGeophysicalSurvey	airborneGeophysicalSurvey	Campaign
GE.Geophysics.seismologicalSurvey	seismologicalSurvey	Campaign
GE.Geophysics.3DResistivitySurvey	3DResistivitySurvey	Campaign

Recommended extensions for Geophysics

Layer type	Layer title	Spatial object type
GE.Geophysics.timeDomainEMSounding	timeDomainEMSounding	GeophStation
GE.Geophysics.frequencyDomainEMSounding	frequencyDomainEMSounding	GeophStation
GE.Geophysics.radiometricStation	radiometricStation	GeophStation
GE.Geophysics.seismologicalStation	seismologicalStation	GeophStation
GE.Geophysics.conePenetrationTest	conePenetrationTest	GeophStation
GE.Geophysics.compositLog	compositLog	curveModel
GE.Geophysics.layerModel	layerModel	curveModel
GE.Geophysics.seismicTimeSection	seismicTimeSection	curveModel
GE.Geophysics.flightLine	flightLine	GeophProfile
GE.Geophysics.verticalSeismicProfile	verticalSeismicProfile	GeophProfile
GE.Geophysics.georadarProfile	georadarProfile	GeophProfile
GE.Geophysics.seismicDepthSection	seismicDepthSection	surfaceGridModel
GE.Geophysics.verticalParameterGrid	verticalParameterGrid	surfaceGridModel
GE.Geophysics.seismicHorizon	seismicHorizon	surfaceGridModel
GE.Geophysics.horizontalParameterGrid	horizontalParameterGrid	surfaceGridModel
GE.Geophysics.parameterBlock	parameterBlock	solidGridModel
GE.Geophysics.seismicVolume	seismicVolume	solidGridModel
GE.Geophysics.3DMultielectrodeDC	3DMultielectrodeDC	GenericGeophyisicalMeasurement
GE.Geophysics.radarInterferometry	radarInterferometry	GeophSwath
GE.Geophysics.sonar	sonar	GeophSwath
GE.Geophysics.2DSeismicSurvey	2DSeismicSurvey	Campaign
GE.Geophysics.3DSeismicSurvey	3DSeismicSurvey	Campaign
GE.Geophysics.boreholeLoggingSurvey	boreholeLoggingSurvey	Campaign
GE.Geophysics.1DResistivitySurvey	1DResistivitySurvey	Campaign
GE.Geophysics.2DResistivitySurvey	2DResistivitySurvey	Campaign
GE.Geophysics.timeDomainEMSurvey	timeDomainEMSurvey	Campaign
GE.Geophysics.frequencyDomainEMSurvey	frequencyDomainEMSurvey	Campaign
GE.Geophysics.magnetotelluricSurvey	magnetotelluricSurvey	Campaign
GE.Geophysics.geoRadarSurvey	geoRadarSurvey	Campaign
GE.Geophysics.CPTSurvey	CPTSurvey	Campaign
GE.Geophysics.VSPSurvey	VSPSurvey	Campaign

GE.Geophysics.sonarSurvey	sonarSurvey	Campaign

11.1.1 Layers organisation

The geologic units layer is related to surface geology. For mapping Geologic features we use the MappedFeature who contains the geometry of all objects.
The model is independent from the scale, but some recommendations (in a technical guidelines) should ask for "harmonised" scale across Europe.

11.2 Styles to be supported by INSPIRE view services

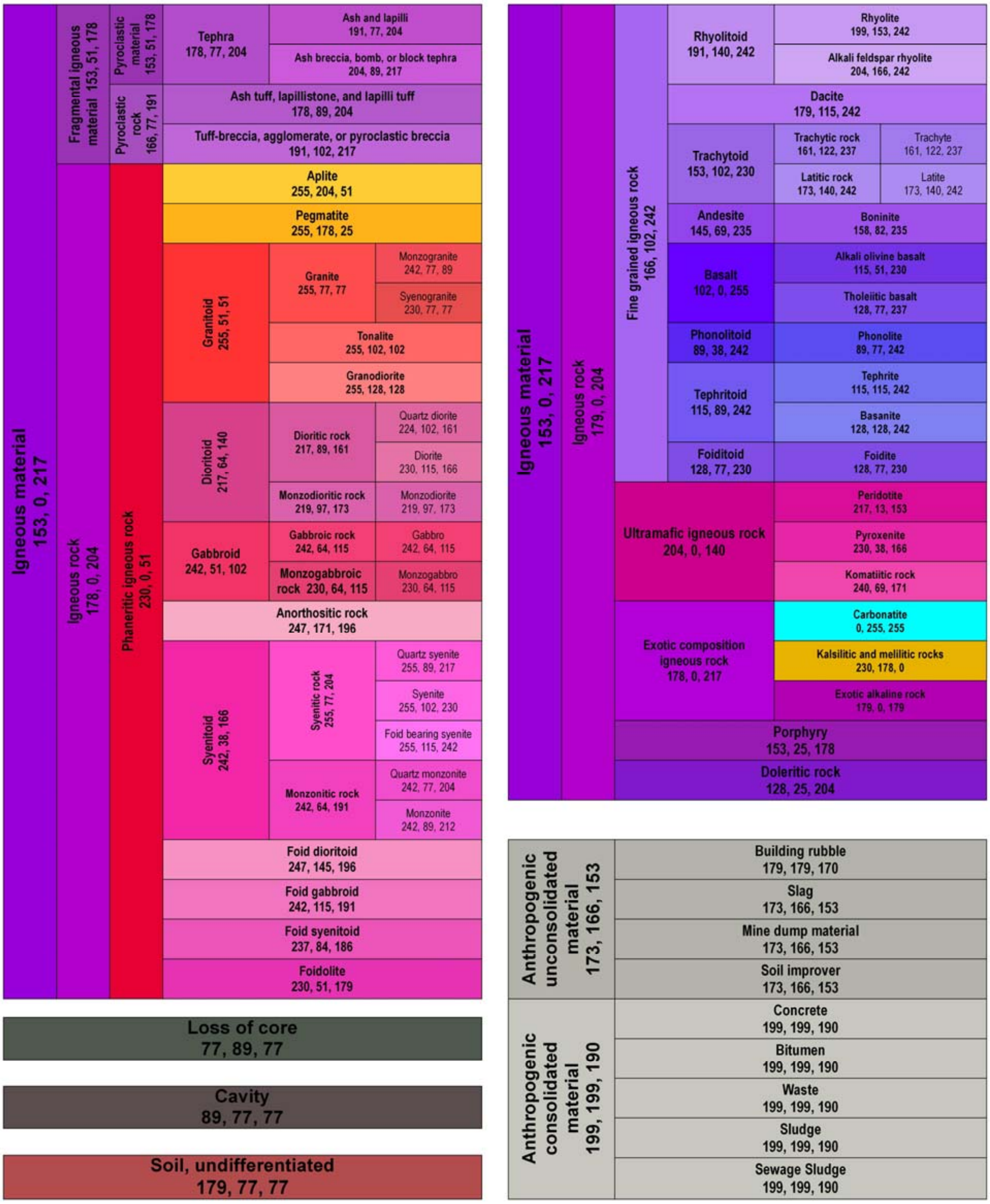
Open issue 2: The suggested styles are presented graphically. As there is no related standard but only some uses, the definition is still in discussion and required comments, suggestions from stakeholders. The template to provide detailed information about styles (Style Name, Default Style, Style Title, Style Abstract, Symbology, Minimum & maximum scales) will be used for the next version of this data specification.

11.2.1 Styles for the layer Geologic Units

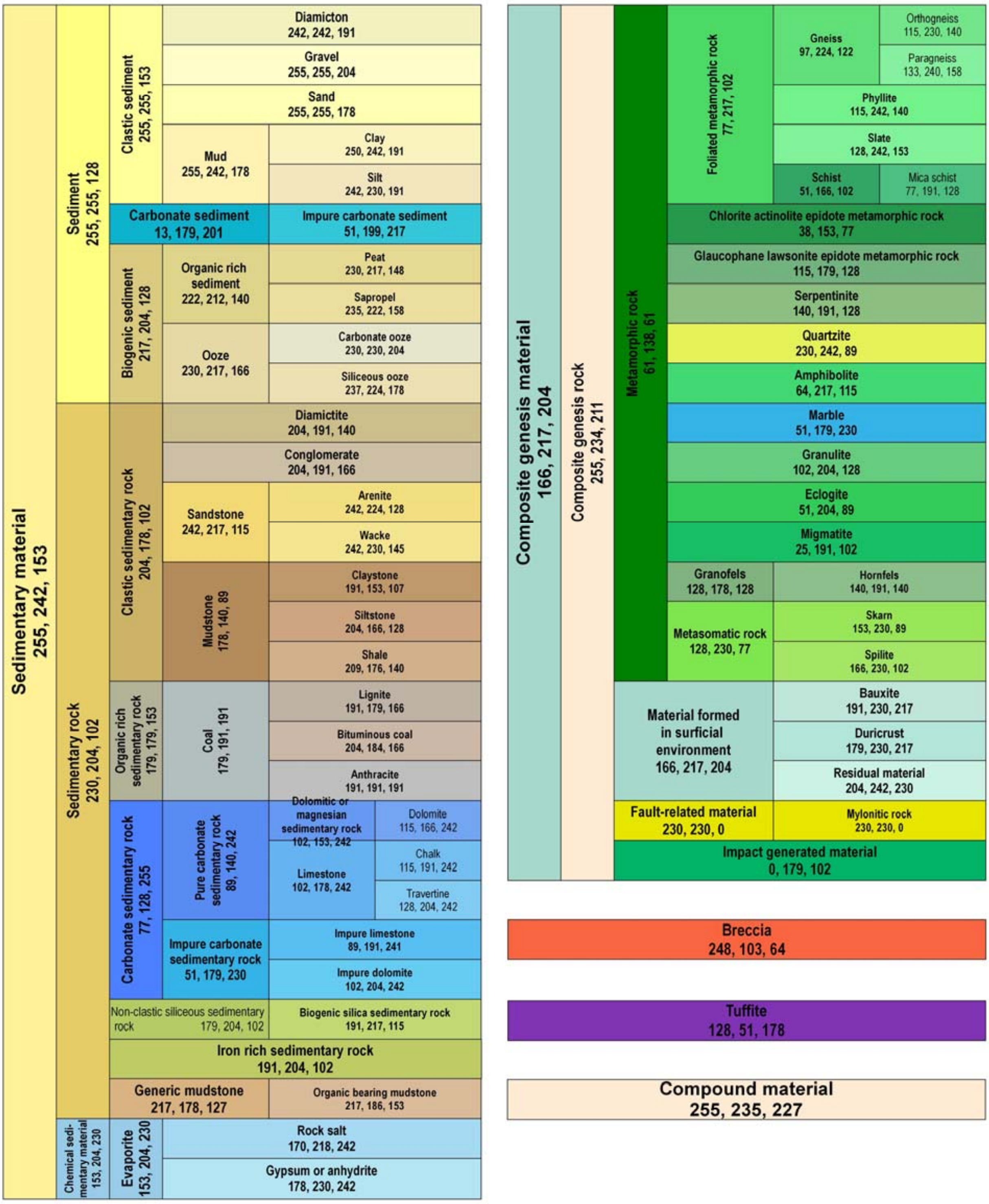
The way rock units are portrayed on maps is an important factor in facilitating the understanding of geological data and can be used to highlight, for example, the different lithologies or ages. For the user it is important to be able to recognise patterns and schemes, so that relevant information can be drawn from the spatial data base immediately.
A portrayal scheme for lithology, age and faults was developed for 1G-E with special attention paid to the particularities of the different European countries.
The polygons (MappedFeatures) of **Geologic Units** are portrayed by colours related to both the property LithologyTerm_Core and by colours related to the property olderNamedAge (based on the lower age). A proposal is to define the colours with the 3 numbers (Red, Green, Blue):

11.2.2 Styles for the lithology layer (LithologyTerm)

The colours and RGB codes for lithology are included as two A 4 sheets.
Colours according to the lithology colour scheme developed for the OneGeology-Europe project, with the addition of anthropogenic consolidated and unconsolidated material, loss of core, cavity and soil, undifferentiated.

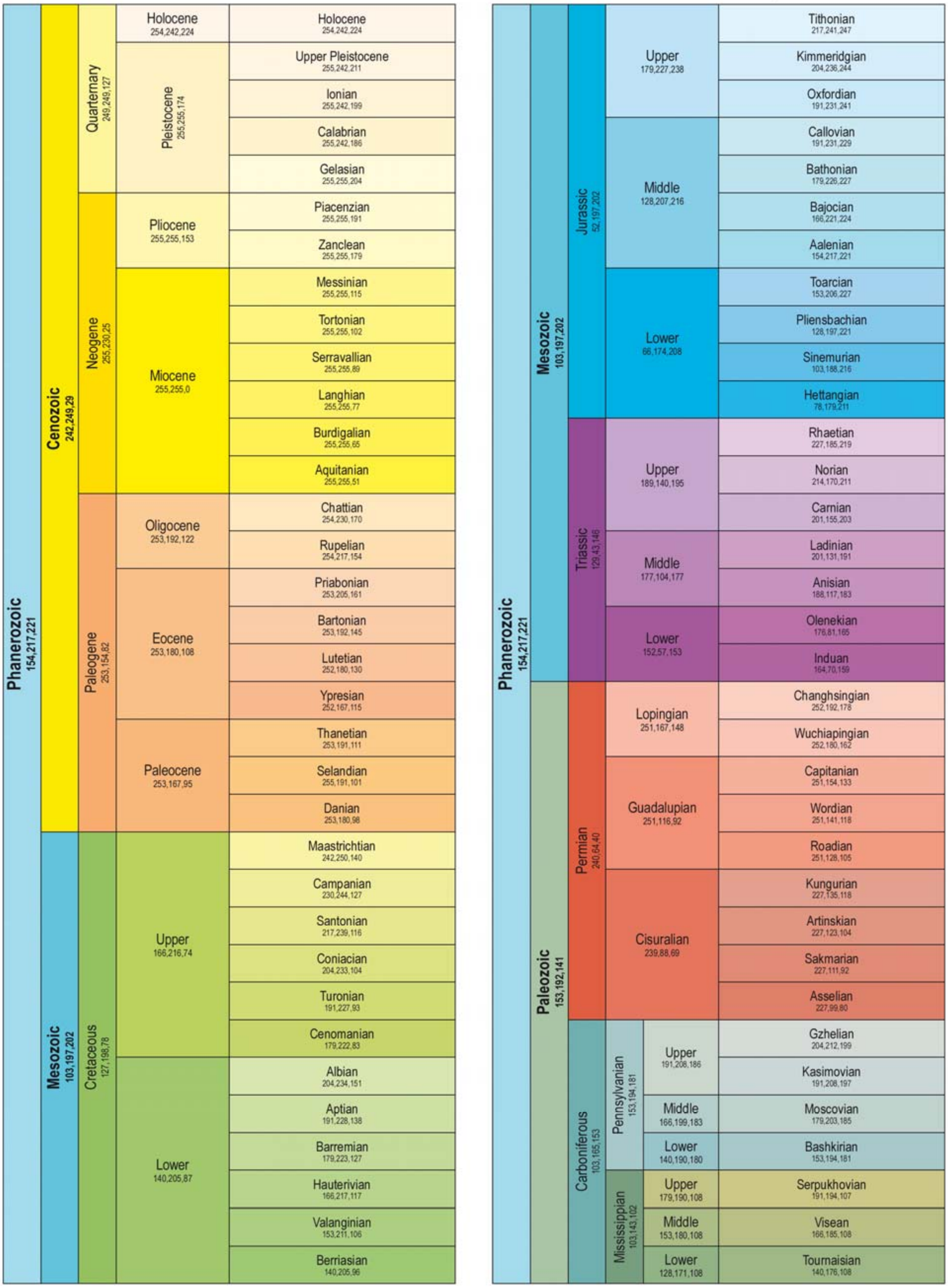


Igneous material 153, 0, 217
Fragmental igneous material 153, 51, 178
Pyroclastic material 153, 51, 178
Tephra 178, 77, 204
Ash and lapilli 191, 77, 204
Ash breccia, bomb, or block tephra 204, 89, 217
Pyroclastic rock 166, 77, 191
Ash tuff, lapillistone, and lapilli tuff 178, 89, 204
Tuff-breccia, agglomerate, or pyroclastic breccia 191, 102, 217
Igneous rock 178, 0, 204
Phaneritic igneous rock 230, 0, 51
Aplite 255, 204, 51
Pegmatite 255, 178, 25
Granitoid 255, 51, 51
Granite 255, 77, 77
Monzogranite 242, 77, 89
Syenogranite 230, 77, 77
Tonalite 255, 102, 102
Granodiorite 255, 128, 128
Dioritoid 217, 64, 140
Dioritic rock 217, 89, 161
Quartz diorite 224, 102, 161
Diorite 230, 115, 166
Monzodioritic rock 219, 97, 173
Monzodiorite 219, 97, 173
Gabbroid 242, 51, 102
Gabbroic rock 242, 64, 115
Gabbro 242, 64, 115
Monzogabbroic rock 230, 64, 115
Monzogabbro 230, 64, 115
Anorthositic rock 247, 171, 196
Syenitoid 242, 38, 166
Syenitic rock 255, 77, 204
Quartz syenite 255, 89, 217
Syenite 255, 102, 230
Foid bearing syenite 255, 115, 242
Monzonitic rock 242, 64, 191
Quartz monzonite 242, 77, 204
Monzonite 242, 89, 212
Foid dioritoid 247, 145, 196
Foid gabbroid 242, 115, 191
Foid syenitoid 237, 84, 186
Foidolite 230, 51, 179
Loss of core 77, 89, 77
Cavity 89, 77, 77
Soil, undifferentiated 179, 77, 77
Igneous material 153, 0, 217
Igneous rock 179, 0, 204
Fine grained igneous rock 166, 102, 242
Rhyolitoid 191, 140, 242
Rhyolite 199, 153, 242
Alkali feldspar rhyolite 204, 166, 242
Dacite 179, 115, 242
Trachytoid 153, 102, 230
Trachytic rock 161, 122, 237
Trachyte 161, 122, 237
Latitic rock 173, 140, 242
Latite 173, 140, 242
Andesite 145, 69, 235
Boninite 158, 82, 235
Basalt 102, 0, 255
Alkali olivine basalt 115, 51, 230
Tholeiitic basalt 128, 77, 237
Phonolitoid 89, 38, 242
Phonolite 89, 77, 242
Tephritoid 115, 89, 242
Tephrite 115, 115, 242
Basanite 128, 128, 242
Foiditoid 128, 77, 230
Foidite 128, 77, 230
Ultramafic igneous rock 204, 0, 140
Peridotite 217, 13, 153
Pyroxenite 230, 38, 166
Komatiitic rock 240, 69, 171
Exotic composition igneous rock 178, 0, 217
Carbonatite 0, 255, 255
Kalsilitic and melilitic rocks 230, 178, 0
Exotic alkaline rock 179, 0, 179
Porphyry 153, 25, 178
Doleritic rock 128, 25, 204
Anthropogenic unconsolidated material 173, 166, 153
Building rubble 179, 179, 170
Slag 173, 166, 153
Mine dump material 173, 166, 153
Soil improver 173, 166, 153
Anthropogenic consolidated material 199, 199, 190
Concrete 199, 199, 190
Bitumen 199, 199, 190
Waste 199, 199, 190
Sludge 199, 199, 190
Sewage Sludge 199, 199, 190

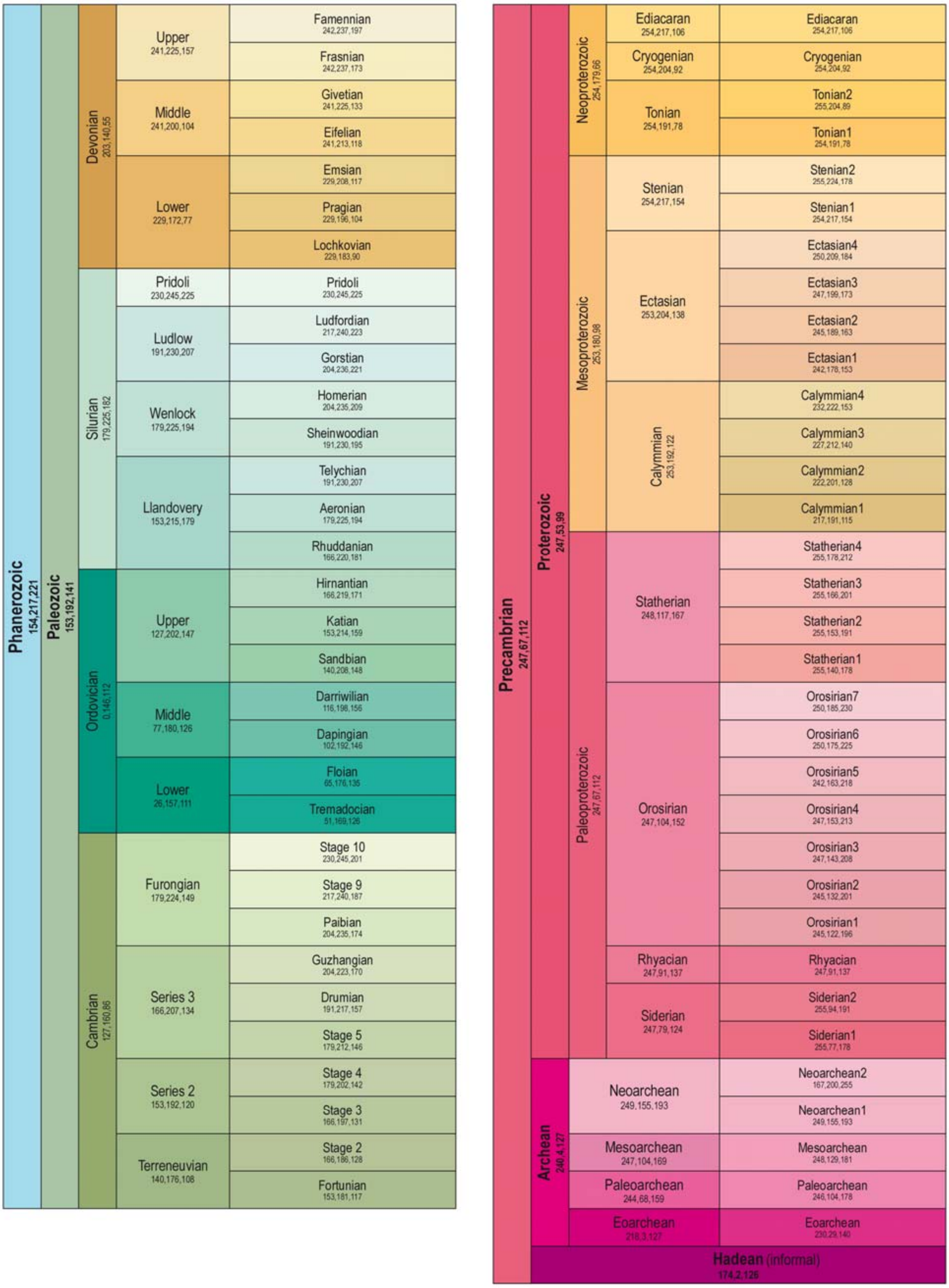


11.2.3 Styles for the age layer (olderNamedAge)

Colours according to the Geological Time Scale 2008, International Commission of Stratigraphy, with the addition of 27 newly defined colours for the proposed new European Proterozoic Epochs (by the OneGeology-Europe project). Please note, the defining age for the unit is the older age.



Phanerozoic 154,217,221
Cenozoic 242,249,29
Quarternary 249,249,127
Holocene 254,242,224
Holocene 254,242,224
Pleistocene 255,255,174
Upper Pleistocene 255,242,211
Ionian 255,242,199
Calabrian 255,242,186
Gelasian 255,255,204
Neogene 255,230,25
Pliocene 255,255,153
Piacenzian 255,255,191
Zanclean 255,255,179
Miocene 255,255,0
Messinian 255,255,115
Tortonian 255,255,102
Serravallian 255,255,89
Langhian 255,255,77
Burdigalian 255,255,65
Aquitanian 255,255,51
Paleogene 253,154,82
Oligocene 253,192,122
Chattian 254,230,170
Rupelian 254,217,154
Eocene 253,180,108
Priabonian 253,205,161
Bartonian 253,192,145
Lutetian 252,180,130
Ypresian 252,167,115
Paleocene 253,167,95
Thanetian 253,191,111
Selandian 255,191,101
Danian 253,180,98
Mesozoic 103,197,202
Cretaceous 127,198,78
Upper 166,216,74
Maastrichtian 242,250,140
Campanian 230,244,127
Santonian 217,239,116
Coniacian 204,233,104
Turonian 191,227,93
Cenomanian 179,222,83
Lower 140,205,87
Albian 204,234,151
Aptian 191,228,138
Barremian 179,223,127
Hauterivian 166,217,117
Valanginian 153,211,106
Berriasian 140,205,96
Phanerozoic 154,217,221
Mesozoic 103,197,202
Jurassic 52,197,202
Upper 179,227,238
Tithonian 217,241,247
Kimmeridgian 204,236,244
Oxfordian 191,231,241
Middle 128,207,216
Callovian 191,231,229
Bathonian 179,226,227
Bajocian 166,221,224
Aalenian 154,217,221
Lower 66,174,208
Toarcian 153,206,227
Pliensbachian 128,197,221
Sinemurian 103,188,216
Hettangian 78,179,211
Triassic 129,43,146
Upper 189,140,195
Rhaetian 227,185,219
Norian 214,170,211
Carnian 201,155,203
Middle 177,104,177
Ladinian 201,131,191
Anisian 188,117,183
Lower 152,57,153
Olenekian 176,81,165
Induan 164,70,159
Paleozoic 153,192,141
Permian 240,64,40
Lopingian 251,167,148
Changhsingian 252,192,178
Wuchiapingian 252,180,162
Guadalupian 251,116,92
Capitanian 251,154,133
Wordian 251,141,118
Roadian 251,128,105
Cisuralian 239,88,69
Kungurian 227,135,118
Artinskian 227,123,104
Sakmarian 227,111,92
Asselian 227,99,80
Carboniferous 103,165,153
Pennsylvanian 153,194,181
Upper 191,208,186
Gzhelian 204,212,199
Kasimovian 191,208,197
Middle 166,199,183
Moscovian 179,203,185
Lower 140,190,180
Bashkirian 153,194,181
Mississippian 103,143,102
Upper 179,190,108
Serpukhovian 191,194,107
Middle 153,180,108
Visean 166,185,108
Lower 128,171,108
Tournaisian 140,176,108

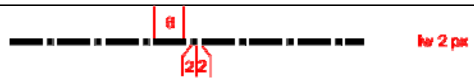
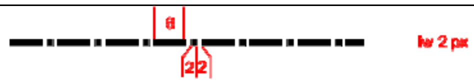
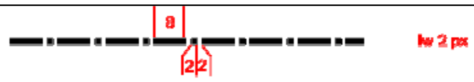
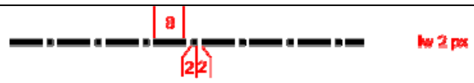
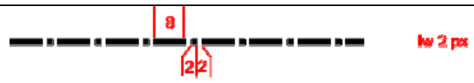


Phanerozoic 154,217,221
Paleozoic 153,192,141
Devonian 203,140,55
Upper 241,225,157
Famennian 242,237,197
Frasnian 242,237,173
Middle 241,200,104
Givetian 241,225,133
Eifelian 241,213,118
Lower 229,172,77
Emsian 229,208,117
Pragian 229,196,104
Lochkovian 229,183,90
Silurian 179,225,182
Pridoli 230,245,225
Pridoli 230,245,225
Ludlow 191,230,207
Ludfordian 217,240,223
Gorstian 204,236,221
Wenlock 179,225,194
Homerian 204,235,209
Sheinwoodian 191,230,195
Llandovery 153,215,179
Telychian 191,230,207
Aeronian 179,225,194
Rhuddanian 166,220,181
Ordovician 0,146,112
Upper 127,202,147
Hirnantian 166,219,171
Katian 153,214,159
Sandbian 140,208,148
Middle 77,180,126
Darriwilian 116,198,156
Dapingian 102,192,146
Lower 26,157,111
Floian 65,176,135
Tremadocian 51,169,126
Cambrian 127,160,86
Furongian 179,224,149
Stage 10 230,245,201
Stage 9 217,240,187
Paibian 204,235,174
Series 3 166,207,134
Guzhangian 204,223,170
Drumian 191,217,157
Stage 5 179,212,146
Series 2 153,192,120
Stage 4 179,202,142
Stage 3 166,197,131
Terreneuvian 140,176,108
Stage 2 166,186,128
Fortunian 153,181,117
Precambrian 247,67,112
Proterozoic 247,53,99
Neoproterozoic 254,179,66
Ediacaran 254,217,106
Ediacaran 254,217,106
Cryogenian 254,204,92
Cryogenian 254,204,92
Tonian 254,191,78
Tonian2 255,204,89
Tonian1 254,191,78
Mesoproterozoic 253,180,98
Stenian 254,217,154
Stenian2 255,224,178
Stenian1 254,217,154
Ectasian 253,204,138
Ectasian4 250,209,184
Ectasian3 247,199,173
Ectasian2 245,189,163
Ectasian1 242,178,153
Calymmian 253,192,122
Calymmian4 232,222,153
Calymmian3 227,212,140
Calymmian2 222,201,128
Calymmian1 217,191,115
Paleoproterozoic 247,67,112
Statherian 248,117,167
Statherian4 255,178,212
Statherian3 255,166,201
Statherian2 255,153,191
Statherian1 255,140,178
Orosirian 247,104,152
Orosirian7 250,185,230
Orosirian6 250,175,225
Orosirian5 242,163,218
Orosirian4 247,153,213
Orosirian3 247,143,208
Orosirian2 245,132,201
Orosirian1 245,122,196
Rhyacian 247,91,137
Rhyacian 247,91,137
Siderian 247,79,124
Siderian2 255,94,191
Siderian1 255,77,178
Archean 240,4,127
Neoarchean 249,155,193
Neoarchean2 167,200,255
Neoarchean1 249,155,193
Mesoarchean 247,104,169
Mesoarchean 248,129,181
Paleoarchean 244,68,159
Paleoarchean 246,104,178
Eoarchean 218,3,127
Eoarchean 230,29,140
Hadean (informal) 174,2,126

11.2.4 Styles for the layer Geologic Structures

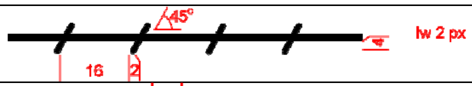
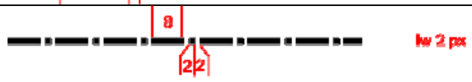
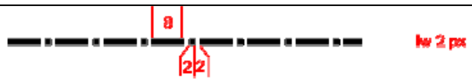
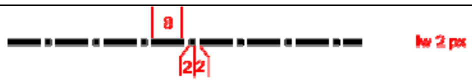
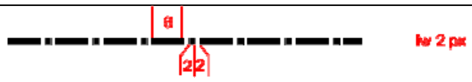
The lines (MappedFeatures) of **Geologic Structures** are portrayed by type. A proposal from the OneGeology_Europe is fault types (only coloured in black):

CGI Term (prefLabel)	Draw annotation	Colour (RGB)	Symbol [lw = line width in pixel]
fault		0, 0, 0	
strike slip fault		0, 0, 0	
dextral strike-slip fault		0, 0, 0	
sinistral strike-slip fault		0, 0, 0	
wrench fault		0, 0, 0	
reverse fault (no dip)	*Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)*	0, 0, 0	
thrust fault	*Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)*	0, 0, 0	
high angle reverse	*Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)*	0, 0, 0	
normal fault (no dip)		0, 0, 0	
low-angle normal fault	*Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction*	0, 0, 0	
detachment fault	*Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction*	0, 0, 0	
high-angle normal fault	*Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction*	0, 0, 0	
high-angle fault		0, 0, 0	
low-angle fault			
horizontal fault			

oblique slip fault			
left normal fault			
right normal fault			
left reverse fault			
right reverse fault			
scissor fault		255,51,51	
extraction fault		128,230,77	
mixed extraction fault		128,230,77	
pure extraction fault		128,230,77	

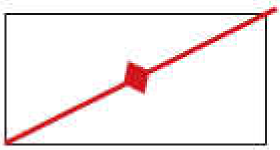
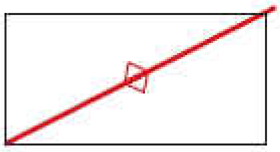
Another proposal makes the faults more visible on the map, but could be more difficult to implement

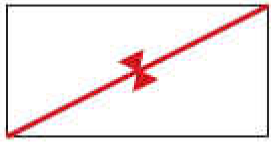
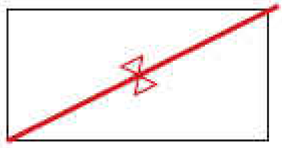
OneGeology-Europe Term	Draw annotation	Symbol [lw = line width in pixel]	R	G	B
fault			0	0	0
strike slip fault			0	0	0
dextral strike-slip fault			0	0	0
sinistral strike-slip fault			0	0	0
reverse fault (no dip)	*Symbols in the upthrown block. The line should be drawn so that the upthrown block is to the right in the drawing direction.)*		0	0	0
thrust fault	*Symbols in the upthrown block. The line should be drawn so that the upthrown block is to the right in the drawing direction.)*		0	0	0
high angle reverse	*Symbols in the upthrown block. (The line should be drawn so that the upthrown block is to the right in the drawing direction.)*		0	0	0
normal fault (no dip)	*Symbols in the downthrown block. (The line should be drawn so that the downthrown block is to the right in the drawing direction)*		0	0	0
low-angle normal fault	*Symbols in the downthrown block. The line should be drawn so that the downthrown block is to the*		0	0	0

	right in the drawing direction)				
detachment fault	*Symbols in the downthrown block. The line should be drawn so that the downthrown block is to the right in the drawing direction)*		0	0	0
high-angle normal fault	*Symbols in the downthrown block. The line should be drawn so that the downthrown block is to the right in the drawing direction)*		0	0	0
oblique slip fault			0	0	0
left normal fault			0	0	0
right normal fault			0	0	0
left reverse fault			0	0	0
right reverse fault			0	0	0
scissor fault	255,51,51	lw 2 px	255	51	51
extraction fault	128,230,77	lw 2 px	128	230	077
mixed extraction fault	128,230,77	lw 2 px	128	230	077
pure extraction fault	128,230,77	lw 2 px	128	230	077

11.2.5 Styles for the layer Folds

The lines (MappedFeatures) of **Folds** are portrayed by type.

Term	Colour (RGB)	Line width	Symbol
anticline	**230, 0,51**	**1 px**	
antiform	**230, 0,51**	**1 px**	

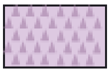
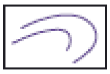
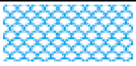
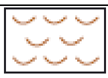
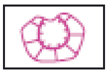
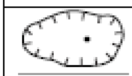
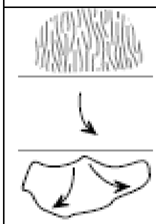
syncline	**230, 0,51**	**1 px**	
synform	**230, 0,51**	**1 px**	

11.2.6 Styles for the layer Geomorphologic Features

The fact that a widely accepted standard for Geomorphological mapping symbology is not yet available makes difficult to present here a generalized portrayal for representing the mapped Geomorphological objects. Some current uses include:
Color codes: Some rules consider color codes associated to the landform genesis or geomorphic environments (References 1 and 2). In other cases (Reference 3) the color code is not directly related to any specific geomorphic environment:

ORIGIN		GENESIS OR GEOMORPHIC ENVIRONMENT	COLOR	C,M,Y,K CODE	REFERENCE
NATURAL	ENDOGENOUS	Structural	**Black**	0,0,0,100	1
			Red	0 100 100 0	2
		Volcanic	**Pink**	18,83,0,0	1
			Black; Red	0,0,0,100; 100% red	3
	EXOGENE	Gravitational (Mass-movements; Landslide and mass-wasting features)	**Brown**	0,56,94,34	1
			Ochre	8 46 91 2	2
			Black; Magenta	0,0,0,100; 0,100,0,0	3
		Fluvial, Alluvial and surface runoff	**Green**	100,0,65,0	1
			Green	100 0 100 20	2
			Cyan	100,0,0,0	3
		Glacial, periglacial and nival	**Violet**	78,79,6,0	1
		Glacial	**Violet**	80 100 0 10	2
			Cyan; Grey	100,0,0,0	3
		Periglacial	**Mauve**	10 100 0 10	2
			Cyan	100,0,0,0	3
		(Snow) Avalanches	**Burgundy Red**	10 100 80 10	2
		Permanent snowfields	**Cyan**	100,0,0,0	3
		Eolian	**Yellow**	0,27,76,0	1
			Black	0,0,0,100	3
		Lacustrine and endoreic	**Light Blue**	76,0,6,0	1
		Lacustrine	**Dark Blue**	100 40 0 40	2
		Lacustrine and marine	**Cyan**	100,0,0,0	3
		Littoral	**Blue**	100,43,0,0	1
		Chemical weathering, Karstic and Collapse features	**Red**	0,91,87,0	1
			Turquoise	100 0 40 0	2
			Black	0,0,0,100	3
		Other natural landforms (i.e, natural impact features)	**Orange**	0,51,87,0	1
			Black	0,0,0,100	3
ANTHROPOGENIC		Anthropogenic	**Olive green**	0,0,100,43	1
			Grey	0 0 0 50	2
		Hazardous waste sites	**Red**	100% red	3
		Surface mining	**Black**	0,0,0,100	
		Areas of extensively disturbed ground; surface workings; subsurface workings projected to surface	**Black; Red**	0,0,0,100; 100% red	

Polygons, lines and points: Depending on the information resolution, the landforms are represented using polygons, lines or points. As an example:

SYMBOL	LANDFORM/FEATURE	GENESIS OR GEOMORPHIC ENVIRONMENT	REFERENCE
	Frontal moraine (Polygon)	Glacial	1
	Cordones, contornos o crestas morrénicas (Line)		1
	Cordon morainique (Line)		2
	Crest of moraine (Line)		3
	Solifluction lobes (Polygon)	Periglacial	3
	Area with solifluction (Polygon)	Gravitational	1
	Loupes de solifluction (Line)	Periglacial	2
	Volcanic cone with crater (Polygon)	Volcanic	1
	Rim of volcanic crater. Dot shows low point of crater		3
	Éboulement (Landslide) (Polygon and line)	Gravitational	2
	Area of slip surface of landslide, Direction of downslope movement of landslide and Landslide deposits—Arrows show direction of downslope movement (Polygon,and line)		3
	Landslide (Line)		1

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2. Université de Lausanne. Faculté des Géosciences et de l'Environnement. Institut de Géographie. *http://www.unil.ch/igul/page19238.html* (April 2011)

3. Federal Geographic Data Committee [prepared for the Federal Geographic Data Committee by the U.S. Geological Survey], 2006, FGDC Digital Cartographic Standard for Geologic Map Symbolization: Reston, Va., Federal Geographic Data Committee Document Number FGDC-STD-013-2006, 290 p., 2 plates.

11.2.7 Styles for the layer for the layer Borehole Purpose

The Point Symbols of Boreholes (Borehole_Core) are portrayed according to the BoreholePurposeTerm_Core by type. Windings Font……..:

Term (BoreholePurposeTerm_Core**)**	**Portrayal**	**Portrayal Code**
Aquaculture	⧈	170-w2
Contingency water supply	◘	165-w2
Dewatering	☐ + ▲	163-w2 + 230-w2
Disposal	⊗	85-w2
Drinking water supply	☐ + ◆	163-w2 + 174-w2
Emergency water supply	☐ + ✷	163-w2 + 237-w2
Enviromental monitoring	⭘	155-w2
Exploration and exploitation of nonmetallic mineral deposits	✖	209-w2
Eploration and exploitation of raw material	★	171-w
Exploration of natural underground storage space	⬟	193-w2
Exploration on exploitation of energy resources	◆	191-w2
Flowing Shot	☒	163-w2
Geochemical survey, analyses	✧	178-w
Geological survey	✚	202-w2
Geophysical survey	✳	226-w2
Geotechnical Survey, construction site charcterization	⌑	179w
Geothermal energy, geothermal heat exchangers	✡	236-w2
Groundwater level monitoring	■ + ✧	162-w2 + 178-w
Hydrogeological survey	■	162-w2
Industrial water supply	☐ + ✸	163-w2 + 236-w2
Irrigation	☐ + ✦	163-w2 + 231-w2
Mineral	⟐	185-w2
Mitigation	◉	156-w2
Monitoring quality	✪	181w
Oil	◈	179-w2
Oil exploratory	◈	178-w2
Pedological Survey	⬢	195-w2
Pollution monitoring (waste dumps etc.)	⦸	88-w2
Recharge	⊡	167-w2
Remediation	●	152-w2
Shallow methane production	◇	176-w2
Shot hole	✳	224-w2
Sparging / thermal cleaning	⊙	56-w2
Water injection	▣	168-w2
	☐	Fonts:

		w = Wingdings
		w2 = Windings2

11.2.8 Styles for Geophysics

11.2.8.1. GeophysicsCore application schema

Geophysical layers have three basic styles according to their projected geometry and feature type: point, line string and polygon styles. Features sub classed from GeophObject are marked by filled symbols, lines or polygons of different colour and size. Features sub classed from GeophObjectSet has no fill. SLD files are to be generated from the style definition tables below. Rendered styling examples are available at *http://geomind.elgi.hu/def/coreStyles.html*

Geophysical stations

Gravity, magnetic and seismological stations are portrayed according to the value of their stationRank attribute.

Layer Title	Station Rank	Geometry	Stroke RGB	Fill RGB	Symbol	Size
gravity station	Observatory	point		#FF6600	square	14
gravity station	1stOrderBase	point		#FF6600	circle	14
gravity station	2ndOrderBase	point		#FF6600	circle	12
magnetic station	Observatory	point		#00CCFF	square	14
magnetic station	secularStation	point		#00CCFF	triangle	14
magnetic station	1stOrderBase	point		#00CCFF	circle	14
magnetic station	2ndOrderBase	point		#00CCFF	circle	12
seismological station	Observatory	point		#993366	square	14
seismological station	1stOrderBase	point		#993366	circle	14
seismological station	2ndOrderBase	point		#993366	circle	12
MT		point		#FFFF00	circle	10
VES		point		#C0C0C0	circle	10

Other core objects

Layer Title	Geometry	stroke RGB	fll RGB	symbol	size
borehole logging	point		#00FF00	circle	12
seismic line	linestring	#FF0000			
Multielectrode DC profile	linestring	#C0C0C0			
3D Seismics	polygon	#000000	#FF0000		
ground gravity survey	polygon	#FF6600			
ground magnetic survey	polygon	#00CCFF			
airborne geophysical survey	polygon	#3366FF			
seismological survey	polygon	#993366			
3D resistivity survey	polygon	#C0C0C0			

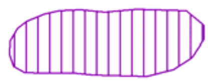
11.2.8.2. Recommended extensions for Geophysics

Recommended styling parameters for optional geophysical layers:

Layer Title	Geometry	stroke RGB	fll RGB	symbol	size
TDEM	point		#FF00FF	circle	10
FDEM	point		#FF99CC	circle	10
radiometric station	point		#800080	circle	10
seismological station	point		#993366	circle	10

CPT	point		#CCFFCC	circle	10
composit log	point		#339966	circle	10
layer model	point		#3366FF	circle	10
seismic time section	linestring	#FF99CC			
Flightline	linestring	#3366FF			
VSP	linestring	#FFCC99			
georadar profile	linestring	#99CC00			
seismic depth section	linestring	#FF00FF			
vertical parameter grid	linestring	#808080			
seismic horizon	polygon	#000000	#FF00FF		
horizontal parameter grid	polygon	#000000	#808080		
radar Interferometry	polygon	#000000	#99CC00		
parameter block	polygon	#000000	#FFFFFF		
seismic volume	polygon	#000000	#FF00FF		
3DMultielectrodeDC	polygon		#C0C0C0		
Sonar	polygon	#000000	#FFFFFF		
2D seismic survey	polygon	#FF0000			
3D seismic survey	polygon	#FF0000			
borehole logging survey	polygon	#00FF00			
VES survey	polygon	#C0C0C0			
2D resistivity survey	polygon	#C0C0C0			
TDEM survey	polygon	#FF00FF			
FDEM Survey	polygon	#FF99CC			
MT survey	polygon	#FFFF00			
georadar survey	polygon	#99CC00			
CPT survey	polygon	#CCFFCC			
VSP survey	polygon	#FFCC99			
sonar survey	polygon	#000000			

11.2.9 Styles for the layer aquifer type

Term	Colour (RGB)	Line width	Symbol
confined SubArtesian	132, 0, 168	1,5 px	
confined Artesian	132, 0, 168	1,5 px	
unconfined	132, 0, 168	1,5 px	

11.2.10 Styles for the layer aquifer media type

Term	Colour (RGB)	Symbol
fractured	161,201,140	
porous	116,181,207	
karstic	204,224,188	
compound	255,211,127	
karsticAndFractured	150,160,110	
porousAndFractured	133,194,163	
other	232,218,193	

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[OGC 06-103r3] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.0

Annex A (normative)

Abstract Test Suite

Any dataset conforming to this INSPIRE data specification shall meet all requirements specified in this document.

Open issue 3: Conformance testing is still an open issue under discussion.

Instructions on conformance testing and a common abstract test suite (including detailed instructions on how to test specific requirements) will be added at a later stage.

(informative)
Use cases

B.1 Introduction
This annex describes the use cases related to Geology, Hydrogeology & Geophysics, that were used as a basis for the development of this data specification.

B.2 Use cases for Geology
Geological information is mainly collected or produced to be used by other thematic domains (geo-hazard assessment, ensuring safe disposal of wastes, providing construction material, …) as described in the document "Examples of use".
B.2.1 UC01: Providing geological data to detect geo-hazards
This use case is related to example of use:
GE-02: Detecting geo-hazards.
B.2.1.1 Overview and involved actors
This use case is a part of a more general use case which provides risk maps in a process that involves many other data than geological data (like meteorological data, elements at risk, …) in the disaster management cycle.
The goal of this use case is therefore to deliver geological data to the engineer responsible for establishing risk maps.

Actors:
Geological surveys to provide geological information (Geological Surveys represent the Member States)
Engineers responsible for establishing risk maps using the geological information in combination with other data.
B.2.1.2 Narrative description
The hazard is often defined as the probability of occurrence of a potentially damaging phenomenon within a given area and a given period of time. To define this probability the engineer has to access data describing the physical, chemical, mechanical properties of rocks.

B.2.1.3 Detailed description

Use case description	
Name	Providing geological data to detect geo-hazards
Priority	High
Description	The user selects the relevant geographic area and search for geological data: geological map, borehole data, and geotechnical data.
Pre-condition	Geological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between geological terms and user's terms (done by the data provider?).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for geological maps with lithological and structural information.
Step 2	The user displays the geological map and accesses detailed information about the geologic units (lithology) and structures (existing faults)
Step 3	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth, water level, physical and chemical properties
Step 4	The user accesses the borehole data to get the values of the properties.
Step 5	The user searches in a metadata catalogue for geotechnical data

	related to the area (existing measurements), or geotechnical properties related to the lithology in general.
Step 6	The user accesses the geotechnical data to get the values of the properties.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of geological data related to the selected area.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Geological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.1.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Geological units with:
their related polygons
lithology

Geologic structures (faults) with:
their related lines
attribute: active or non-active

Borehole data with:
geologic unit thickness and depth
water level
any other properties (physical and chemical) measured

Geotechnical data with:
data related to the geologic units (from measurements: porosity, …)
or values related to the rock types in general

B.2.1.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Soils: the geotechnical properties are those of the rocks but also of the soil on a “continuous column”.
Natural Risk Zones: Geology is a provider of information about underground to engineers who has to define the risk zones.

B.2.2 UC02: Providing geological data to ensure safe disposal of waste
This use case is related to example of use:
GE-03: Ensuring the safe disposal of wastes, Nuclear Waste, Carbon Capture and Storage.
B.2.2.1 Overview and involved actors
This use case is a part of a more general use case which provides geological data in a process that involves many other data than geological data (like population distribution, land use …) in the waste disposal management cycle. It is relevant for the disposal of many different kinds of waste in various

geological environments. The goal of the use case is to deliver geological data to the authorities and companies responsible for safe disposal of waste.

Actors:
Geological surveys to provide geological data (Geological Surveys represent the Member States)
Authorities and companies responsible for safe disposal of waste using the geological data in combination with other data.
B.2.2.2 Narrative description
“Safe disposal” usually means that the waste is placed in the bedrock or in unconsolidated superficial deposits at some depth (< 2 500 meters) below the surface. Depending on the nature of the waste the actual site of disposal is either in a natural space (e.g. pore space) or in man-made space (e.g. excavation or bore hole). Examples of waste are burned nuclear fuel and carbon dioxide. Geological data is needed to build a 3D-model that is used and refined during all stages of the waste disposal process: site selection, planning, characterization, construction, and follow-up program.

B.2.2.3 Detailed description

Use case description	
Name	Providing geological data to ensure safe disposal of waste
Priority	High
Description	The user selects the relevant geographic area and searches for geological data from the surface and underground: geological map, borehole data, groundwater data, geophysical and geochemical data.
Pre-condition	Geological data are available in line with INSPIRE specifications.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps with lithological and structural information.
Step 2	The user displays the geological map and accesses detailed information about the geologic units (lithology etc) and structures (existing faults)
Step 3	The user searches in a metadata catalogue for mineral resource data with information about location of known mineral deposits
Step 4	The user displays the mineral resource data and accesses detailed information about the deposits
Step 5	The user searches in a metadata catalogue for geophysical data with information about seismicity and survey data
Step 6	The user displays the geophysical data and accesses detailed information about the geophysical expression of the rocks
Step 7	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth, water level, physical and chemical properties, fracture properties
Step 8	The user accesses the borehole data to get the values of the properties.
Step 9	The user searches in a metadata catalogue for groundwater data with information about groundwater flow and groundwater chemistry
Step 10	The user accesses the groundwater data to get the values of the properties.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of geological data for 3D-modelling of the selected area.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	

Description	Geological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	National to local
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.2.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Geological units with:
their related spatial objects
lithology, mineralogical composition, chemical composition, age, contact relationships, alteration

Geologic structures (faults) with:
their related spatial objects
attribute: active or non-active

Mineral resource data
location of mineral deposits

Geophysical data
seismicity
survey data (magnetic, electromagnetic, gravity, elevation)

Borehole data with:
location of bore holes
geologic unit thickness and depth
water level
mineralogical and chemical composition of rocks
porosity, permeability, temperature, fracture pressure, capillary pressure
fracture frequency, fracture fillings

Groundwater data
location of wells
groundwater flow
groundwater chemistry

B.2.2.5 Relationship with other INSPIRE Themes
This use case some relationships with the following INSPIRE data themes.

Environmental monitoring facilities: Aquifer monitoring stations, seismicity networks
Protected sites: Groundwater protection
Elevation: Digital elevation models

B.2.3 UC03: Providing geological data to detect ground instability in a flat area

This use case is related to example of use:
GE-02: Detecting geo-hazards.
B.2.3.1 Overview and involved actors
This use case is a very particular case which provides risk maps in a process that involves many other data than geological data (like use of the subsurface data, elements at risk…) in the land and urban management cycle.

The goal of this use case is to deliver geological data to the responsible for land and urban planning. These data should then be merged with other related data, in order to construct a basic framework which allows classifying areas according to its hazard and risk levels. From this, further specific works, at the scale of the project, should be developed.

Actors:
Geological surveys to provide geological information, including hazard assessment, if available (Geological Surveys represent the Member States)
Mining Authorities to provide information on active and abandoned underground activities
Geological Surveys and/or Water Authorities to provide information on groundwater
Responsible for establishing risk maps using the geological information in combination with other data.
Land and urban planners
B.2.3.2 Narrative description
Land and urban planning need to know the ground stability for safe infrastructure development.

In flat areas, ground instabilities are mainly related to:

The existence of soluble lithologies in the subsurface (i.e. evaporites: gypsum or salt; carbonates…)
The existence of sand and gravel deposits, loess, peat, shrinking and swelling clays, and other unconsolidated materials, including artificial landfills.
The variations in the water table (natural and induced by artificial activities)
The existence of a (melting) permafrost
The presence of mining, gas production, subsurface infrastructures and other anthropic underground structures, both active and abandoned
The seismic activity

Some surface features, as are dolines, some kind of depressions, or other landforms, can be indications of ground instability.

The three first groups of data (lithologies, unconsolidated deposits and hydrogeological data) and the surface features indicating ground instability (geomorphological elements) are geological data and the rest are related data.

(The hazard is often defined as the probability of occurrence of a potentially damaging phenomenon within a given area and a given period of time. To define this probability the engineer has to access data describing the physical, chemical, mechanical properties of rocks).

B.2.3.3 Detailed description

Use case description	
Name	Providing geological data to detect ground stability in a flat area
Priority	High
Description	The user views the geographic work area and search for geological data (geological map, borehole data, geotechnical data) and other related data (presence of mining, gas production, subsurface infrastructures and other anthropic underground activities, both active and abandoned; presence of permafrost; seismological zoning)
Pre-condition	Geological and the other related data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between geological terms and user's terms (done by the data provider).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for geological maps with lithological, structural and geomorphological information.
Step 2	The user displays the geological map and accesses detailed information about the geologic units (rock type, including unconsolidated natural materials and anthropogenic deposits or landfills), the landforms (indices of collapse structures), hydrogeological (watertable) and tectonic structures (existing faults)

Step 3	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth (including artificial landfills), water level, physical and chemical properties
Step 4	The user accesses the borehole data to get the values of the properties.
Step 5	The user searches in a metadata catalogue for geotechnical data related to the area (existing measurements), or geotechnical properties related to the materials in general.
Step 6	The user accesses the geotechnical data to get the values of the properties.
Step 7	The user downloads all the selected information to his computer and makes a specific map of the work area
Flow of events – Alternative path	
Post-conditions	
Post-condition 1	The user has a set of geological data related to the selected area (a specific geological map).
Post-condition 2	The same user (or a different user involved in the land and urban management) merges the geological information with the other related data and constructs a map which will be the basis for further specific, on site works, at the scale of the project.
Data source: INSPIRE-conformant Geology and other related data set provided by Member Sate	
Description	Geological and other related data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.3.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Geological units, including artificial unconsolidated deposits, with:
their related polygons
lithology

Geologic structures (contacts (primary = original, and secondary = mechanical: faults) with:
their related lines
their related indications of dip and dip direction
landforms (collapse structures, dolines)
attribute: active or non-active

Borehole data with:
geologic unit thickness and depth
water level
any other properties (physical and chemical) measured

Geotechnical data with:
data related to the geological units (from measurements: porosity, …)
or values related to the rock types in general

B.2.3.5 Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:
Soils: the geotechnical properties are those of the rocks but also of the soil on a "continuous column".
Natural Risk Zones: Geology is a provider of information about underground to engineers who have to define the risk zones.
Energy
Several aspects from Annex I
B.2.4 UC04: Looking for deep fractured zones in the basement (Geothermal exploration)
This use case is related to example of use:
GE-12: Use of geophysics.
B.2.4.1 Overview and involved actors
This use case is part of a more general use case of providing access to public geophysical information for users interested in mineral or geothermal exploration.
The goal of this use case is to demonstrate the interoperability between geological, borehole and geophysical data services.

Actors:
Geological surveys to provide geological information
Geophysicists responsible for establishing
Geothermal exploration company (user)
B.2.4.2 Narrative description
.
In order to find an optimum location for a geothermal drilling the user is looking for data resources related to deep fractured zones in a specific geological unit. Borehole locations are identified in a GIS search and then a specific borehole is selected. From the list of geological units crossed by the borehole the one related to the carboniferous basement is selected and the related observations are examined. From the observation results a geophysical resistivity cross section is selected. If it is freely available the user can download the online resource, otherwise the distributor is contacted and the data is purchased.

B.2.4.3 Detailed description

Use case description	
Name	Looking for deep fractured zones in the basement
Priority	High
Description	
Pre-condition	Geological data are available in line with INSPIRE specifications.
Flow of events – Basic path	
Step 1	The user selects „borehole" from the catalogue of available features on the geoportal.
Step 2	Starts a BBOX search for boreholes in the target area
Step 3	Locates a borehole and opens it
Step 4	Identifies a geologicUnit from the list of features of interest and opens it. (basement)
Step 5	Selects a physical property (conductivity) of the geologicalUnit and opens the list of related observations
Step 6	The results of the selected observation is a geophysical model (2D MT conductivity profile showing the resistivity variations of the basement)
Step 7	The user opens the coverage in a 3D viewer
Flow of events – Alternative path	
Step 7	The user checks the distribution metadata of the model and finds the link to the data provider
Step 8	Data provider is contacted and the results are purchased
Post-conditions	
Post-condition	
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Geological data from national sources.

Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.4.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Borehole data with:
geologic unit thickness and depth
water level
any other properties (physical and chemical) measured

Geological units crossed by the borehole with:
their physical properties (conductivity) and related observations

Geophysical objects:
geophysical method type, location, distribution metadata
geophysical cross section, online resource, distribution metadata

B.2.4.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Mineral resources – for exploration
Energy resources – for the Geothermal potential

B.2.5 UC05: Checking background radiation level changes

This use case is related to example of use:
GE-12: Use of geophysics.
B.2.5.1 Overview and involved actors
This use case is part of a more general use case of providing access to public geophysical information for users interested in the physical state of environment and the impact of industrial contaminations.
The goal of this use case is to demonstrate the importance of access to geophysical monitoring data in order to locate large areas affected by possible radioactive contamination.

Actors:
Environment agency (user)
Geophysicists responsible for establishing
B.2.5.2 Narrative description

After a nuclear power plant accident an environment agency analyses the impact of the possible radioactive contamination and collects information on the changes of background radiation intensity. The INSPIRE geoportal is used to locate airborne geophysical surveys that acquired total gamma radiation data over large areas before and after the accident. The results are compared and the areas showing significant changes are outlined for further inversitation.

B.2.5.3 Detailed description

Use case description	
Name	Checking background radiation level changes
Priority	High
Description	
Pre-condition	Geological data are available in line with INSPIRE specifications.
Flow of events – Basic path	
Step 1	The user starts a BBOX search for airborne geophysical surveys

	carried out before the accident in the target area
Step 2	The user locates a survey and checks the measured physical parameters
Step 3	If the list of physical parameters include total gamma radiation the user checks the distribution metadata of the model and finds the link to the data provider
Step 4	The user starts a BBOX search for airborne geophysical surveys carried out after the accident in the target area
Step 5	The user locates a survey and checks the measured physical parameters
Step 6	If the list of physical parameters include total gamma radiation the user checks the distribution metadata of the model and finds the link to the data provider
Step 7	Data provider is contacted and the results are purchased
Step 8	Radiation maps are compared and anomalous areas are selected for further investigation
Post-conditions	
Post-condition	
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Geological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.5.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Geophysical Survey:
geometry, geophysical method type (airborne geophysics), list of measured physical parameters (total gamma radiation)
distribution metadata

B.2.5.5 Geophysical features

From the use cases there is a request for three main types of geophysical features. These are:

Geophysical measurement
Geophysical model
Geophysical survey

Geophysical measurement

Geophysical measurements are artifacts to study the spatial distribution of physical properties within the observed domain, most often underground geologic structures. Usually measured data itself can not be used directly in geological interpretation. It has to be analyzed by experts to create geophysical models. The availability and location of geophysical measurements, especially those collected in hydrocarbon, geothermal exploration or environmental studies are considered as information of public interest in most member states.

Geophysical model

Geophysical models are results of data processing. They represent spatial distribution of physical properties within the observed domain, typically underground geologic structures. Geophysical models can be used directly for geologic interpretation. Results are distributed either in industry standard format or as GML coverage.

Geophysical survey

Geophysical exploration surveys may include large number of measurements over large areas. The individual measurements may not be important for the user, but the existence, type, and availability of their results are essential.

B.2.5.6 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:

Human health – for identifying areas with different level of hazard caused by increased background radiation intensity
Natural risk zones – to register hazardous areas with increased background radiation intensity

B.2.6 UC06: Providing data to undertake water balance to ensure compliance with the WFD
This use case is related to example of use:
AQ-01: Water supply (water abstraction).
B.2.6.1 Overview and involved actors
The goal of this use case is therefore to deliver hydrogeological data to professionals responsible for establishing whether groundwater bodies are over or under abstracted according to the WFD. Examples of the professionals include regulators such as the Environment Agency of England and Wales.
Actors:
Geological surveys to provide geological information (Geological Surveys represent the Member States)
Other hydrometric organizations to provide relevant hydrological data, e.g. rainfall
Professionals responsible for ensuring compliance with the WFD, e.g. regulator in each member state.
Professionals responsible for establishing water supply system, for local government to support water management decision process as well as individual investors.
Water modelers.
B.2.6.2 Narrative description
The WFD requires that a groundwater body has “good status” in that it is not over abstracted. In order to ensure that a groundwater body is not over abstracted, then a water balance needs to be undertaken. The various inputs and outputs to the system need to be quantified and the balance calculated. Importantly the proportion of abstraction compared to recharge to the aquifer has to be determined. The water balance is created for an Assessment Point (AP) for each sub-catchment.
B.2.6.3 Detailed description

Use case description	
Name	Providing data to undertake water balance to ensure compliance with the WFD
Priority	High
Description	The user selects the relevant geographic area and searches for hydrogeological and hydrological data: abstraction, baseflow, springflow, rainfall, potential evaporation.
Pre-condition	Hydrogeological and hydrometric data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between hydrogeological terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for hydrogeological maps and other relevant hydrological data.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater resources location (useful groundwater aquifers) and hydrogeological parameters

	(potential discharge of the well, drawdown)
Step 3	The user searches in a metadata catalogue for relevant hydrological data.
Step 4	The user accesses the hydrological data to get the values of the properties and combines them with the hydrogeological data to perform a water balance for the required AP.
Step 5	The user uploads the water balance back into a portal to provide information at the AP.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of hydrogeological and hydrometric data related to the selected area as well as a water balance for the relevant AP.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Hydrogeological and hydrological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.6.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Hydrogeological units with:
their related polygons
potential discharge
water table depth
aquifer type
rock lithology

Well data in relation to borehole with:
geologic unit thickness and depth
water level
any other properties (physical and chemical) measured

Generally to create water balance two main information are needed:
Recharge (rainfall, river infiltration, river vanish point)
Discharge – groundwater abstraction (water well, effluent stream, spring or seep)

Vanishing point, spring and seep are objects of interest in Hydrography DS (Annex I)
B.2.6.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Hydrology: HydroPointOfInterest
Geology: the geologic property of an aquifer

Groundwater Unit is an object in GWML in relation to Geologic Unit in GeoSciML. Although to describe aquifer the more precise information is expected. The GWML object structure may be use as pointed at figure bellow (pink). Those object allow to define type aquifer water table (confined, unconfined).

B.2.7 UC07: Groundwater reporting for WFD
This use case is related to example of use:

AQ-05: Groundwater quality and quantity assessment.
B.2.7.1 Overview and involved actors
The implementation of the WFD requires the handling of spatial data both for the preparation of the River Basin Management Plans and for the reporting to the Commission.
Article 15 of the Water Framework Directive (WFD) requires Member States to provide information to the European Commission concerning the river basin management plans (RBMP). The RBMP covers, among others a general description of the characteristics of the river basin district (RBD) required under Article 5 and Annex II WFD including the mapping of the location and boundaries of groundwater bodies (GWB) (Annex VII, WFD).
Recommendation for the form and scope of spatial information deliver under the WFD and the Groundwater Directive (GWD) were presented in “Updated Guidance on Implementing the Geographical Information System (GIS) Elements of the EU Water policy”.
Member States are obliged to deliver necessary data to fulfill Water Information System of Europe (WISE) managed by European Environmental Agency (EEA).

Actors:
Geological surveys to provide geological information (Geological Surveys represent the Member States)
Member States Environmental Agencies or other bodies responsible for reporting
European Environmental Agencies (EEA)

B.2.7.2 Narrative description
GWBs according to Article 2.12 WFD are defined as “a distinct volume of groundwater within an aquifer or aquifers”. Thus GWBs are three-dimensional. For the time being it is not possible to represent WBs three-dimensionally in geographic information systems as there are, in most cases, not enough data available to develop three-dimensional models of GWBs. Thus the representation of the feature will be as two-dimensional polygons.

The spatial data concerning GWB is a basis for general maps produce:
- Map 1: Quantitative status – Identification of bodies that are at “good quantitative status” and those that are at “poor quantitative status”;
- Map 2: Achievement/exceedance of standard for nitrates (value in Annex 1 of GWD or set according to paragraph 3 of Annex 1 GWD, and according to status assessment procedure in Article 4 of GWD);
- Map 3: Achievement/exceedance of standard for pesticides (combined total and individual value in Annex 1 of GWD or set according to paragraph 3 of Annex 1 GWD, and according to status assessment procedure in Article 4 of GWD);
- Map 4: Achievement/exceedance of threshold values set by Member States for other pollutants (considering in this category the list of substances as contained in Part B of Annex II of GWD and more generally any other pollutants contributing to the characterisation of groundwater bodies as being 'at risk', and according to status assessment procedure in Article 4 of GWD);
- Map 5: Trends - Identification of: (a) groundwater bodies with environmentally significant and sustained upward trends in pollutant concentrations, and (b) groundwater bodies in which trends have been reversed;

GIS data submitted by Member States will be also used to produce a WISE Reference GIS dataset of groundwater bodies by the EEA or its contracted partners.
GWBs provided by Member States will be merged into one dataset taking into account the description of the submitted GWBs (layered, depth range, aquifer type etc.) to produce a consistent dataset.

B.2.7.3 Detailed description

Use case description	
Name	Providing groundwater data to WISE reporting
Priority	High
Description	The Member States are obliged to deliver Groundwater Bodies and Groundwater monitoring information to European Environment Agency (EEA) for Water Management Plans
Pre-condition	Hydrogeological data are available in line with INSPIRE specifications. The Reporting schema provide a framework for

	water related reporting(Water Framework Directive). Format of reporting sheets is defined in Water Information System for Europe (WISE) hosted by EEA
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for groundwater maps with groundwater bodies.
Step 2	The user displays the groundwater map and accesses detailed information about the groundwater bodies (status) and monitoring stations (quality and quantity)
Step 3	The user searches in a metadata catalogue for groundwater monitoring station data with information about aquifer unit thickness and depth, water level, physical and chemical properties
Step 4	The user accesses the monitoring station data to get the values of the properties.
Flow of events – Alternative path	
	The user (EEA) selects on a geo-portal the area of interest and search in a metadata catalogue for groundwater maps with groundwater bodies and monitoring stations
	The user (EEA) displays the groundwater map and accesses detailed information about the groundwater bodies (status) and monitoring stations (quality and quantity)
Post-conditions	
Post-condition	The user has a set of groundwater data related to the selected area.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Groundwater data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.7.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

The following data were requested as a minimum to be provided for each GWB (under Reporting sheet GWB1):
- Unique code;
- Name (if available);
- X co-ordinate (Longitude) of the centroid of the GWB;
- Y co-ordinate (Latitude) of the centroid of the GWB; and
- Size (surface area (m2), unique identifier for the horizon where separate overlying bodies exist and, if possible, volume of aquifer (m3).

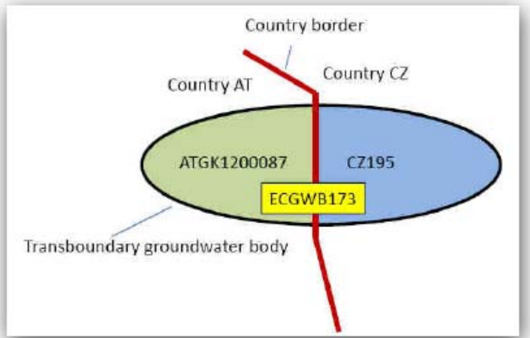
This was translated into the reporting schemas as follows:

Field	Data Type	Size	Obligation	Description
EU_CD	Text	42	mandatory	Unique code for GWB at European level
MS_CD	Text	40	mandatory	Unique code for the GWB within the MS
LAT	Text	9	mandatory	Latitude of the centre of the GWB in ETRS89 projection
LON	Text	9	mandatory	Longitude of the centre of the GWB in ETRS89 projection
AREA	Double		mandatory	GWB1: Total surface area of the water body in sq km
NAME	Text	100	optional	Locally used name for GWB
TRANSBOUNDARY	Text	1	optional	Does the groundwater body crass a country border
CAPACITY	Double		optional	Capacity of GWB in m3
HORIZON	Double		optional	Groundwater horizon when separate overlaying GWB exist
LAYERED	Text	1	optional	Indicator for groundwater bodies with deeper relevant layers 0 = no deeper layers 1 = deeper aquifer layers
OUT_OF_RBD	Text	1	optional	Indicator if any part of GWB falls outside RBD

In addition to the IDs assigned by Member States (MS_CD), unique IDs will be generated at EC level (EU_CD) to uniquely identify groundwater bodies in the WISE Reference GIS dataset. This is necessary to identify and visualise transboundary GWBs. With the IDs assigned by Member States only the Member State part of transboundary GWBs can be identified.

The structure of the WISE code will be defined by the data provider of the reference dataset according to the specifications given in the WISE GIS guidance document, second edition. The data provider will be the EEA or its contracted partner.

The following diagram illustrates a fictive example of MS GWB-IDs and European (WISE) GWBIDs for a transboundary groundwater body.



There is a transboundary GWB between AT and CZ. Both Member States delineate the national parts of the transboundary GWBs and assign IDs (EUGroundwaterBodyCode=ATGK1200087, CZ195). The boundaries of the GWB are harmonised at the country border and the GWBs are marked as transboundary. At EU level it will be identified which Member State parts of transboundary GWBs belong together and unique IDs for the total GWB will be assigned (ECGWB173).

To develop a more consistent picture of groundwater bodies it will be necessary to get information on aquifer types and the 3-dimensional characteristics of GWBs, as they might overlay each other.

GIS data to be reported for each groundwater body are specified in Guidance Document: Guidance for reporting under the Water Framework Directive (see Chapter 13). This data will allow the description and visualisation of GWBs and groups of GWBs. Furthermore the parameter horizon should also be characterised according to the groundwater body layer (e.g. alluvial deposit layer, “main” layer, deep horizon (cenoman), thermal or mineral water).

The definition of the parameter “horizon”, which will be used in the sense of the numerical position of groundwater body layer (e.g. 1 for the first horizon from the surface, 2 for the second horizon from the surface, 3 for the third horizon from the surface, 4 for fourth and deeper horizons from the surface).

The following attributes should be reported for each GWB
- Water body code
- Water body name
- Shape/GML file
o Groundwaters: boundaries of all groundwater bodies or groups of groundwater bodies identified.
- For groundwater bodies or groups of groundwater bodies, if available:
o Layered (Y/N)
o Average depth to groundwater body (m)
o Average thickness of groundwater body (m)
o Assignment to a depth range where the main part of the GWB is situated in (depth ranges: 0-20m, 20-50 m, 50-200 m, >200m)
o Directly dependent aquatic ecosysteRBD (Y/N)
o Directly dependent terrestrial ecosysteRBD (Y/N)
o Geological formation – aquifer type (according to a predefined typology)
o Type of vertical orientation of GWB (indicated by category and visualised by symbols)
o Volume of aquifer (m3) (if possible)
- Relevant point source discharges to groundwater
o ID of significant point sources where data already available
o Latitude and longitude of each relevant point source (if possible)
o Type of point source (see GWPI3)
- Relevant diffuse source pollution to groundwater bodies
o WB Affected? (Y/N)
o Type of source (see GWPI4)
- Relevant abstractions from groundwater
o WB Affected? (Y/N)
o Latitude and longitude of each abstraction (if possible)
o Type of abstraction (see GWPI5)
Relevant artificial recharge of groundwater
o WB Affected? (Y/N)
o Type of Regulation/Alteration (see GWPI6)
- Significant saltwater or other intrusion
o WB Affected? (Y/N)
- Other pressures
o WB Affected? (Y/N)
o Type of Pressure (to be specified see GWPI8)
- Impacts
o Type of impact identified (see GWPI9)
- Protected areas
o Water body within or overlapping with a protected area (Y/N)
o Type of protected area (provide a shape file only where information is NOT reported under any other Directive. Where information has been provided under other Directives provide the unique identifier (code) of the appropriate protected area)

For WISE reporting it is expected that except the GroundWater bodies the Groundwater monitoring station location will be required for reporting.

B.2.7.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Hydrography (HY): GWB is a subset of Water Body class which is the main element in WFD directive reporting as well as base information for Water Management Plans analyzes (water balance)..
Area management/restriction/regulation zones and reporting units (AM): there is a important relation between GWB and water related reporting units
Environmental Monitoring Facilities (EF): location and characteristics of Groundwater monitoring facilities will be provided by EF specification, but the link to GW monitoring measurement method and properties is needed in Geology DS

B.2.8 UC08: Providing hydrogeological data to define significant pressure

This use case is related to example of use:

AQ-04: Protecting ecosystems dependent on groundwater

B.2.8.1 Overview and involved actors

The goal of this use case is therefore to deliver hydrogeological data to professionals responsible for biological diversity

Actors:

Geological surveys to provide geological information (Geological Surveys represent the Member States)

Professionals responsible for biological diversity.

Soil experts

B.2.8.2 Narrative description

Groundwater dependent ecosystems (GDE) are a diverse and important component of biological diversity. The term GDE takes into account ecosystems that use groundwater as part of survival, and can potentially include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps. The groundwater dependence of ecosystems will range from complete reliance to those that partially rely on groundwater, such as during droughts. The degree and nature of dependency will influence the extent to which ecosystems are affected by changes to the groundwater system, both in quality and quantity. The EU Water Framework Directive (WFD) requires those terrestrial ecosystems dependent on groundwater be identified and the anthropogenic pressures acting on the ecosystems analysed.

B.2.8.3 Detailed description

Use case description	
Name	Managing the positive role aquifers play in supporting ecosystems
Priority	High
Description	The user selects the relevant geographic area and search for hydrogeological data: hydrogeological map (groundwater table level) and well data (geological profile) to estimate the risks associated with groundwater abstraction pressures on the condition of groundwater dependent ecological features.
Pre-condition	Hydrogeological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between hydrogeological terms and user’s terms (done by the data provider?).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for hydrogeological maps with groundwater bodies information.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater bodies location, useful groundwater aquifers and hydrogeological parameters (potential discharge of the well, regional discharge pressures, drawdown)
Step 3	The user searches in a metadata catalogue for well data with information about geologic unit thickness and depth, water level changes, groundwater quality (physical and chemical properties)
Step 4	The user accesses the well data to get the values of the properties.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of hydrogeological data related to the

	selected area and is able to analyse data to provide information for decision makers.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Hydrogeological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.8.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Hydrogeological units with:
their related polygons
potential discharge
water table depth
rock lithology

The dependency of ecosystems on groundwater is based on some basic groundwater attributes :
flow or flux - the rate and volume of supply of groundwater;
level - for unconfined aquifers, the depth below surface of the water table;
pressure - for confined aquifers, the potentiometric head of the aquifer and its expression in groundwater discharge areas;
quality - the chemical quality of groundwater expressed in terms of pH, salinity and/or other potential constituents, including nutrients and contaminants.

B.2.8.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:

Bio-geographical Regions, Habitats and Biotopes, Species Distribution (BR, HB, SD): existence of some ecosystems in strong plant and animal communities relations with groundwater system.
Geology (GE): the geologic property of an aquifer
Soil (SO): changing soil moisture level can cause drought
Sea region (SR): saline or other intrusion changing ecosystem condition
Land Use (LU)

B.2.9 UC09: Providing data to assess Corrosivity to Underground Assets
This use case is related to example of use:
AQ-07: Groundwater as a hazard
B.2.9.1 Overview and involved actors
The goal of this use case is therefore to deliver hydrogeological and geochemical data to professionals responsible for operating underground assets such as water pipes and building foundations to establish whether corrosion will occur and degrade the asset sufficient to cause a leakage, etc.
Actors:
Geological surveys to provide geological information (Geological Surveys represent the Member States)
Other organizations to provide relevant geochemical data, e.g. concentration of sulphates/sulphides.
Professionals responsible for assessing risk of corrosivity to underground assets, i.e. pipeline operators, etc.
B.2.9.2 Narrative description
Underground assets, such as iron pipes, concrete foundations are at risk from corrosion due to chemical attack from solutes found in groundwater and leached from the rock they are in contact with. To provide an understanding of areas where the potential for corrosion is greatest, then the relevant data need to be brought together and an assessment undertaken of the potential for corrosion. By combining hydrogeologcial and geochemical data then the likelihood of corrosion occurring to the

underground asset can be quantified and maps produced to inform operators of these assets to be informed.

B.2.9.3 Detailed description

Use case description	
Name	Providing data to assess Corrosivity to Underground Assets
Priority	Medium
Description	The user selects the relevant geographic area and searches for hydrogeological and geochemical data: depth to water table, geochemical information - sulphate/sulphides, pH, moisture content, organic carbon and resistivity.
Pre-condition	Hydrogeological and geochemical data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between hydrogeological terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps and other relevant hydrogeological and geochemical data.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater system (depth to water table and moisture content), rock properties (resistivity) and geochemistry (pH, Organic Carbon and sulphate/sulphide concentration)
Step 3	The user accesses the relevant data to get the values of the properties and combines them to produce potential corrosion maps for each type of asset.
Step 4	The user uploads the gridded data back into a portal to provide information for the operator of the asset.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of hydrogeological and geochemical data related to the selected area as well as a map of potential corrosivity..
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Hydrogeological and geochemical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.9.4 Requirements from the use case

Analyzing the use case, there is a need to provide the following objects and attributes:

Hydrogeological units with:
their related polygons
water table depth
rock lithology

Unsaturated zone data:
moisture content

Geochemical data:
pH
Sulphate/sulphide concentration

Geophysical data:
Resistivity of the rocks

B.2.9.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Soils: moisture content:
Geology: the geologic property of an aquifer

To understand corrosivity, it is important to quantify groundwater flow and solute transport, therefore data for groundwater quantity and quality need to be available.

The majority of groundwater measurements are undertaken at a well, therefore the WaterWell feature type needs to be included.

B.2.10 UC10: Providing data to plan tunneling operations safely and effectively
This use case is related to example of use:
AQ-07: Groundwater as a hazard

B.2.10.1 Overview and involved actors
The goal of this use case is therefore to deliver hydrogeological data to professionals responsible for tunneling operations.
Actors:
Geological surveys to provide geological information (Geological Surveys represent the Member States)
Other organizations to provide relevant hydrogoelogical data, e.g. groundwater level.
Professionals responsible for planning and undertaking tunneling operations.

B.2.10.2 Narrative description
Tunneling is an activity that required suitable knowledge of the geological and hydrogeological conditions to be undertaken safely and cost effectively. Knowledge of the ground conditions that are likely to be encountered is very important to ensure that the correct tunnel boring techniques are used and that the operations are conducted in a safe a way as possible. Understanding of the saturation of the deposits being tunnelled through is equally important to ensure the safe undertaking of underground working. Therefore, building a 3D understanding of the geology combined with the variation of groundwater heads is important in planning any tunneling operation.

B.2.10.3 Detailed description

Use case description	
Name	Providing data to plan tunneling operations safely and effectively
Priority	Medium
Description	The user selects the relevant geographic area and searches for geological and hydrogeological data. The geological data will be used to construct a 3D model
Pre-condition	Geological and hydrogeological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a “mapping” between hydrogeological terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps and other relevant hydrogeological data.
Step 2	The user accesses a DTM, borehole data and other relevant data to produce a 3D geological model.
Step 3	The user displays the hydrogeological map and accesses detailed information about the groundwater system (water table

	and moisture content).
Step 4	The user accesses the relevant data to get the values of the properties and combines them with the 3D geolgocial model to produce the required understanding of rock properties and moisture content to plan the tunneling activities.
Step 5	The user uploads the 3D geological model with groundwater data back into a portal to provide information for the tunneling organisation.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a 3D geological model and a set of hydrogeological data related to the selected area. The can be combined to produce a 4D understanding of groundwater flow.
Data source: INSPIRE-conformant Geology data set provided by Member Sate	
Description	Hydrogeological and geochemical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE Geology Data Specification

B.2.10.4 Requirements from the use case
Analyzing the use case, there is a need to provide the following objects and attributes:

Topographic data:
DTM

Geological data:
borehole logs
2D maps
previously created cross sections
physical and mechanical properties of geological units
rock mass classification

Hydrogeological units with:
their related polygons
water table depth
rock lithology

Unsaturated zone data:
moisture content

B.2.10.5 Relationship with other INSPIRE Themes
This use case has some relationships with the following INSPIRE data themes:
Soils: moisture content:
Elevation: DTM
Geology: the geologic property of an aquifer

To understand water movement around any underground structure, it is important to quantify groundwater flow, therefore data for groundwater quantity need to be available.

The majority of groundwater measurements are undertaken at a well, therefore the WaterWell feature type needs to be included.

Annex B
(informative)
Aquifers and Groundwater bodies

B.1 *Aquifers and Groundwater bodies*

B.1.1 Introduction

Water has always been the basis for human existence. World water use in the past century grew twice as fast as world population. Groundwater has been described as “our Hidden Asset” and although this is a truism groundwater makes up about twenty percent of the world's fresh water supply. As far as “clean”, drinking water resources are concerned it is much more. Groundwater is one of the most important components of water cycle in environment (Fig. 1).

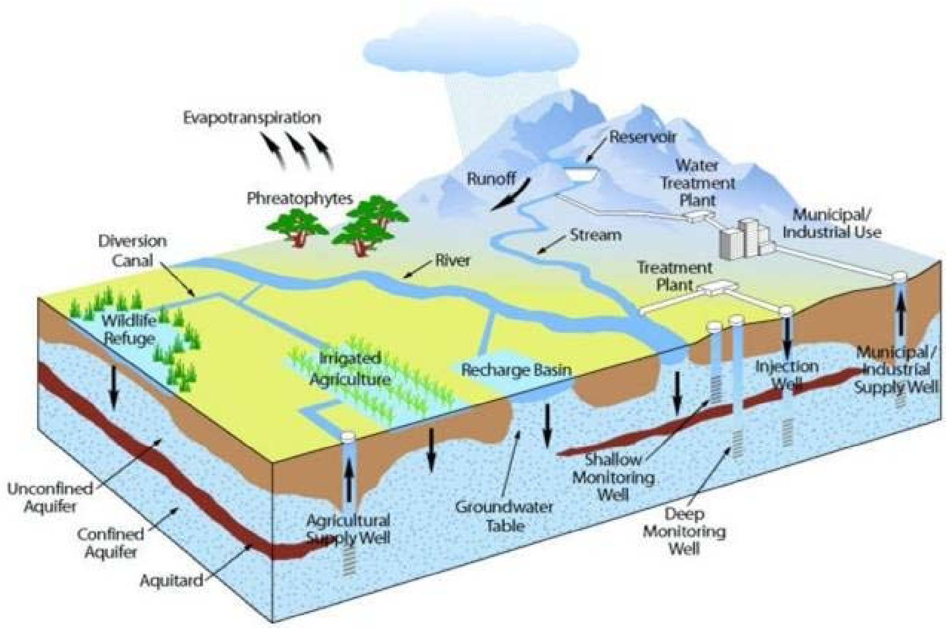


Fig. 1 Summary of groundwater processes.

The European Union has recognized the need for a consistent framework for legislation on water management. According to the Water Framework Directive (WFD) introduced in 2000 water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such.
Hydrogeology describes the flow, condition of occurrence and behaviour of water in the underground environment. It is a science located between hydrology and geology, whilst it is necessary to have an understanding of both disciplines. Hydrological processes are responsible for the quantity of water supply e.g. as a result of aquifer recharge. On the other hand, the physical properties and composition of the geologic materials (rocks and sediments) create the main environment for groundwater flow and storage and rocks and sediments also influence groundwater quality as a result of their chemical composition.
Groundwater can be both a resource and a problem depending on what activity is being undertaken. A positive benefit is abstraction for drinking water supply, whereas groundwater flooding causes significant problems to properties and transport infrastructure. Hydrogeology has a direct influence on the environment; groundwater abstraction not only provides water for human consumption but also can cause changes in water flow direction and in some cases may have a dramatic impact on surface water bodies. Overexploitation in an area where groundwater dependent ecosystems are located may

change the water table level or the chemical composition of water which may lead to irreversible changes in the ecosystems.
In terms of INSPIRE, the groundwater domain has many connections and dependencies on other human activities described in other themes (Area Management, Soil, Environmental Facilities, Energy Resources, Hydrography, Protected Sites, Utility and Governmental Services). Contamination introduced to groundwater systems takes years to decades to be cleaned out. Prediction is a problem but slow rates of flushing and low rates of degradation are significant issues.
This document intends to introduce groundwater issues to the members of the INSPIRE Geology and Mineral Resources TWG.

B.1.2 Background to groundwater processes

One suitable source of background information for groundwater issues is the UK's groundwater forum website – *www.groundwateruk.org*. The section "Groundwater in Depth", see *www.groundwateruk.org/Groundwater-in-depth.aspx*, has some excellent articles on some of the issues introduced below.

Hydrogeology is a large and complex subject involving the appreciation of many aspects of groundwater, including flow, solute and heat transport, and multi-phase flow. The discipline also includes the study of the unique ecology that inhabits the sub-surface water environment. However, for the purposes of this document, a short summary of the most important aspect of groundwater is required.

Traditionally sub-surface flow of water has been defined as occurring in aquifers, which consist of permeable rocks through which water can flow. These aquifers can be separated by aquitards which are less permeable, or are not as good at passing water through them. In the extreme low permeability case, aquicludes are defined as geological strata which impede the flow of water. However, in the last decade, this definition has been seen as too simplistic and the concept of a groundwater system has been developed. This concept allows the study of the sub-surface water environment in a holistic way which better reflects the hydrological cycle.

Typically the approach to understanding a groundwater system is to determine the inflows, outflows and the movement of water through the system (see Fig. 2). For example the WHO defines a groundwater system as "a discrete, closed three-dimensional system containing flow paths from the point at which recharging water enters an aquifer to the topographically lower point at which it leaves the aquifer (WHO 2006)". Inflows to and outflows from the system can be effected by both natural and anthropogenic factors.

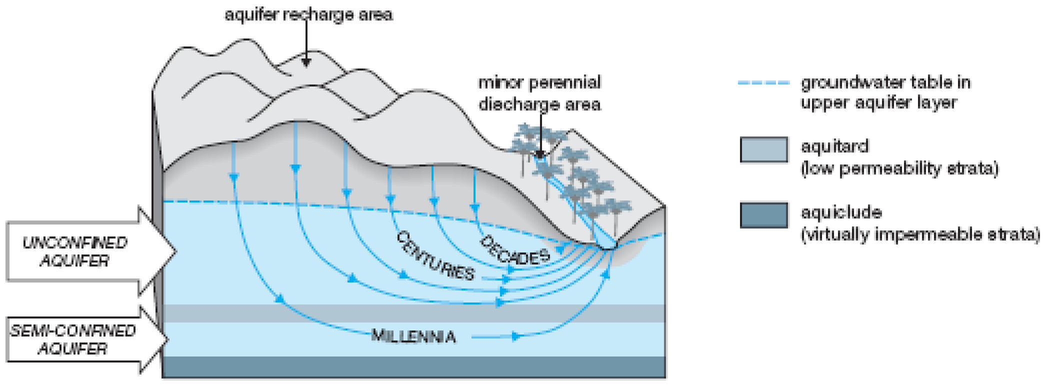


Fig. 2 Example groundwater system showing inflows and outflows and time of travel of water through the system. (GWMate briefing note no. 2: Characterization of Groundwater Systems).

Inflow: The majority of recharge occurs through the soil zone, especially in temperate countries, such as those in Europe. Recharge is defined as the amount of water leaving the soil zone that can eventually reach the groundwater table. Other ways water can be emplaced in the groundwater system include artificial recharge by injecting water into the aquifer via boreholes or surface ponds.

Outflow: There are a number of natural ways that water can leave a groundwater system. These include baseflow to rivers, springflow and outflow to the sea. The most obvious man made outflow to any groundwater system is pumped abstraction from a borehole.

The interaction between rivers and groundwater is complex; rivers can provide both inflow and outflow to the system (Fig. 3) and this can change with time depending on the relationship of the river stage and groundwater head locally. When the groundwater head is below the river stage then water can flow from the river to the aquifer beneath the river. When the flow in the river reduces and thus the stage, then the flow direction can be reversed and the groundwater system can provide an input to the river (Fig. 3). The contribution of groundwater to a river is normally termed "baseflow".

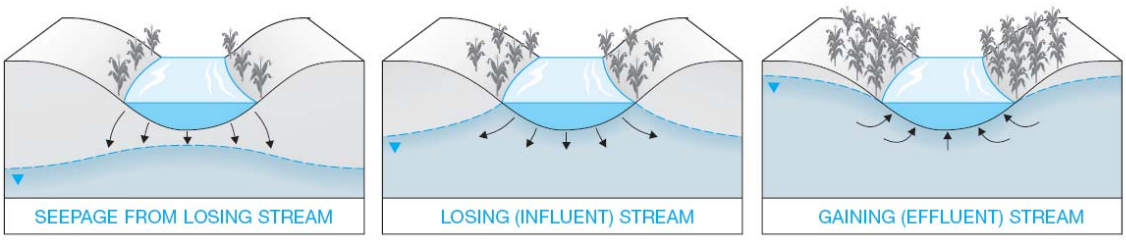


Fig. 3 Different types of river-aquifer interaction (GWMate briefing note no. 2: Characterization of Groundwater Systems).

There are a number of different ways that groundwater can move through the sub-surface (Fig. 4): flow through porous media, flow through fractured aquifers and karstic flow. Flow through porous media is characterised by water moving through the gaps between the rock particles, often in unconsolidated deposits. Where water movement exploits cracks or fissures in the rock to move then this is termed fracture flow. In the extreme case large connected conduit or even "cave" systems can be developed and water movement through this system is termed karstic flow.

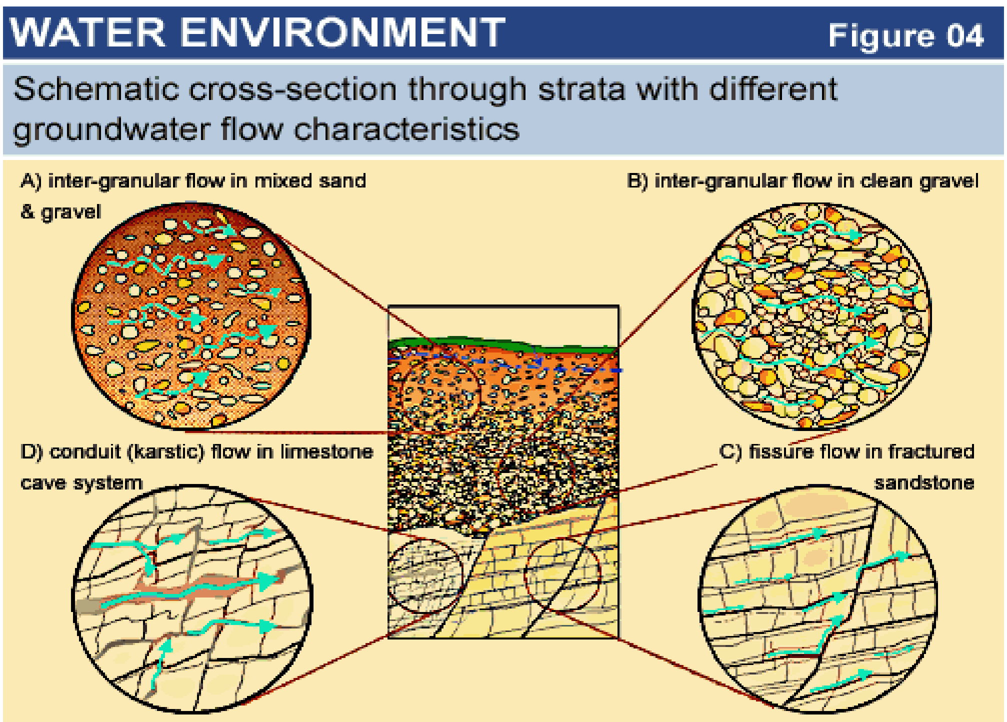


Fig. 4 Different types of flow regimes in groundwater systems (www.goodquarry.com).

Groundwater systems can be exploited for a number of uses: supply, including water for drinking, heat reservoir, repository for waste (solid and liquid), a store for excess water during the winter, to name but a few. Groundwater systems are used by humans in many ways and an understanding of the complex interaction between the natural system and the effects of human intervention needs to be developed, normally called conceptualisation.

Conceptualisation: collect data, develop an understanding of the groundwater system and formalise this understanding into a conceptual model, quantify processes including water balance and then create a model of the system. Attention needs to be given to the question that is under consideration.

B.1.3 Description of issues

Traditionally the study of groundwater has been categorised as examining either water quantity or quality; the former examining the amount of groundwater flow and the latter examining the solutes dissolved in groundwater. However, the occurrence and use groundwater is much wider than this. For example as part of climate change mitigation, groundwater systems have been recognised as heat stores for ground source heat pumps and saline aquifers for the disposal of supercritical CO_2.

Groundwater flow

Groundwater flow is important for supporting abstractions for water supply for domestic (i.e. people in their homes) as well as industrial purposes. It is also important to support river flows for ecological purposes, amenity value (people to enjoy their surroundings), etc. Groundwater dependent ecosystems, as the name suggests, are also supported by sub-surface flows. These include wetlands, which can be small areas fed by seeps to large nationally significant bodies.

Pollution

Aquifers are vulnerable to polluting activities. These include “catastrophic” events such as accidental spills, i.e. a road tanker crash, to diffuse pollution from agricultural activities. European countries have a long history of industrial activities and groundwater has been polluted from these processes. Understanding the vulnerability of groundwater systems to pollution from current activities and clean-up of aquifers from past activities is equally important. Polluted groundwater can contribute to pollution in rivers, lakes and the seas as well as causing hazards for activities such as mining, etc.

Natural attenuation
Reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favourable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

Saline aquifers

Saline aquifers occur in a range of settings. Aquifers in close proximity to estuaries and the sea are often saline. Deep aquifers with old or “connate” waters are also often highly saline. Basins of internal drainage, where evaporation is the only outflow are highly saline. Saline intrusion is a problem where abstraction occurs in aquifers close to saline water bodies. Careful management has to be undertaken to avoid despoiling the systems permanently. However, deep saline aquifers are being considered for disposal of supercritical CO_2. Finally highly saline aquifers that are the result of evaporative processes often contain economically important minerals and are exploited commercially.

Geotechnical considerations

The interaction of groundwater with the built environment is extremely important. As the water content or pore pressure of the ground changes so does its geotechnical properties. For example, rising groundwater in cities causes problems with deep foundations and tunnels. An understanding of water movement in the sub-surface is, therefore, important to ensure safe construction of buildings. Dewatering of aquifers for temporary works is also important to allow sub-water table working in construction works.

Groundwater monitoring
Groundwater, in view of its prevalence and quality is a very important source of supply for the population with drinking water. Because of its economic importance and the widespread risks to water quality caused by pollution discharged to the ground, it requires special protection. This protection is achieved, inter alia, by using amonitoring network for both qualitative and quantitative aspects of groundwater status.

Geohazards

As well as being a resource, groundwater can cause problems either by appearing at the surface or by entering sub-surface structures. Groundwater flooding is one such problem. Under extreme recharge events, the water table can rise to the surface and result in flooding. Groundwater flooding differs from surface water flooding in that it is often long-lasting, typically of the order of weeks to months and can affect areas not identified in traditional flood risk mapping. Unlike surface water floods, it is not possible to control this phenomenon easily by flood defences.

Other geohazards that are related to groundwater include:
- landslides
- swell-shrink clays
- subsidence

All of these geohazards need an assessment of water movement in the sub-surface to understand how they occur and what influence human activity and climate change will have on them.

Heat

Heat flows both into and out of aquifers are increasingly being recognised as a way of reducing reliance on fossil fuels. Groundwater systems and aquifers are being developed to be used as a temporary store for heat. Systems may be based on pumping groundwater into and out of an aquifer using boreholes, such as Ground Source Heat Pumps (GSHP), or heat exchange in trenches or boreholes for Ground Coupled Heat Pumps (GCHP). Groundwater can also be used to exploit hotter rocks close to the surface by pumping cold water down or abstracting hot water. These systems can be used to heat, cool and power systems in buildings. Where very elevated groundwater temperatures are found, electricity generation is possible.

Mineral resources

Exploitation of mineral resources requires the control of water where it isn't wanted and supply of water where it is in short supply. So-called “wet working” of mines requires removal of water where it enters the mine. However mining requires water to operate its processes so in some areas, where water is scare, then groundwater can be used for supply purposes. Groundwater can be rich in minerals and the economic extraction of minerals from groundwaters is possible for high value minerals such as Lithium. As well as this mineral waters can be thought of groundwater as an economic resource, with the dissolved solids giving the water its taste, e.g. bottled waters.

B.1.4 Approach to data models

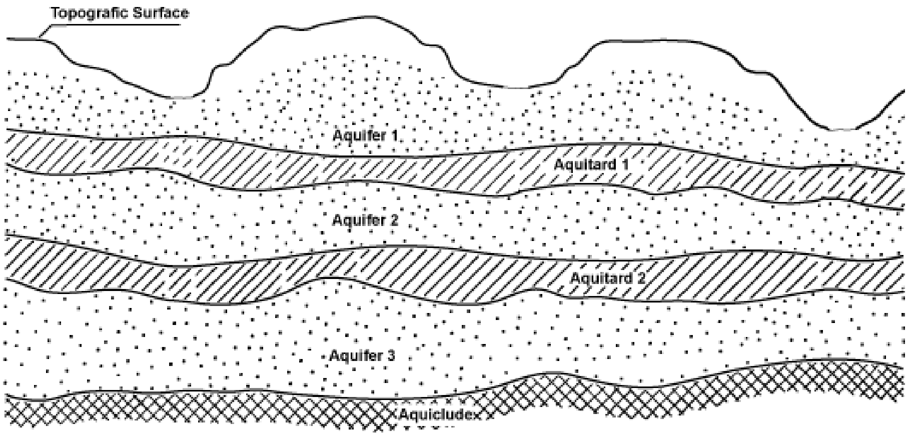


Fig. 5 Example of an aquifer system

The Aquifer System is dependent of rock properties such as permeability and porosity for water flow and storage. Generally the two main components are Aquifers (e.g. sand and gravel) where water flow is may easily occur and Aquitards, which are poorly permeable formations (e.g. clay) that do not yield water freely to a well or a spring. However, an aquitard may transmit appreciable water to or from adjacent aquifers.

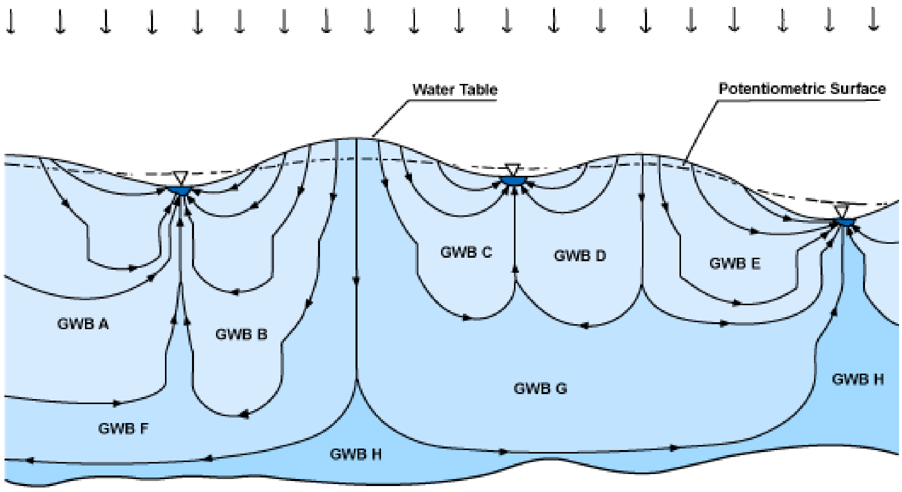


Fig. 6 Example of a groundwater flow system

The aquifer system provides a framework for the groundwater flow system and encompasses it. The nature of the groundwater flow system depends partly on the aquifer system but also on factors such as the geometry of the water table (or confined potentiometric surface) and the location of discharge points such as rivers, springs and wells. Groundwater bodies are discrete bodies of groundwater lying within a groundwater flow system'.

The basic idea of the INSPIRE model for groundwater is to identify two basic elements: the Aquifer System (dependent on the geological conditions) and the Groundwater Flow System. Both components taken together create the Hydrogeological System.

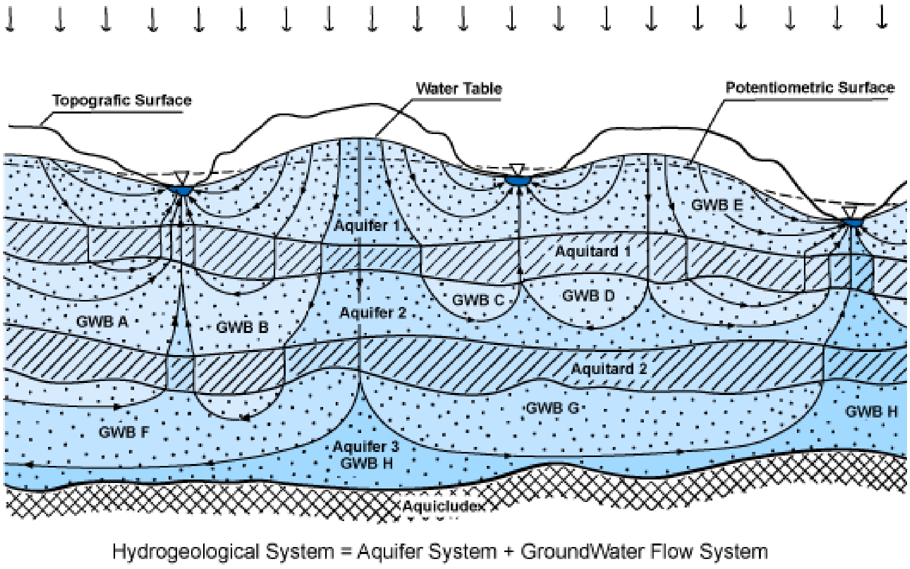


Fig. 7 Example of an hydrogeological system

The mutual relationships between those components create and build the condition for groundwater flow. The main assessment of model is base on the hydrodynamic processes (groundwater flow).

B.1.5 Relevant EU legislation

There is a significant amount of EU legislation that impacts on groundwater systems and their management. The following provides a list of the relevant EU legislation. The most important piece of legislation in terms of shaping how groundwater systems are conceptualised and managed is the water framework Directive. This legislation has encapsulated the changes in approach to the study of groundwater flow described above.

Bathing Water Directive 76/160/EEC
Birds Directive 79/409/EEC
Drinking Water Directive 98/83/EEC
Major Accidents (Seveso) Directive 96/82/EC
Environment Impact Assessment 85/337/EEC
Sewage Sludge Directive 86/278/EEC
Urban Wastewater Treatment Directive 91/271/EEC
Plant Protection Products Directive 91/414/EEC
Nitrates Directive 91/676/EEC
Habitats Directive 92/43/EEC
Integrated Pollution Prevention Control 96/61/EEC
Nitrates Directive
Urban Wastewater Treatment Directive
Plant Protection Products Directive - Directive 91/414/EEC, OJ L230 of 19.08.1991
Biocides Directive - Directive 98/8/EC, OJ L123 of 24.04.1998
Integrated Pollution Prevention and Control (IPPC) Directive - Directive 96/61/EEC, OJ L257 of 10.10.1996
Landfill Directive - Directive 99/31/EC, OJ L182 of 16.07.1999
Waste Framework Directive - Directive 2006/12/EC, OJ L102 of 11.04.2006
Construction Product Directive - Directive 89/106/EC, OJ L40 of 11.02.1989
Floods Directive 2007/60/EC
Water Framework Directive (2000/60/EC)
Groundwater Directive (2006/118/EC)
Groundwater Directive (80/ 68/EEC)

Annex C
(informative)
Data model extensions

C.1 *Introduction*

The INSPIRE GeologyCore and GeophysicsCore models are both simple and designed to enable harmonised INSPIRE services. However for many use cases a wider range of more detailed information will be required. This section indicates how the core models can be extended to meet this requirement, in the case of Geology through the use of GeoSciML and in the case of geophysics through the use of the GeophysicsExtension model described in this annex.

At present no extension is recommended for hydrogeology.

C.2 *GeoSciML as the data model extension for Geology*

C.2.1 *Introduction*

GeoSciML is a model for the exchange of geoscience information which has been developed by the international geosciences community, in particular Geological Survey Organisations (*http://www.geosciml.org/*). GeoSciML version 3, the current version, was the starting point in developing the INSPIRE GE model and has heavily influenced its design. However GeoSciML has much broader scope than is required for INSPIRE so the INSPIRE GE model has been developed through a simplification of the required parts of GeoSciML, while aiming to retain the same overall design pattern and key features. The INSPIRE GE model can therefore be extended using GeoSciML.

In this annex we will give an overview of GeoSciML and its scope and its relationship with the INSPIRE GE model.

C.2.2 *Background and scope of GeoSciML*

GeoSciML is an application schema that specifies a set of feature-types and supporting structures for information used in the solid-earth geosciences. GeoSciML is scoped approximately to the information required to construct geologic maps. However it also includes boreholes, laboratory analyses, and a wide range of information associated with features shown on geological maps but which would not normally be shown on the maps. "Map" is interpreted broadly, and not constrained to conventional 2-D semi-horizontal cartography, so the GeoSciML information structures also support representation of the distribution of geologic features on sections, along curvilinear-traverses and boreholes, and within volumetric samples, etc. GeoSciML is primarily concerned with "interpreted" geology (units, structures, etc), but links to external schemas for the descriptions of observational data. GeoSciML is factored into a set of sub-packages and from v3.0 on these component packages are maintained separately.

GeoSciML v3 contains the following packages:

- ***GeoSciML/GeoSciML-Core*** - the GeoSciML-Core schema specifies a set of feature-types describing core geoscience information, including geologic features and relations between geologic features, and spatial geometries that represent geologic features on maps
- ***GeoSciML/GeoSciML-Core/GeologicFeature*** - the GeoSciML GeologicFeature package contains the root Feature classes MappedFeature and GeologicFeature. GeologicFeature represents a conceptual feature that is hypothesized to exist coherently in the world. Specialised geologic features are contained in other packages.
- ***GeoSciML/GeoSciML-Core/GeologicRelation*** - the GeoSciML GeologicRelation package contains the root relation class. Geologic Relations are typed, directed associations between geologic objects. They represent any of a wide variety of relationships that can exist between two or more Features or other entities. For example, the GeologicRelation "intrudes" is a

relationship between an intrusive igneous rock and some host rock. Includes spatial, temporal, sequence, correlation, and parent/child relations.

- ***GeoSciML/Borehole*** - the GeoSciML Borehole package contains model elements for representing Boreholes. This is primarily through re-use of standard components from the (external) Observations and Measurements package.
- ***GeoSciML/CGI_Utilities*** - a package of specialist value types for geological structural measurements. "CGI_GeometricDescriptions" allow the description of the planar or linear orientation of a geologic feature. It allows the specifying of direction by DirectionVector (eg Dip/Dip Direction), compass point (NE), description ("toward fold hinge", "below'). These values are usually obtained as the result of an observation. The description of the associated observation event will provide more detail about the observation method, result quality, etc.
- ***GeoSciML/Collection*** - the GeoSciML Collection package contains facade classes that facilitate the structuring of WFS response documents and other application uses.
- ***GeoSciML/EarthMaterial*** - the GeoSciML EarthMaterial package contains classes representing a description of a naturally occurring substance in the Earth. Earth Material represents material composition or substance, and is thus independent of quantity or location. Ideally, Earth Materials are defined strictly based on physical properties, but because of standard geological usage, genetic interpretations may enter into the description as well.
- ***GeoSciML/Fossil*** - The Fossil package is provided for information only. It is not encoded as part of the GeoSciML schemas. Associations to other GeoSciML packages are all byReference only. Fossils that occur as constituent parts of rocks are described as particleType = "fossil". Fossils are linked (byReference) to living or once living things by the Organism class. Fossil specimens are modelled as O&M SF_Specimen, with specimenType = "fossil". Results of observations on that specimen can describe the fossil.
- ***GeoSciML/GeologicAge*** - the GeologicAge package contains classes to support the description of geologic ages and events. A geologic age is related to a particular GeologicEvent, during which one or more geological processes act to modify geological entities. "NumericAgeRange" allows the description of geological ages expressed as numbers of years before 1950.
- ***GeoSciML/GeologicStructure*** - GeologicStructures are a configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an Earth Material. The scale of geological structures ranges from microscopic (micron-scale) to megascopic (km-scale). Examples of such inhomogeneities include fractures, mineral grain boundaries, and boundaries between parts of the rock with different particle geometry (texture) or composition. Geologic structure is grounded in relationships between parts of a rock or rock body. As used here, it includes sedimentary structures. The identity of a Geologic Structure is independent of the material that is the substrate for the structure. There are almost always strong dependencies between the nature of the Earth Material substrate and the kinds of Geological Structure that may be present. A disaggregated heap of particles does not have structure, and can only be described in terms of the mineralogy and geometrical character of the constituent particles. Geologic Structures are more likely to be found in, and are more persistent in, consolidated materials than in unconsolidated materials. Properties like "clast-supported", "matrix-supported", and "graded bed" that do not involve orientation are considered kinds of Geologic Structure because they depend on the configuration of parts of a rock body.
- ***GeoSciML/GeologicTimescale*** - the GeologicTimescale package contains elements used to describe the classification of geologic time: time periods, time boundaries, and the relationships between them as defined by the International Commission on Stratigraphy.
- ***GeoSciML/GeologicTimescale/GSSP*** - the GSSP model describes "Global Boundary Stratotype Sections and Points" as defined by the International Stratigraphy Commission.
- ***GeoSciML/GeologicTimescale/TimeScale*** - the Timescale package describes geologic time periods (geochronologic eras) and the boundaries between them.
- ***GeoSciML/GeologicUnit*** - the GeoSciML GeologicUnit Package contains classes representing notional geologic units, whose complete and precise extent is inferred to exist. Explicit spatial

properties are available through association with a MappedFeature. Geologic units includes both formal units (i.e. formally adopted and named in the official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised).

- ***GeoSciML/Geomorphology*** - the Geomorphology package describes features that comprise the shape and nature of the Earth's land surface (ie, landforms). These landforms may be created by natural Earth processes (eg, river channel, beach, moraine, mountain) or through human (anthropogenic) activity (eg, dredged channel, reclaimed land, mine waste dumps).
- ***GeoSciML/LaboratoryAnalysis-Specimen*** - the LaboratoryAnlaysis-Specimen application schema extends the ISO19156 schema for Observations, Measurements and Sampling. It specifically describes processes and results related to the analysis of (geological) samples using instruments, most commonly in a laboratory environment. (Design of this package is based upon, and extends, the MOLES v3 data model.)
- ***GeoSciML/LaboratoryAnalysis-Specimen/LaboratoryAnalysis*** - the LaboratoryAnalysis leaf package describes processes, instruments and result quality associated with quantitative analysis of samples.
- ***GeoSciML/LaboratoryAnalysis-Specimen/Geochronology*** - the Geochronology package allows the delivery of an interpretation of geochronological analytical data.
- ***GeoSciML/LaboratoryAnalysis-Specimen/GeologicSpecimen*** - the GeologicSpecimen package extends the ISO19156 O&M schema, and describes processes relevant to the sampling, preparation and analysis of geologic specimens.
- ***GeoSciML/TemporalReferenceSystem*** - this package is an extension of ISO19108 Temporal Schema
- ***GeoSciML/PhysicalProperties*** - the PhysicalProperties Application Schema permits description of bulk physical properties of earth materials, geologic units and geologic structures. The model borrows from the SWECommon model to describe scalar (quantity) values of physical property measurements such as density, porosity, permeability, magnetic susceptibility, and other geophysical properties. Individual physical property measurements made on sampling features such as specimens, outcrops, and boreholes should be delivered using the ISO19156 Observations and Measurements model.
- ***GeoSciML/Vocabulary*** - the GeoSciML Vocabulary package contains classes to support definitions and classifications. This package is conceptual only, and is implemented using SKOS-RDF encoded vocabularies, and URI's to link by reference to controlled concepts which define classifiers.

C.2.3 *Outline of GeoSciML*

Full details of GeoSciML packages including documentation, the UML model and schemas can be found at http://www.geosciml.org/ and this information won't be repeated here. In this section the packages most closely related to the INSPIRE GE model will be briefly illustrated along with the principal differences with the corresponding part of the INSPIRE GE model. In the next section a mapping from the INSPIRE GE model to GeoSciML will be provided.

It can be seen that in most cases the INSPIRE GE model has greatly simplified its GeoSciML equivalent. Where there is a requirement to deliver information that is out of scope of the INSPIRE GE model it is recommended that GeoSciML be used.

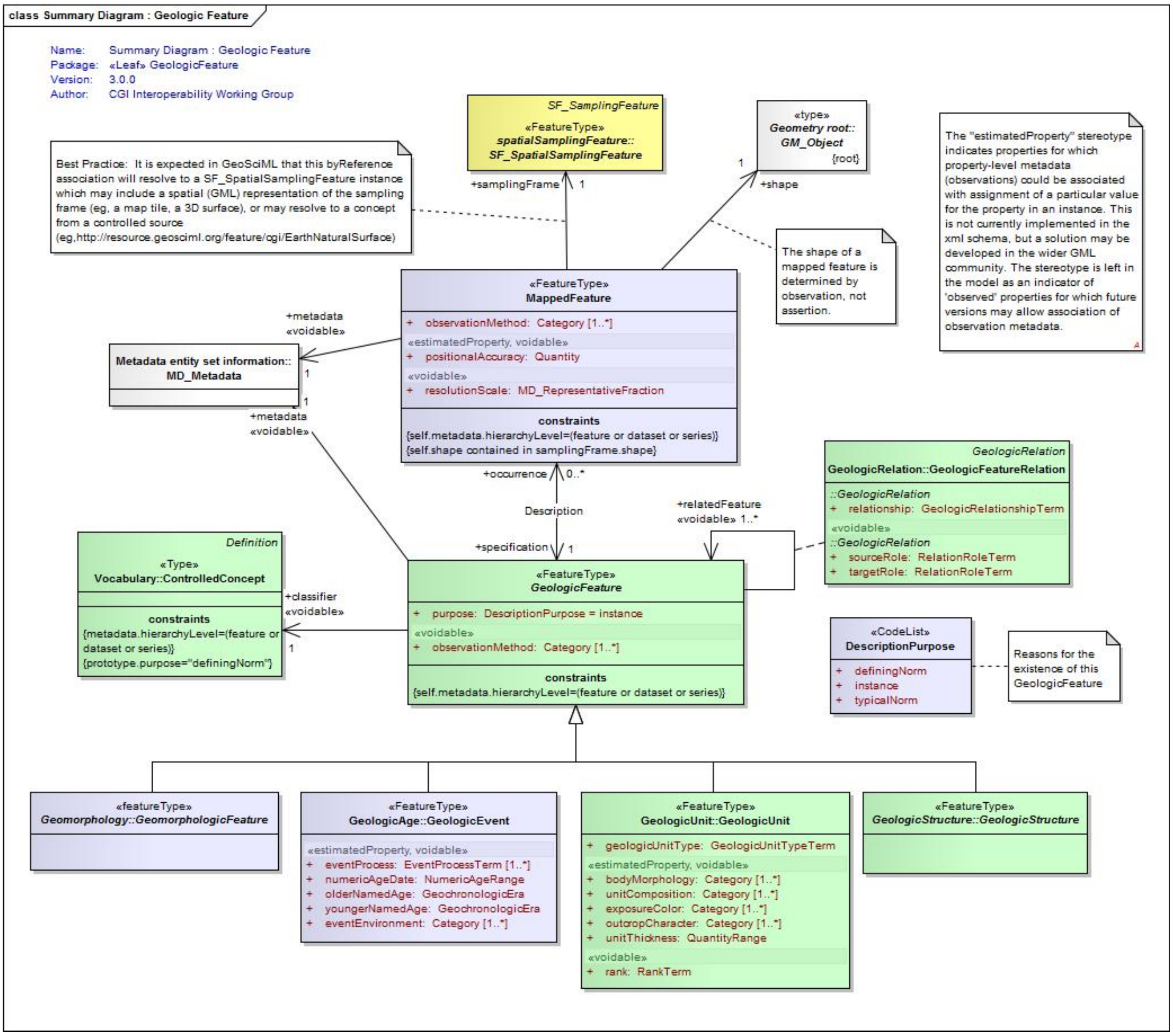


Figure 2 - UML class diagram for the GeoSciML GeologicFeature package

In the INSPIRE GE model the MappedFeature and GeologicFeature properties have been simplified, and also modified to conform to the INSPIRE Generic Conceptual Model (GCM). In GeoSciML geometry is provided by the 'shape' association from MappedFeature to GM_Object, whereas in the INSPIRE GE model 'shape' is a property of MappedFeature. Similarly the samplingFrame association from MappingFeature to SF_SpatialSamplingFeature has been replaced with the mappingFrame property constrained by a codelist. GeoSciML incorporates the GeologicFeatureRelation property as a powerful way of describing the relationship between any pair of GeologicFeatures, but this was seen as too generic within the INSPIRE context so has been replaced with specific associations where needed.

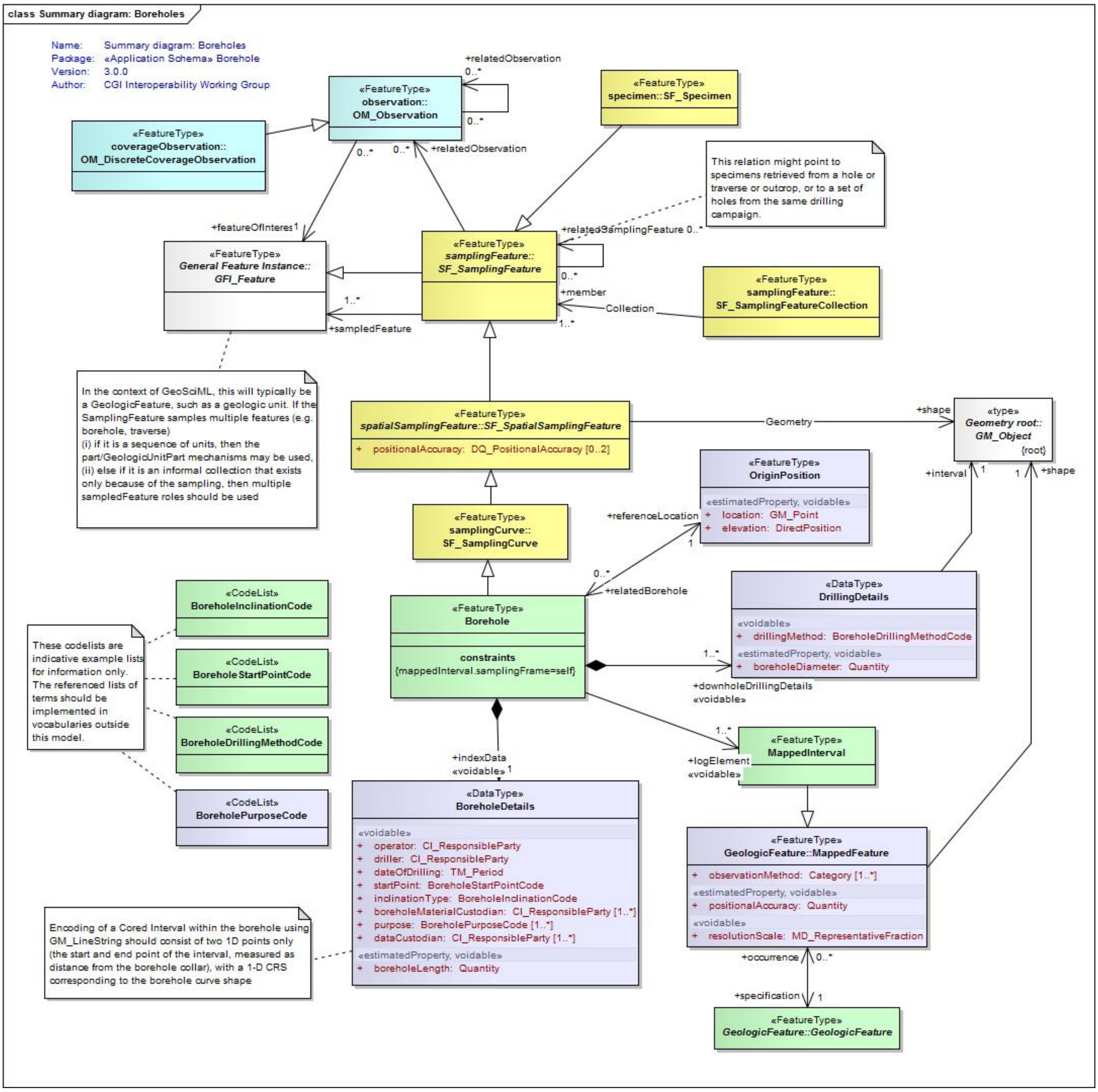


Figure 3 - UML class diagram for GeoSciML Borehole

In the INSPIRE GE model the Borehole package has been greatly simplified with a few key properties incorporated into the Borehole feature, and the associations to datatypes providing further index information removed. However Borehole has still been modelled as a type of SF_SamplingCurve allowing its extension with GeoSciML to enable borehole logs to be modelled as a series of observations as an alternative to the MappedInterval approach.

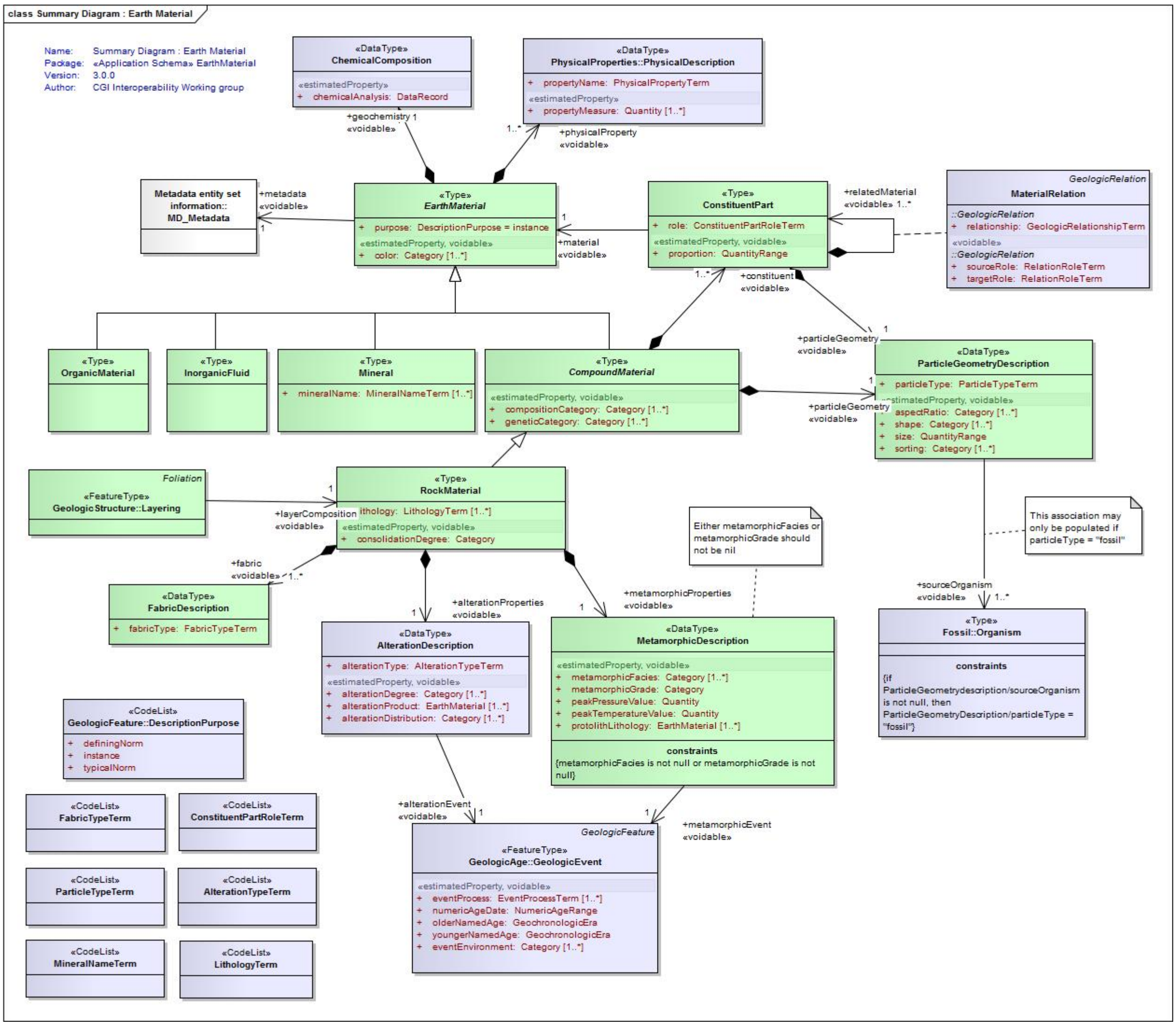


Figure 4 - UML class diagram for the GeoSCiML EarthMaterial package

In GeoSciML the composition of GeologicUnits is described using the EarthMaterial package. While this allows lithologies to be described using a vocabulary of concepts (eg sandstone), it also allows a much more detailed description of the material making up a GeologicUnit, along with its fabric, particle geometry, alteration and metamorphic characteristics. This was considered too complex for the INSPIRE GE model where composition is described only using a vocabulary of concepts.

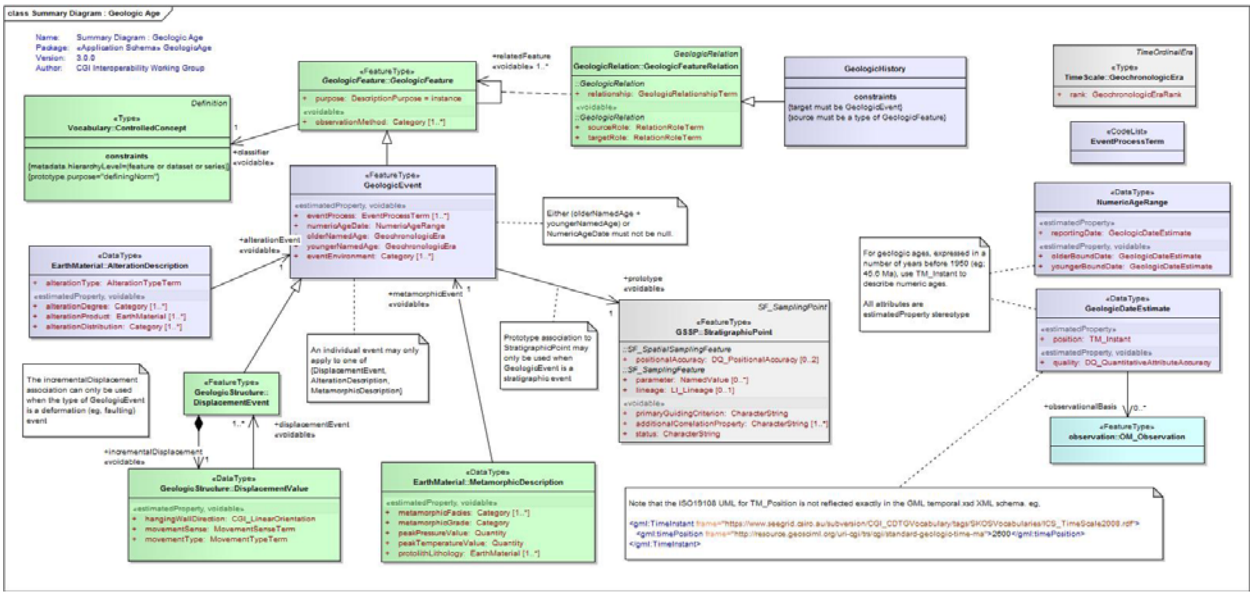


Figure 5 - UML class diagram for GeoSciML GeologicAge

In GeoSciML, as in the INSPIRE GE model, geologic age is considered a property of a GeologicEvent. In GeoSciML GeologicEvent is modelled as a type of GeologicFeature and GeologicHistory as a sub-type of the GeologicFeatureRelation class. In the INSPIRE GE model this has been simplified - GeologicEvent is not a sub-type of GeologicFeature and geologicHistory is an association from GeologicFeature to GeologicEvent. Geologic History is the only type of event that is modelled in the INSPIRE GE model. In GeoSciML age can be given using both numeric and named (eg 'Cambrian') ages, but in the INSPIRE GE model only named ages have been modelled.

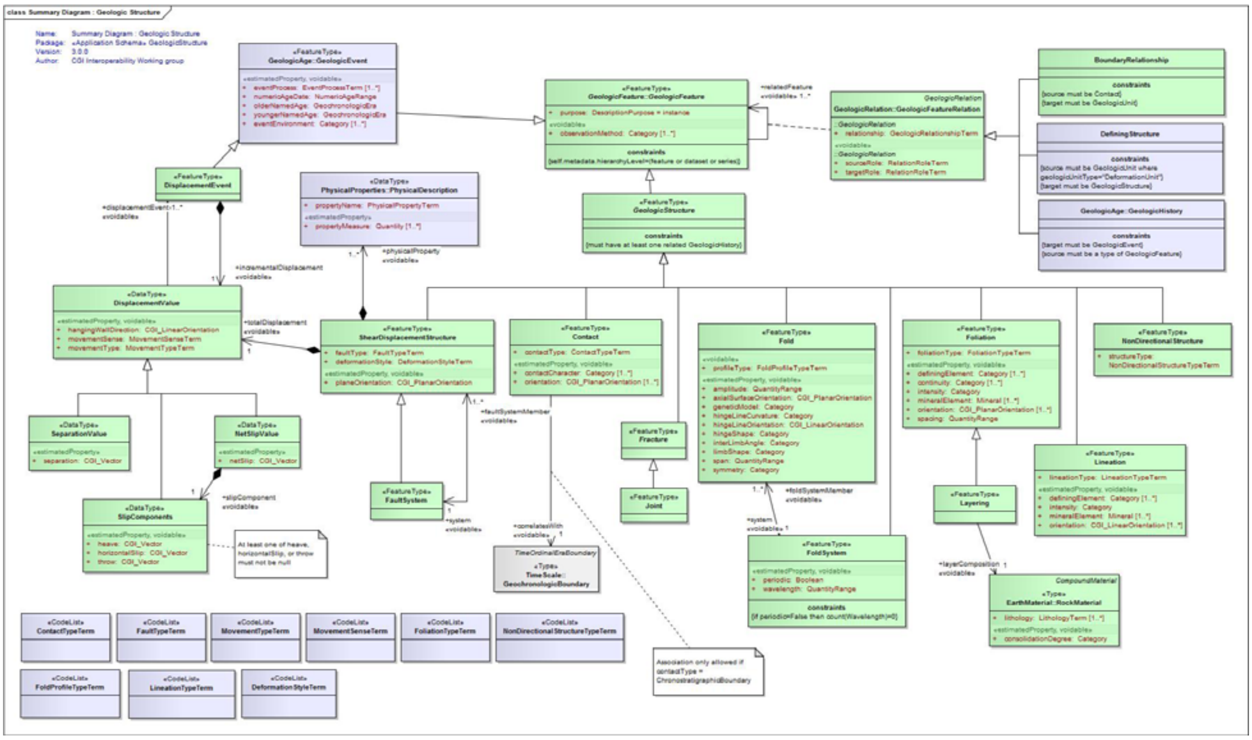


Figure 6 - UML class diagram for GeoSciML GeologicStructure

GeoSciML allows the modelling of a wide range of types of GeologicStructure, and the provision of detailed property information about them. In the INSPIRE GE model this has been greatly simplified so that the only structures modelled are ShearDisplacementStructures (including faults) and Folds, and the only properties provided are the type of ShearDisplacementStructure or Fold.

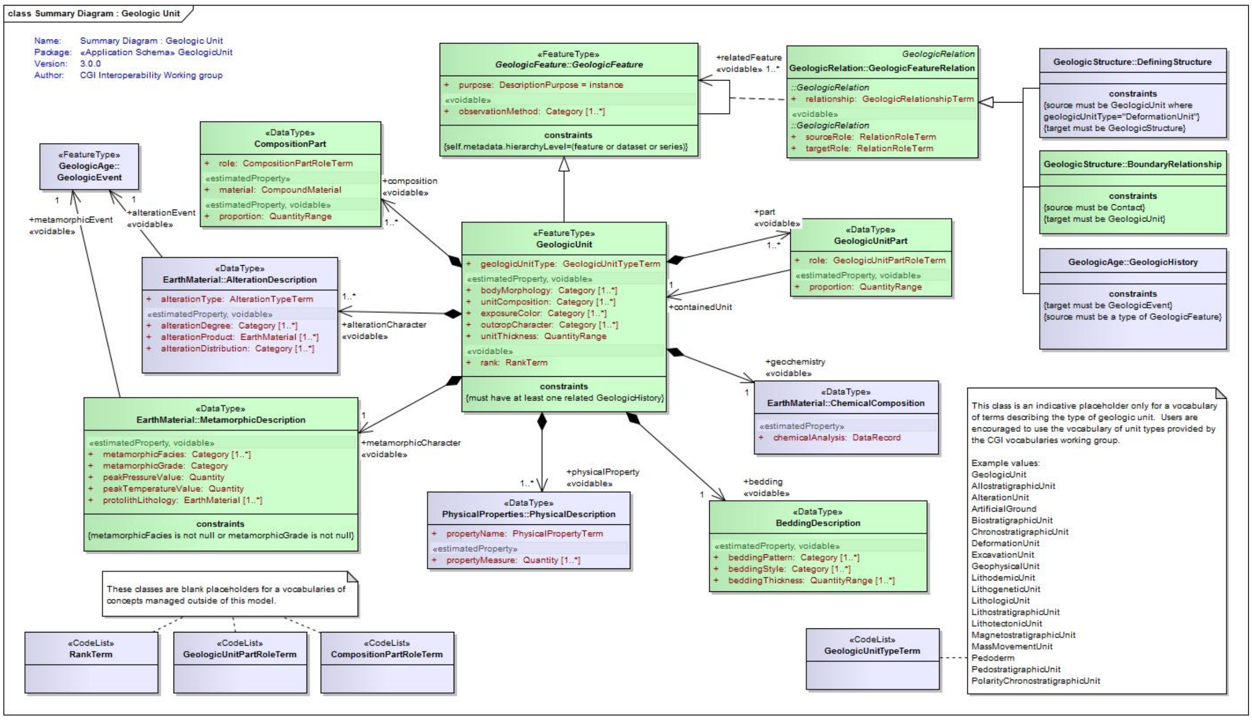


Figure 7 - UML class diagram for GeoSciML GeologicUnit

GeologicUnit is a central feature in both GeoSciML and the INSPIRE GE model. GeoSciML allows the provision of detailed property information for GeologicUnits as well as information about the composition, sub-units (GeologicUnitPart), the chemical composition, the bedding, the physical properties, metamorphism, and alteration. In the INSPIRE GE model this has been simplified so that just the GeologicUnit type and composition are modelled.

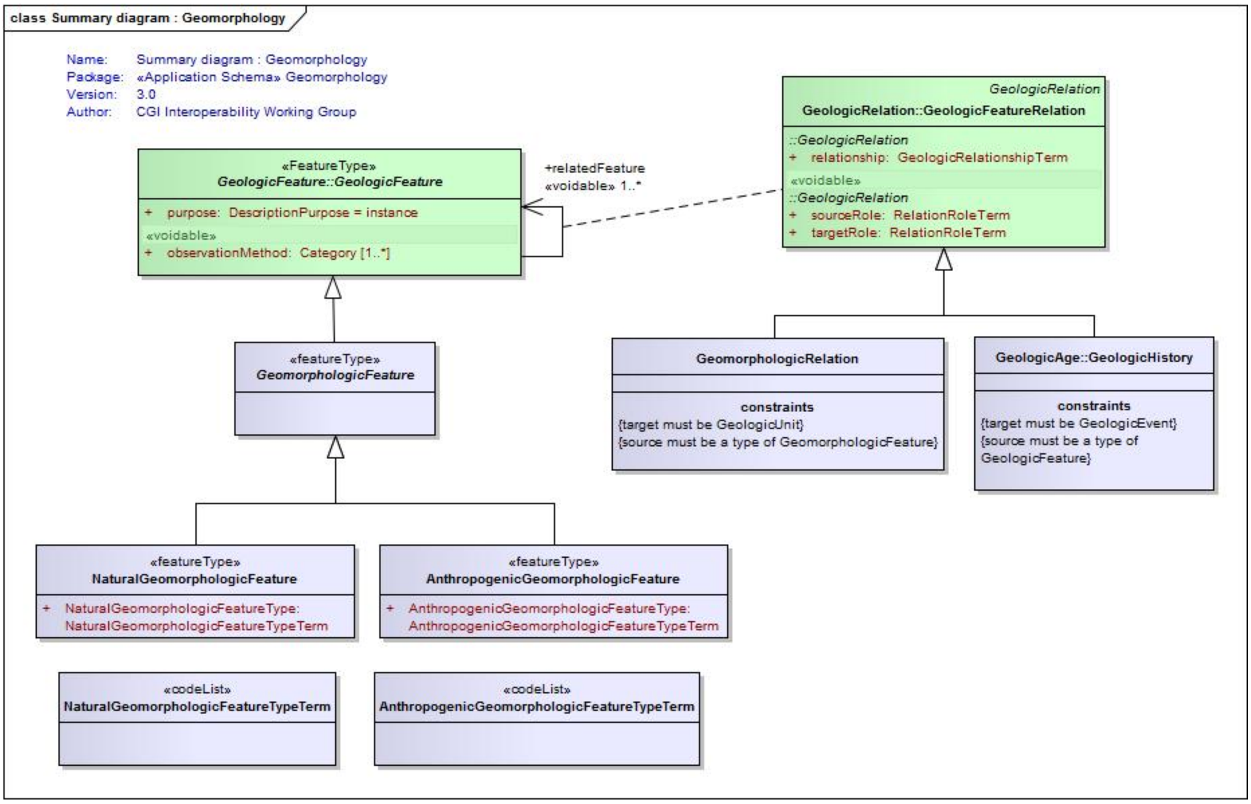


Figure 8 - UML class diagram for GeoSciML Geomorphology

Geomorphology was incorporated into GeoSciML v3 as a result of the requirements of INSPIRE and therefore is very similar to the INSPIRE GE model. However GeoSciML does additionally allow the modelling of the relation between GeomorphologicFeature and a related GeologicUnit (for example relating a River Terrace feature to a River Terrace Deposit) using GeomorphologicRelation. The INSPIRE GE model includes an 'activity' property of NaturalGeomorphologicFeature which is not in GeoSciML v3.

C.2.4 *Mapping between INSPIRE GE model and GeoSciML*

The following table shows the mapping of INSPIRE GE model features and propertiies to their GeoSciML equivalents. Where there is no entry in the GeoSciML columns then there is no GeoSciML equivalent. Note that implementing INSPIRE GE classes in GeoSciML may require the delivery of various other classes and properties which are mandatory in GeoSciML, for example the 'purpose' property of GeologicFeature, as can be seen in the figures of the previous section.

INSPIRE GE class	INSPIRE GE property	GeoSciML class	GeoSciML property
AnthropogenicGeomorphologicFeature		AnthropogenicGeomorphologicFeature	
AnthropogenicGeomorphologicFeature	Anthropogenic GeomorphologicFeatureType	AnthropogenicGeomorphologicFeature	Anthropogenic GeomorphologicFeatureType
Borehole		Borehole	
Borehole	inspireId	Borehole	gml:identifier
Borehole	location	OriginPosition	location
Borehole	boreholeLength	BoreholeDetails	boreholeLength
Borehole	elevation	OriginPosition	elevation
Borehole	purpose	BoreholeDetails	purpose
CompositionPart		CompositionPart	
CompositionPart	material	RockMaterial	lithology
CompositionPart	role	CompositionPart	role
CompositionPart	proportion	CompositionPart	proportion
Fold		Fold	
Fold	profileType	Fold	profileType
GeologicCollection		GSML	
GeologicCollection	inspireId	GSML	gml:identifier
GeologicCollection	name	GSML	gml:name
GeologicCollection	collectionType		
GeologicCollection	reference		
GeologicCollection	beginLifespanVersion		
GeologicCollection	endLifeSpanVersion		
GeologicEvent		GeologicEvent	
GeologicEvent	name	GeologicFeature	gml:name
GeologicEvent	eventEnvironment	GeologicEvent	eventEnvironment
GeologicEvent	eventProcess	GeologicEvent	eventProcess
GeologicEvent	olderNamedAge	GeologicEvent	olderNamedAge
GeologicEvent	youngerNamedAge	GeologicEvent	youngerNamedAge
GeologicFeature		GeologicFeature	
GeologicFeature	inspireId	GeologicFeature	gml:identifier
GeologicFeature	name	GeologicFeature	gml:name
GeologicStructure		GeologicStructure	
GeologicStructure		GeologicStructure	
GeologicUnit		GeologicUnit	
GeologicUnit	geologicUnitType	GeologicUnit	geologicUnitType
GeomorphologicFeature		GeomorphologicFeature	
MappedFeature		MappedFeature	
MappedFeature	shape	MappedFeature	shape (association)
MappedFeature	mappingFrame	MappedFeature	samplingFrame (association)
MappedInterval		MappedInterval	
NaturalGeomorphologicFeature		NaturalGeomorphologicFeature	
NaturalGeomorphologicFeature	naturalGeomorphologicFeatureType	NaturalGeomorphologicFeature	naturalGeomorphologicFeatureType
NaturalGeomorphologicFeature	activity		
ShearDispacementStructure		ShearDispacementStructure	
ShearDispacementStructure	faultTypeTerm	ShearDispacementStructure	faultTypeTerm
ThematicClass			
ThematicClass	themeName		
ThematicClass	themeClassValue		

Table – Mapping of INSPIRE GE classes and properties to GeoSciML equivalents

C.3 *Data model extension for Geophysics*

C.3.1 *Narrative description and UML overview*

The core application schema is very limited to successfully serve the complex use cases. When the request for data provisioning exceeds the limits of the *GeophysicsCore* application schema the extension model can be used. It allows data providers to publish many types of geophysical measurements and results with sufficient detail to fulfil the user requirements documented in the use cases. The most significant difference between the core and extension models is that the extension model introduces additional elements to share observation results in a harmonized way. This is done through the ISO 19156 Observations and Measurements (O&M) standard and specialized observation classes from the INSPIRE Generic Conceptual Model. For the sake of simplicity the *GeophysicsExtension* application schema defines only a few additional observation classes that are specific to geophysical measurements and models. It is mainly left to the data provider to decide how the standard is used. However by providing controlled dictionaries and best practice examples the guidance tries to help in achieving maximum level of interoperability.

Project

The extension model provides an additional class to model geophysical *Projects*. Together with the *Campaign* class of the core model these two can be used for a more detailed description of the geophysical dataset hierarchy. In practice geophysical surveys are often organised into campaigns and projects. A large exploration project may contain several campaigns. e.g.: A big project is started with an airborne measurement campaign. After identifying the main target area a seismic campaign with several seismic lines is carried out. Meanwhile in certain areas where expensive seismic is not feasible magnetotelluric measurements are completed. Each campaign is carried out by different companies, and produce different maps, reports and datasets. The whole activity is controlled by one responsible party, the principal investigator. To model such complex hierarchies the core *Campaign* and the extension *Project* feature types can be used.

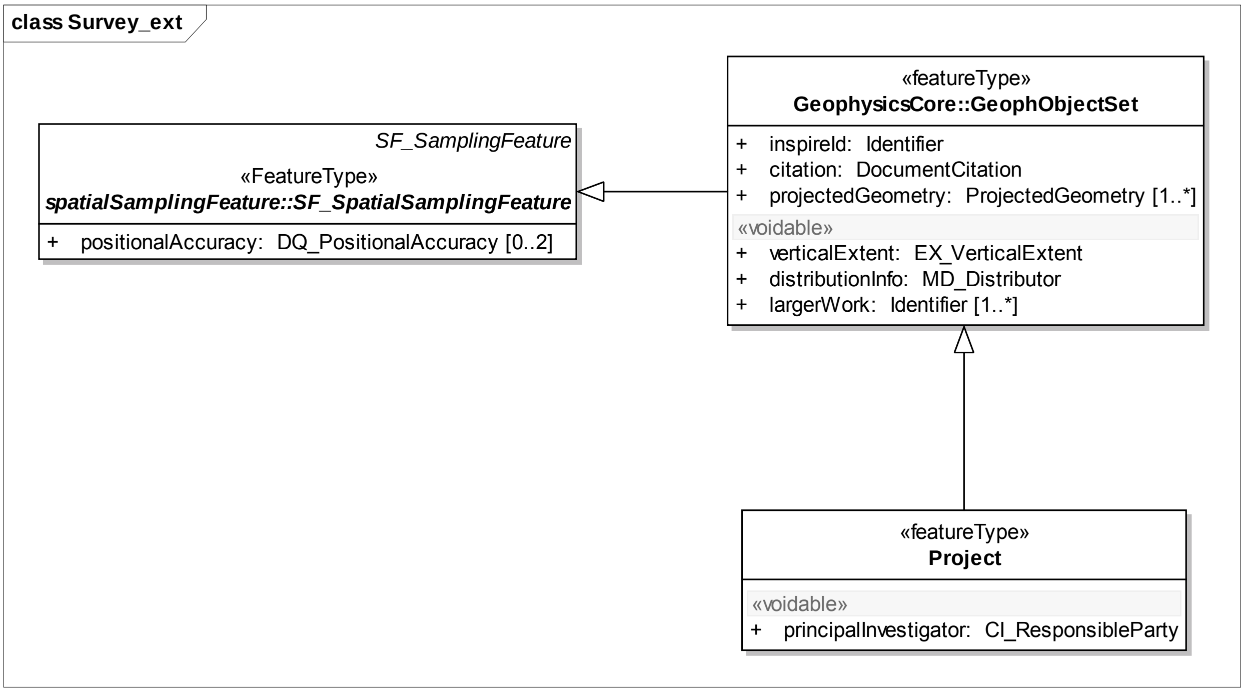


Figure 9 – UML class diagram: Project

Campaign is geophysical activity extending over a limited time range and limited area for producing geophysical measurements, processing results or models. Campaigns can be considered as parents of geophysical measurements or models. Children geophysical objects may refer to their parent campaign through the largerWork attribute.

Project is geophysical activity extending over a longer time period and larger area, containing any number of campaigns or subprojects. In the hierarchy of geophysical data sets projects are parents of geophysical campaigns, and usually cover whole exploration programs. *Project* has one added voidable attributes:

- principalInvestigator: Key party responsible for conducting research

In many cases it is useful to link observation results to collections, rather than to individual geophysical objects. (e.g. a gravity map can be associated with a gravity survey and not with a single station) Both Campaign and Project are subtypes of SF_SpatialSamplingFeature, so it can be done by using the O&M standard. While it sounds quite natural to link observations to *Campaigns*, it is not very likely that any kind of observation is going to be linked to a *Project*. Even in this case at least a shape for bounding geometry shall be provided.

GenericGeophMeasurement

The list of geophysical methods in the *GeopysicsCore* application schema is very limited. This class was added to *GeophysicsExtension* as a generic container for geophysical methods that do not fit in the core measurement types (station, profile, swath). This class adds one attribute to the supertype *GeophMeasurement*

- measurementType: Value must be one of the items listed in the *OtherMeasurementTypeValue* codelist. This codellist is expected to be extended in the future.

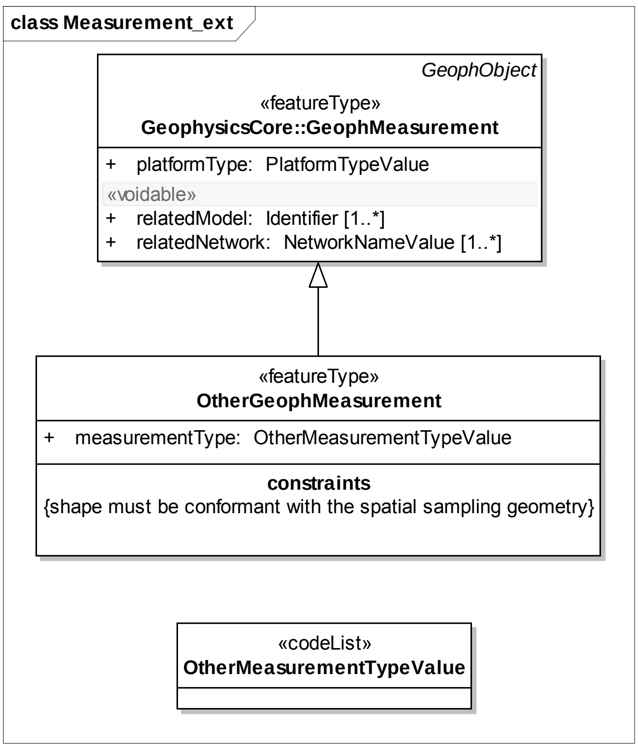


Figure 10 – UML class diagram: GenericGeophMeasurement

Publishing observation data related to a geophysical measurement is optional in INSPIRE. The *GeophObject* class has the *distributionInfo* attribute that holds metadata about data access, ordering procedures, fees etc. When the data provider wants to share observation results in a more interoperable manner the use of *SF_SpatialSamplingFeature* properties is recommended. Guidance to encode observations is given in chapter A.3.7

Models

In the *GeophysicsExtension* application schema *GeophModel* is a geophysical object that is created as a result of data processing or interpretation, representing the distribution of physical or geophysical properties within the observed spatial domain. This definition is broader than the usual concept of model in geophysics that is rather a mathematical construction, a replacement of the reality and it can be used for forward modeling. In INSPIRE under model a geophysical product is meant that can be useful not only for geophysicists, but also for specialists of other domains. It is somewhere at the end of the processing chain. Using O&M terminology the sampledFeature association of a *GeophModel* always can be connected to one or more *GeophMeasurements*.

Apart from the ones inherited from *GeophObject GeophModel* has one voidable attribute:

- relatedMeasurement: It can be used to identify related *GeophMeasurement* instances.

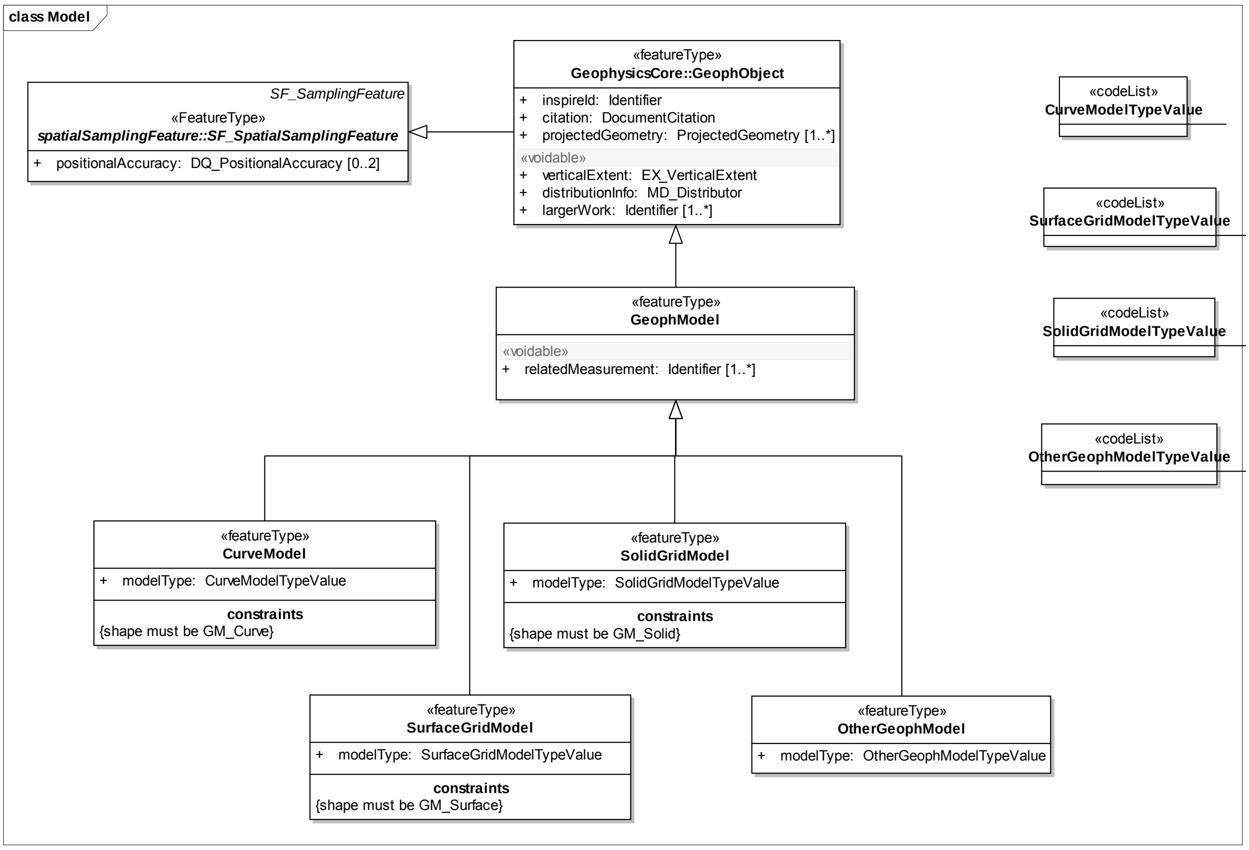


Figure 11 – UML class diagram: GeophModel

Just like measurements, geophysical models are also categorized on the basis of sampling geometry. *CurveModel* is a *GeophModel* with curve geometry. Calculated property values are referenced to a curve. Typical examples are compositLog, layerModel, seismicTimeSection.

Note 1. A 1D layerModel is represented by the trajectory perpendicular to the layer boundaries. Layer parameters are referenced to the curve section overlapping the corresponding layer. The last section of the curve ends at the depth of penetration.

CurveModel has one attribute:

- *modelType*: must be a value from the *CurveModelTypeValue* codelist.

Constraint: shape must be *GM_Curve*

SurfaceGridModel is a *GeophModel* with surface geometry. Calculated property values are referenced to a series of grid points on the surface. Typical examples are seismicDepthSection or 2D resistivity section.

It has one attribute:

- *modelType*: must be a value from the *SurfaceGridModelTypeValue* codelist.

Constraint: shape must be *GM_Surface*

SolidGridModel is a *GeophModel* with solid geometry. Calculated property values are referenced to a series of grid points in the solid. Typical examples are seismicVolume or 3D resistivity block.

It has one attribute:

- *modelType*: must be a value from the *SolidGridModelTypeValue* codelist.

Constraint: shape must be *GM_Solid*

OtherGeophModel is a *GeophModel* with any geometry not listed above.
Examples: Interpreted resistivity cross section (discrete surface coverage that contains polygon patches with resistivity values assigned to them) or Gravity point source distribution (multipoint coverage).

It has one attribute:

- *modelType*: must be a value from the *OtherGeophModelTypeValue* codelist.

How to decide between Measurement and Model?

In contrast to Geophysical measurements geophysical models represent spatial distribution of physical or geophysical properties within the observed spatial domain. Models are created by processing or interpretation and carry the characteristics of the investigated domain as a function of 1 2 or 3 spatial dimensions. It is a matter of data processing to convert measurement data from non spatial dimensions (time, frequency, electrode distance etc.) into space. As a result of this procedure the number of dimensionality increases by 1.

GeophMeasurement and GeophModel are the initial and final stage of the geophysical processing chain. However, the processing chain can be long and if the result originates from an intermediate step it is not always easy to decide which class it belongs to. Table 1. can help in the classification of a feature type.

GeophMeasurement	GeophModel
Data is spatially referenced outside or on the boundary of the investigated domain	Data is spatially referenced to the internal part of the investigated domain
Observed data is a function of some non spatial domain (propagation time, frequency, etc.) to be transformed into space by processing	Observed data is a function of space (or space and time for monitoring.)
Observed property is a geophysical property and not directly interpretable as property of the investigated domain.	Observed property is a property of the investigated domain.

Result can not be used directly for interpretation	Result can be directly used for interpretation

Examples:
- SeismicLine is GeophMeasurement (field data). Observed property is seismic amplitude as a function of time, It is not the property of the investigated domain and the data is not usable for direct interpretation.

- SeismicTimeSection is somewhere between measurement and model. It has one spatial and one non spatial domain (propagation time) to be converted into depth, but it carries information on the seismic reflectivity of the investigated domain and in practice it is often used directly for interpretation. So it is classified as a curve model.

- SeismicDepthSection is clearly a model: a 2D spatial coverage of seismic reflectivity that is directly usable for interpretation.

Observations Result and Procedure

In the O&M schema OM_Observation has four main associations: Phenomenon, Domain, Range, and ProcessUsed (Figure 4). Phenomenon connects to the observedProperty. Domain is the observed spatial domain with the featureOfInterest at the target end. Range means the result that was acquired while examining the target. These two relates to each other like domain and range of GML coverages.

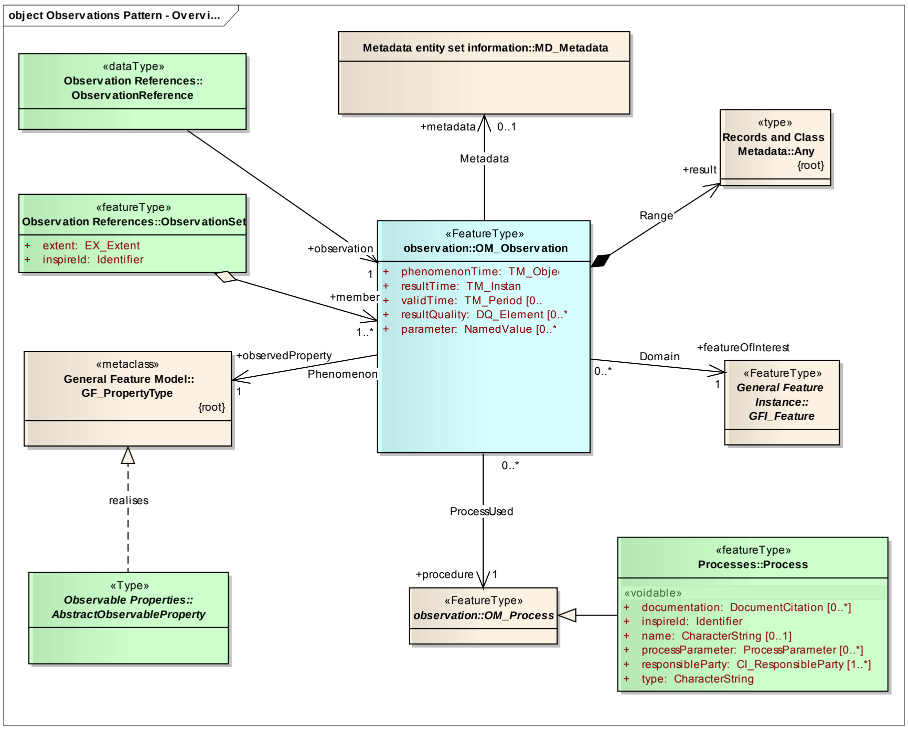


Figure 12 – UML class diagram: Observations overview (GCM)

Results contain observedProperty values characterising the featureOfInterest. ProcessUsed links to a procedure that was used to generate results. Type of result is “Any” since it may represent the value of any feature property. The procedure has the abstract OM_Process type with no properties and serves as a base class for observation processes. Using these concepts any type of observation can be fully described, and it is true for geophysical observations as well.

Geophysics has a rich history of describing observation processes and results, and strong industrial standards for data exchange. Many of the standards were developed long before O&M. However, most geophysical data resources can fit to the O&M concept and plugged into some of the above associations. The *GeophysicsExtension* application schema does not provide a full scale model for geophysical objects. Instead, providing a few auxiliary classes it helps to use the O&M standard as a frame for geophysical information.

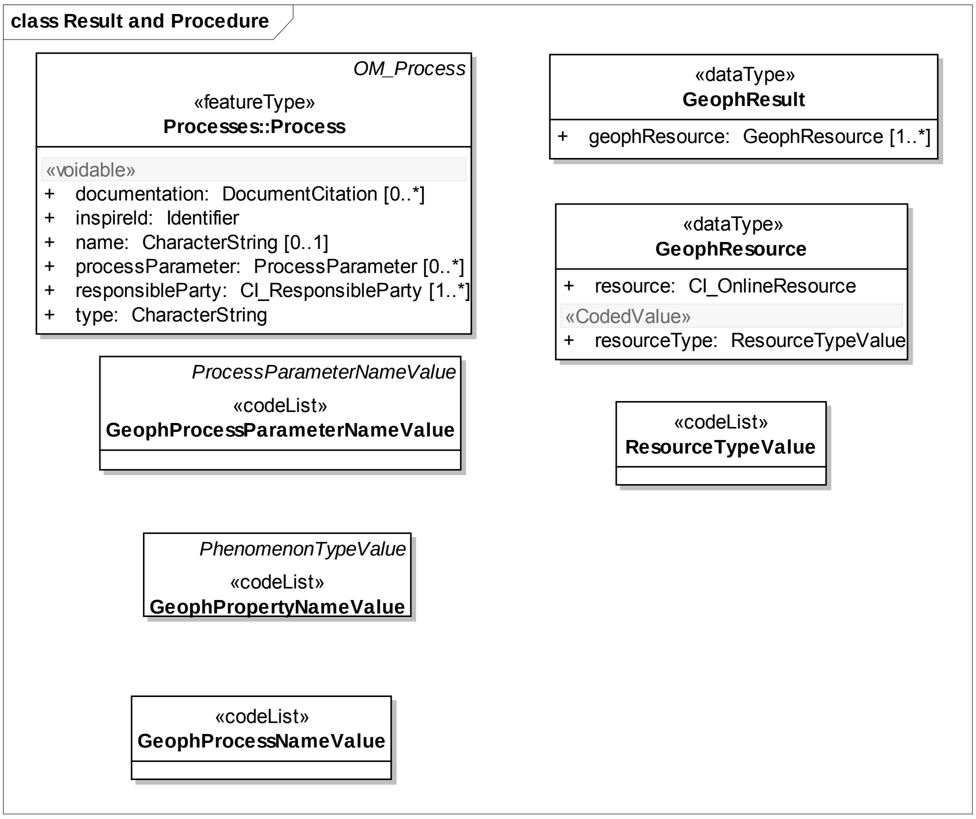


Figure 13 – UML class diagram: Result and Procedure

In the INSPIRE Generic Conceptual Model OM_Process has a specialized subclass: Processes::Process. (Figure 5.) It has the role of describing generic procedures that are common in practice and can be referenced from many observations that were made in the same or similar way. It has name, identifier, documentation, responsibleParty to inform the user about the nature of the procedure and the authority that maintains the record. ProcessParameters are names of important parameters that are characteristic to the procedure. A useful set of names is available in the hierarchical GeophProcessParameterNameValue codelist. In geophysical terminology process parameters can be considered as header parameters. An instance of Processes::Process contains only the names and descriptions. It is the parameter property of OM_Observation that holds the values and tell how a generic procedure was applied in a specific case. In order to assure consistency between the processParameters in the procedure and the parameters within OM_Observation, constraints should be applied.

Example: A generic process is 2D seismic data acquisition. Suitable processParameters in this case are sampling rate, sensor spacing, minimum offset, coverage, etc. An observation instance contains the values that give the user an idea about the most important conditions that influenced data production.

Codelist GeophProcessNameValue contains common names that can be used as the name attribute of Processes:: Process.

GeophResult is a container class for geophysical result files. The INSPIRE recommendation for encoding observations is to use specialized observations with proper coverage types from the Generic Conceptual Model, if appropriate. For non coverage observations the Sensor Web Enablement (SWE) schema can be used to encode results. Annex A contains several examples to demonstrate best practices and to help data providers to encode their results. Very often in geophysics data is provided in widely used industry standard format, and XML encoding is not an option. In such cases *GeophResult* is used to include data resources in *GeophysicalObject*s. The class has one attribute:

- *geophResource*: Any number of geophResource items can be included in *GeophResult*.

GeophResource has two attributes:

- *resource*: Data access is provided as CI_OnlineResource, a URL for online access, and an optional description about the resource.
- *resourceType*: Type must be one of the items in the *ResourceTypeValue* codelist.

O&M data must contains physical and geophysical property names either as references to observed properties or embedded in the result. For such referencing items in the GeophPropertyNameValue codelist are recommended.

C.3.2 The use of O&M in the GeophysicsExtension schema

SF_SpatialSamplingFeature

Both *GeophObject* and *GeophObjectSet* are derived from SF_SpatialSamplingFeature. Direct observations do not exist in geophysics, it is always about sampling. Geophysical measurements are artefacts that are created with the only intention to realize sampling. The ultimate feature of interest is a part of the earth. The final outcome is a spatial distribution of some physical property of the observed domain, usually the result of a processing chain. Each processing step can be exactly modelled as a separate sampling feature with its' own observation, procedure, observed property and result. The output of one step is the input of the next one. In other words: the sampling feature of one step becomes the sampled feature of the next one. It means that geophysical models are also sampling features that realize sampling by mathematical procedures. The difficulty of modelling geophysical entities comes from the fact that the processing chain can be very long and the intermediate observations are often hidden or out of interest. Intermediate outputs are bundled with final results. Lots of ambiguities can be explained by this condition. As a compromise in INSPIRE the geophysical processing chain is cut into two parts. The first part is represented by GeophMeasurement, the second by GeophModel. The scope of measurement, model, and the differences are explained in chapter A.3.1. (How to decide between Measurement and Model?)

As a minimum, SF_SamplingFeature requires two properties: shape and sampledFeature. Shape is the geometry of the domain where the sampled values are referenced. SampledFeature can be any feature that is considered as the target of observation. An efficient way of binding geology and geophysics is to refer to one or more geological units. If no specific feature can be named, reference to a generic concept (e.g. *http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere*) can be used. Data provisioning by the *GeophysicsCore* application schema does not have to go any further in using O&M. An example samplingFeature representing a seismic line

```
<sams:SF_SpatialSamplingFeature gml:id="sf-1"/>
   <sam:sampledFeature  xlink:href="http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere"/>
   <sams:shape>
      <gml:Curve gml:id="crv-1" srsDimension="2" srsName="EPSG:32700">
         <gml:segments>
            <gml:LineStringSegment>
               <gml:pos>654583 76651</gml:pos>
               <gml:pos>665473 76552</gml:pos>
               <gml:pos>654563 76653</gml:pos>
               <gml:pos>665453 76554</gml:pos>
               <gml:pos>654543 76655</gml:pos>
               <gml:pos>665433 76556</gml:pos>
            </gml:LineStringSegment>
         </gml:segments>
      </gml:Curve>
   </sams:shape>
</sams:SF_SpatialSamplingFeature>
```

OM_Observation

To be able to serve requirements identified in the use cases further elements provided by the O&M standard has to be used. Measurement details must be documented in one or more relatedObservation elements. Results originating from different processes must be separated in different observations. It is a matter of convention what is included in a process. A list of process types is available in the GeophProcessNameValue codelist. Example processes from the dictionary:

- *2DseismicDataAcquisition*
- *2DseismicProcessing*
- *airborneDataAcquisition*
- *boreholeLogging*
- *gravityProcessing*
- *inversion*
- *magneticObservation*
- *timeDomainEMSounding*
- *verticalElectricSounding*

Associated process parameter names and category values can be found in the GeophProcessParameterNameValue hierarchical codelist. Process parameter names and allowed category values are available as narrower terms of the appropriate elements.

Example: Following the GCM Observation schema definition a process descriptor file for 2DseismicDataAcquisition would look like this (pseudo XML encoding):

```
Process
   Documentation href="http://any.institution/geophProcess/2DseisDAQ.html"
   inspireId
      localId http://anyCompany/processes/2DSeismicDataAcquisition.xml
      namespace ""
   name 2DseismicDataAcquisition
   processParameter
      description "sensor type"
      name href="
http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parameter/SEN_TYPE"
   processParameter
      description "source type"
      name href="
http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parameter/SRC_TYPE"
   processParameter
      description "sensor spacing"
      name href="
http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parameter/SEN_SPACING"
   …
   …
   …
   processParameter
      description "resource in industry standard format"
      name href="
http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parameter/
industryStandardResource"
   responsibleParty
      role custodian
      organisation AnyCompany
      contacInfo "http://anyCompany/contact.xml"
   type "measuring procedure"
```

Any GeophProfile of type 2D seismicLine can refer to this process record in its relatedObservation element. An example OM_Observation instance for such a 2D seismic data acquisition:

```
   <om:OM_Observation gml:id="obs-1">
      <om:phenomenonTime>
         <gml:TimePeriod gml:id="tp-1">
            <gml:beginPosition>2000-01-01T08:00:0.0</gml:beginPosition>
            <gml:endPosition>2000-01-04T08:00:0.0</gml:endPosition>
         </gml:TimePeriod>
```

```
      </om:phenomenonTime>
      <om:resultTime>
         <gml:TimeInstant gml:id="ti-02">
            <gml:timePosition>2000-01-01T08:00:0.0</gml:timePosition>
         </gml:TimeInstant>
      </om:resultTime>
      <om:procedure xlink:href="http://anyCompany/processes/2DSeismicDataAcquisition.xml"/>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_TYPE"/>
            <om:value>
               <gml:Category
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_TYPE">geop
hone</gml:Category>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_TYPE"/>
            <om:value>
               <gml:Category
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_TYPE">vibr
ator</gml:Category>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_SPACING"/
>
            <om:value>
               <gml:Quantity uom="m">5</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_SPACING"/
>
            <om:value>
               <gml:Quantity uom="m">50</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/NUM_CH"/>
            <om:value>
               <gml:Quantity uom="m">1024</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/industryStand
ardResource"/>
            <om:value xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123.sps"/>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/industryStand
ardResource"/>
            <om:value xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123.ukooa"/>
         </om:NamedValue>
      </om:parameter>
      <om:observedProperty
xlink:href="http://geomind.elgi.hu/skos/GeophProperty/seismics/seismicAmplitude"/>
```

```
      <om:featureOfInterest xlink:href="../../.."/>
      <om:result xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123"/>
   </om:OM_Observation>
```

Referencing the generic process by the xlink:href attribute makes the code compact and more readable.

```
   <om:procedure xlink:href=" http://anyCompany/2DSeismicDataAcquisition.xml"/>
```

The series of <om:parameter> elements follow the definitions in the process descriptor. Category parameter values are taken from the narrower terms in the SKOS dictionary. E.g.: value of SRC_TYPE shall be one of {vibrator, explosive, hammer, airgun}. Numeric values must be encoded as gml:Quantity elements completed with unit of measurement. For referencing Industry standard resource files the industryStandardResource parameter is used. The value of the parameter is a URL pointing to the resource itself. Seismic process descriptors like SPS and UKOOA files shall be accessed through this parameter. URL can be an entry point to a secure data service maintained by the data provider.

Note: Hierarchical code list dictionaries were constructed from GEOMIND parameter catalogues, and cover only a few of the most important geophysical methods. These dictionaries were set up for demonstration purposes to support encoding of geophysical procedures in INSPIRE documents. A full coverage of all geophysical methods can't be the task of the INSPIRE data specification. The responsibility to improve the geophysical SKOS dictionaries will be passed to appointed organizations representing the geophysical community.

The OM_Observation instance contains important temporal information about the geophysical object, such as phenomenonTime, and resultTime. PhenomenonTime can be a time instant or a time range and refers to the time of the sampling activity. For a seismic line it is reasonable to use time range documenting the measurement start and measurement end. For a survey station measurement providing a time instant is appropriate. ResultTime rather means the time instant from when result is available.

observedProperty

Observations always focus on some property of the feature of interest. It is either a physical property of the ultimate feature of interest, or a more abstract geophysical property that is measured or simulated by the geophysical process. It can also be a composit property that is a group of properties measured together. The om:observedProperty element is used to include such information in the OM_Observation element. A list of geophysical properties is available at *http://geomind.elgi.hu/skos/GeophProperty.xml*. The ObservableProperty application schema in the GCM Observation package allows data providers to define complex properties with statistical measures and constraints like "total magnetic field average over 1 minute period derived from 1 second averages". Example:

```
<omop:ObservableProperty gml:id="op1">
   <omop:basePhenomenon
codeSpace="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/magneticProperty">MAG_T
</omop:basePhenomenon>
   <omop:uom uom="nT"/>
  <omop:statisticalMeasure>
      <omop:StatisticalMeasure gml:id="sm1">
         <omop:derivedFrom>
            <omop:StatisticalMeasure gml:id="sm2">
               <omop:statisticalFunction
codeSpace="http://sweet.jpl.nasa.gov/2.0/mathStatistics.ow">Mean</omop:statisticalFunction>
               <omop:aggregationTimePeriod>PT1S</omop:aggregationTimePeriod>
            </omop:StatisticalMeasure>
         </omop:derivedFrom>
         <omop:statisticalFunction
codeSpace="http://sweet.jpl.nasa.gov/2.0/mathStatistics.ow">Mean</omop:statisticalFunction>
         <omop:aggregationTimePeriod>PT1M</omop:aggregationTimePeriod>
      </omop:StatisticalMeasure>
   </omop:statisticalMeasure>
</omop:ObservableProperty>
```

featureOfInterest

The feature of interest (FOI) of a direct observation is the natural target that is observed (color of an apple – observedProperty is color, FOI is apple). When sampling is carried out the observations' feature of interest is the sampling feature itself. The proximate target of a seismic observation is the seismic line and not the earth. The observed property is the seismic amplitude measured on the geophones that are part of the seismic line. This is expressed by the xlink:href attribute that points back to the SF_SpatialSamplingFeature:

```
<om:featureOfInterest xlink:href="../../.."/>
```

Result

There are several ways to include geophysical results in an OM_Observation instance. In the case of coverage observations, or when results are available in XML format, inline encoding or referencing directly from the om:result element is recommended. When results are provided in non XML industry standard format, or more result files are bundled together the GeophResult element shall be used. An example seismic field data result package may look like this (pseudo XML encoding):

```
GeophResult
   geophResource
      resource
         linkage ″http://any.institution/getItem?id=asd-123.1.1.segy″
         description ″SEG-Y field data line-1.1″
      resourceType
"http://inspire.ec.europa.eu/codeList/ResourceTypeValue/seismicResource/SEG-Y "
   geophResource
      resource
         linkage ″http://any.institution/getItem?id=asd-123.1.2.segy″
         description ″SEG-Y field data line-1.2″
      resourceType                                                              "
http://inspire.ec.europa.eu/codeList/ResourceTypeValue/seismicResource/SEG-Y "
   geophResource
      resource
         linkage ″http://any.institution/getItem?id=asd-123.1.3.segy″
         description ″SEG-Y field data line-1.3″
      resourceType                                                              "
http://inspire.ec.europa.eu/codeList/ResourceTypeValue/seismicResource/SEG-Y "
```

Dividing data sets

When larger geophysical data sets extend over concession area boundaries, there may be a request to divide observation results into separate peaces. In such cases the use of SamplingFeatureComplex elements are recommended. Parts can be encoded in individual SF_SpatialSamplingFeature elements, and results are accessed at separate web locations with different distribution options. The main geophysical object contains the shape of the whole complex and the links to the related sampling features.

```
<sams:SF_SpatialSamplingFeature gml:id="sf-1"/>
   <sam:sampledFeature  xlink:href="http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere"/>
   <sam:relatedSamplingFeature>
      <sam:SamplingFeatureComplex>
         <sam:role xlink:href="http://geomind.elgi.hu/skos/role/part.xml"/>
         <sam:relatedSamplingFeature xlink:href="part1.xml"/>
      </sam:SamplingFeatureComplex>
   </sam:relatedSamplingFeature>
   <sam:relatedSamplingFeature>
      <sam:SamplingFeatureComplex>
         <sam:role xlink:href="http://geomind.elgi.hu/skos/role/part.xml"/>
         <sam:relatedSamplingFeature xlink:href="part2.xml"/>
      </sam:SamplingFeatureComplex>
   </sam:relatedSamplingFeature>
   <sams:shape>
      <gml:Curve gml:id="crv-1" srsDimension="2" srsName="EPSG:32700">
         <gml:segments>
```

```
            <gml:LineStringSegment>
               <gml:pos>654583 76651</gml:pos>
               <gml:pos>665473 76552</gml:pos>
               <gml:pos>654563 76653</gml:pos>
               <gml:pos>665453 76554</gml:pos>
               <gml:pos>654543 76655</gml:pos>
               <gml:pos>665433 76556</gml:pos>
            </gml:LineStringSegment>
         </gml:segments>
      </gml:Curve>
   </sams:shape>
</sams:SF_SpatialSamplingFeature>
```

Using Coverages

In principle any geophysical observation result can be encoded as GML coverage. To achieve a higher level of interoperability the use of coverages is highly recommended in INSPIRE. At the same time GML and other XML based encodings are not very common in geophysics, and there are situations when it is neither practical nor possible. Though, there are several ways to efficiently bind XML and binary data, converting huge seismic data files is still not an option. In cases when data exchange is based on widely accepted international standards, the use of those standards must be supported. On the other hand, out of the hydrocarbon industry the weight of standards is not so high, in fact, the lack standards and the virulence of ad-hoc formats is typical. In such cases following the O&M standard and the coverage model is a good alternative for data exchange.

The recommendation of the INSPIRE Cross Thematic Working Group on Observations & Measurements is to use GCM specialized observations when it is possible [DS-D2.9]. The abundance of geophysical data types and the need of supporting industrial standards make the exclusive usage of coverage observations impossible. To avoid fragmentation of the data model a more generic approach seems to be more appropriate in the geophysical domain. However, in result encoding whenever it is feasible the coverage types recommended in the [DS-D2.9] document should be used. (RectifiedGridCoverage, ReferenceableGridCoverage, MultiPointCoverage, TImeSeries)

The GML coverage model supports all discrete coverage types to encode many geophysical data types (*http://www.opengis.net/gmlcov/1.0* name space):

- MultiPointCoverage
- MultiCurveCoverage
- MultiSurfaceCoverage
- MultiSolidCoverage

It also provides coverage types for gridded geophysical data:

- RectifiedGridCoverage
- ReferenceableGridCoverage

The table below gives an overview of how results of different geophysical methods can be encoded in principle by the GML coverage model.

Coverage Type	Geophysical Feature Type	Subtype
gmlcov:MultiPointCoverage	GeophStation	gravityStation
gmlcov:MultiPointCoverage	GeophStation	magneticStation
gmlcov:MultiPointCoverage	GeophStation	verticalElectricSounding
gmlcov:MultiPointCoverage	Campaign	gravityProcessingCampaign
gmlcov:MultiCurveCoverage	CurveModel	layerModel
gmlcov:MultiCurveCoverage	CurveModel	compositLog
gmlcov:MultiSurfaceCoverage	DiscreteSurfaceModel	horizontalCrossSection

gmlcov:MultiSurfaceCoverage	DiscreteSurfaceModel	verticalCrossSection
gmlcov:MultiSolidCoverage	DiscreteSolidModel	bodyReconstruction
gmlcov:RectifiedGridCoverage	SurfaceGridModel	horizontalParameterGrid
gmlcov:RectifiedGridCoverage	SolidGridModel	seismicVolume
gmlcov:ReferenceableGridCoverage	SurfaceGridModel	verticalParameterGrid
gmlcov:ReferenceableGridCoverage	GeophProfile	boreholeLog
gmlcov:ReferenceableGridCoverage	GeophProfile	flightLine
TimeSeries	GeophStation	magneticStation (observatory,secular station)
TimeSeries	GeophStation	seismologicalStation (observatory)

Encoding GeophStation results

It seems to be reasonable not to use different encoding on the basis of the number of points included in a data set. DomainSet of a MultiPointCoverage is one or more points. In this case a station is considered a multipoint object with one single member. (For single point data CV_DiscretePointCoverage could also be used). The following example shows the encoding of a Vertical Electric Sounding:

```
<gmlcov:MultiPointCoverage>
   <gml:multiPointDomain>
      <gml:MultiPoint gml:id="mp-1" srsDimension="3" srsName="EPSG:23700" axisLabels="x y z"
uomLabels="m m m">
         <gml:pointMember>
            <gml:Point gml:id="p-1">
               <gml:pos>654543 76654</gml:pos>
            </gml:Point>
         </gml:pointMember>
      </gml:MultiPoint>
   </gml:multiPointDomain>
   <gml:rangeSet>
      <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList ts=" " cs="\n">3.2 0.5 123.4
         6.4 0.5 122.3
         8.0 0.5 121.1
         12.8 0.5 120 .0
         16.0 0.5 119.8</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name="ABdistance">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/AB_DIST">
               <swe:uom code="m"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="MNdistance">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/MN_DIST">
               <swe:uom code="m"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="apparentResitivity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophPropertyNameValue/VES_Property/APP_RES">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:MultiPointCoverage>
```

Encoding processing campaign results

Multipoint coverage is also useful to deliver results of point observation collections. The following example shows the results of a gravity processing campaign.

```
<gmlcov:MultiPointCoverage gml:id="mpc-1">
   <gml:multiPointDomain>
      <gml:MultiPoint gml:id="mp-1" srsDimension="2" srsName="EPSG:4326">
         <gml:pointMember>
            <gml:Point gml:id="stn-001">
               <gml:pos>654543 76674</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-002">
               <gml:pos>654553 76634</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-003">
               <gml:pos>654573 76654</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-004">
               <gml:pos>654593 76624</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-005">
               <gml:pos>654533 76614</gml:pos>
            </gml:Point>
         </gml:pointMember>
      </gml:MultiPoint>
   </gml:multiPointDomain>
   <gml:rangeSet>
      <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList cs="\n" ts=" ">stn-001 980000 980000 980000 0 0
stn-002 980000 980000 980000 0 0
stn-003 980000 980000 980000 0 0
stn-004 980000 980000 980000 0 0
stn-005 980000 980000 980000 0 0</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord id="drec-1">
         <swe:field name="identifier">
            <swe:Text>
               <swe:identifier/>
            </swe:Text>
         </swe:field>
         <swe:field name="observedGravity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/gravimetricProperty/ob
servedGravity">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="gravityFreeAirAnomaly">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/gravimetricProperty/gr
avityFreeAirAnomaly">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="gravityBouguerAirAnomaly">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/gravimetricProperty/gr
avityBouguerAnomaly">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="innerTopoCorrection">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophProcessParameterNameValue/gravityProcess
Parameter/topoCorrection/innerTopoCorrection">
```

```
            <swe:uom code="microGal"/>
         </swe:Quantity>
      </swe:field>
      <swe:field name="totalTopoCorrection">
         <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophProcessParameterNameValue/gravityProcess
Parameter/topoCorrection/totalTopoCorrection">
            <swe:uom code="microGal"/>
         </swe:Quantity>
      </swe:field>
   </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:MultiPointCoverage>
```

Encoding LayerModels

Layer model is a generic concept for representing a 1D structure. An efficient way of encoding is to use MultiCurveCoverage. Typical use cases are delivering inversion results from VES, TDEM, or MT measurements. Composit logs or borehole data can also be encoded like this. Originally GeoSciML also uses CurveCoverage to describe boreholes. Curve segments of the multi curve domain coincide with the layers. For positions a 3D coordinate system is used. The following example shows a horizontally layered earth with vertical curve segments below the station location. Range data contains resistivity and chargeability values from the inversion of a VES/IP sounding station.

```
<gmlcov:MultiCurveCoverage gml:id="mcc-1">
   <gml:multiCurveDomain>
      <gml:MultiCurve gml:id="mc-1" srsDimension="3" srsName="EPSG:23700" axisLabels="x y z"
uomLabels="m m m">
         <gml:curveMember>
            <gml:LineString gml:id="ls-1">
               <gml:pos>654543 76654 0</gml:pos>
               <gml:pos>654543 76654 -1</gml:pos>
            </gml:LineString>
         </gml:curveMember>
         <gml:curveMember>
            <gml:LineString gml:id="ls-2">
               <gml:pos>654543 76654 -1</gml:pos>
               <gml:pos>654543 76654 -10</gml:pos>
            </gml:LineString>
         </gml:curveMember>
         <gml:curveMember>
            <gml:LineString gml:id="ls-3">
               <gml:pos>654543 76654 -10</gml:pos>
               <gml:pos>654543 76654 -100</gml:pos>
            </gml:LineString>
         </gml:curveMember>
      </gml:MultiCurve>
   </gml:multiCurveDomain>
   <gml:rangeSet>
         <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList ts=" " cs="\n">2.1 0.1
         2.2 0.2
         2.3 0.3</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name="resistivity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/electromagneticPropert
y/resistivity">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="chargeability">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/electromagneticPropert
y/chargeability">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
```

```
   </gmlcov:rangeType>
</gmlcov:MultiCurveCoverage>
```

Encoding VerticalParameterGrid

The following example shows a resistivity cross section encoded as ReferenceableGridCoverage. Grid geometry is defined by node locations in a 3D coordinate system. The trace of the profile is a straight line in SW-NE direction. Nodes are located under the surface in a vertical plain. According to the rangeType element the coverage contains resistivity values for each node.

NOTE: Referenceable grids can be used for nodes with uneven spacing or to project grid data to curved surfaces (e.g.: vertical section along a meandering profile)

```
<gmlcov:ReferenceableGridCoverage gml:id="rgc-1">
   <gml:domainSet>
      <gmlrgrid:ReferenceableGridByArray gml:id="rga1" dimension="2" srsDimension="3"
axisLabels="x z"  uomLabels="m m">
         <gml:limits>
            <gml:GridEnvelope>
               <gml:low>0 0</gml:low>
               <gml:high>3 3</gml:high>
            </gml:GridEnvelope>
         </gml:limits>
         <gml:axisLabels>x z</gml:axisLabels>
         <gml:posList count="16">654543 76654 0
654543 76654 -1
654543 76654 -2
654543 76654 -3
654553 76664 0
654553 76664 -1
654553 76664 -2
654553 76664 -3
654563 76674 0
654563 76674 -1
654563 76674 -2
654563 76674 -3
654573 76684 0
654573 76684 -1
654573 76684 -2
654543 76684 -3</gml:posList>
         <gmlrgrid:sequenceRule>Linear</gmlrgrid:sequenceRule>
      </gmlrgrid:ReferenceableGridByArray>
   </gml:domainSet>
   <gml:rangeSet>
      <gml:QuantityList uom="mV">1.0 2.0 3.0 4.0 2.0 3.0 4.0 5.0 3.0 4.0 5.0 6.0 4.0 5.0 6.0
7.0</gml:QuantityList>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord id="drec-1">
         <swe:field name="resistivity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/electromagneticPropert
y/resistivity">
               <swe:uom code="mV"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:ReferenceableGridCoverage>
```

Encoding HorizonalParameterGrid

The following example shows a Bouguer anomaly map encoded as RectifiedGridCoverage. Grid geometry is defined by the origin and two offset vectors in a 2D coordinate system. Grid spacing is 10 m in both directions. According to the rangeType element the coverage contains Bouguer anomaly values for each node.

```
<gmlcov:RectifiedGridCoverage gml:id="rgc-1">
   <gml:rectifiedGridDomain>
```

```
      <gml:RectifiedGrid gml:id="rg-1" dimension="2" axisLabels="x y" srsDimension="2"
uomLabels="m m" srsName="EPSG:23700">
         <gml:limits>
            <gml:GridEnvelope>
               <gml:low>0 0</gml:low>
               <gml:high>3 3</gml:high>
            </gml:GridEnvelope>
         </gml:limits>
         <gml:axisLabels>x y</gml:axisLabels>
         <gml:origin>
            <gml:Point gml:id="p-1">
               <gml:pos>654543 76654</gml:pos>
            </gml:Point>
         </gml:origin>
         <gml:offsetVector>10 0</gml:offsetVector>
         <gml:offsetVector>0 10</gml:offsetVector>
      </gml:RectifiedGrid>
   </gml:rectifiedGridDomain>
   <gml:rangeSet>
      <gml:QuantityList uom="ohmm">1 2 3 4 2 3 4 5 3 4 5 6 4 5 6 7</gml:QuantityList>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name=" gravityBouguerAnomaly ">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue/gravimetricProperty/gr
avityBouguerAnomaly">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:RectifiedGridCoverage>
```

In practice grid coverages may contain large amount of data. XML text encoding in such cases is not practical. The [DS-D2.9] document contains recommendations on “out-of band result encoding” explaining how to include optimized binary files in the rangeSet element.

12.3.1 Feature catalogue

Feature catalogue metadata

Feature catalogue name	INSPIRE feature catalogue GeophysicsExtension
Scope	GeophysicsExtension
Version number	2.9
Version date	2012-04-04
Definition source	INSPIRE data specification GeophysicsExtension

Types defined in the feature catalogue

Type	Package	Stereotypes	Section
CurveModel	GeophysicsExtension	«featureType»	.1.1
CurveModelTypeValue	GeophysicsExtension	«codeList»	.3.1
GeophModel	GeophysicsExtension	«featureType»	.1.2
GeophProcessNameValue	GeophysicsExtension	«codeList»	.3.2
GeophProcessParameterNameValue	GeophysicsExtension	«codeList»	.3.3
GeophPropertyNameValue	GeophysicsExtension	«codeList»	.3.4
GeophResource	GeophysicsExtension	«dataType»	.2.1
GeophResult	GeophysicsExtension	«dataType»	.2.2
OtherGeophMeasurement	GeophysicsExtension	«featureType»	.1.3
OtherGeophModel	GeophysicsExtension	«featureType»	.1.4

Type	Package	Stereotypes	Section
OtherGeophModelTypeValue	GeophysicsExtension	«codeList»	.3.5
OtherMeasurementTypeValue	GeophysicsExtension	«codeList»	.3.6
Project	GeophysicsExtension	«featureType»	.1.5
ResourceTypeValue	GeophysicsExtension	«codeList»	.3.7
SolidGridModel	GeophysicsExtension	«featureType»	.1.6
SolidGridModelTypeValue	GeophysicsExtension	«codeList»	.3.8
SurfaceGridModel	GeophysicsExtension	«featureType»	.1.7
SurfaceGridModelTypeValue	GeophysicsExtension	«codeList»	.3.9

12.3.1.1. Spatial object types

12.3.1.1.1. CurveModel

CurveModel	
Name:	Curve Model
Subtype of:	GeophModel
Definition:	Geophysical model that represents a curve coverage of some geophysical properties
Description:	Distribution of physical or geophysical properties along a curve. Examples: layer model from 1D inversion, interpreted borehole log.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: modelType	
Value type:	CurveModelTypeValue
Definition:	Type of curve model
Description:	It must be a value from the CurveModelTypeValue codelist.
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)
Constraint: shape must be GM_Curve	
Natural language:	shape must be GM_Curve
OCL:	inv: shape.oclIsKindOf(GM_Curve)

12.3.1.1.2. GeophModel

GeophModel	
Name:	Geoph Model
Subtype of:	GeophObject
Definition:	Geophysical object that is created as a result of geophysical data processing or interpretation
Description:	Models represent spatial distribution of physical or geophysical properties within the observed spatial domain. The sampledFeature association of a GeophModel (as a sampling feature) usually connects to one or more GeophMeasurements.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: relatedMeasurement	
Value type:	Identifier
Definition:	Identifier of the geophysical measurement that was used to create the model result.
Description:	It can be used to identify related *GeophMeasurement* instances.

GeophModel	
Multiplicity:	1..*
Stereotypes:	«voidable»

12.3.1.1.3. OtherGeophMeasurement

OtherGeophMeasurement	
Name:	Other Geoph Measurement
Subtype of:	GeophMeasurement
Definition:	Generic class for any geophysical measurement type that is listed in the GeophMeasurementTypeValue code list.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: measurementType	
Value type:	OtherMeasurementTypeValue
Definition:	Type of geophysical measurement
Description:	Type must be one of the items in the GeophMeasurementTypeValue codelist.
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)
Constraint: shape must be conformant with the spatial sampling geometry	
Natural language:	shape must be conformant with the spatial sampling geometry
OCL:	

12.3.1.1.4. OtherGeophModel

OtherGeophModel	
Name:	Other Geoph Model
Subtype of:	GeophModel
Definition:	Geophysical model that represents a coverage of physical or geophysical properties
Description:	Geophysical model type that is listed in the "OtherGeophModelTypeValue" code list.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: modelType	
Value type:	OtherGeophModelTypeValue
Definition:	Type of geophysical model
Description:	It must be a value from the OtherGeophModelTypeValue codelist
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)

12.3.1.1.5. Project

Project	
Name:	Project
Subtype of:	GeophObjectSet
Definition:	Geophysical activity extending over a longer time range and larger area, containing any number of campaigns or subprojects
Description:	In the hierarchy of geophysical data sets projects are parents of geophysical campaigns, and usually cover whole exploration programs.
Status:	Proposed

Project	
Stereotypes:	«featureType»
Identifier:	null
Attribute: principalInvestigator	
Value type:	CI_ResponsibleParty
Definition:	Main party responsible for the project
Multiplicity:	1
Stereotypes:	«voidable»

12.3.1.1.6. SolidGridModel

SolidGridModel	
Name:	Solid Grid Model
Subtype of:	GeophModel
Definition:	Geophysical model that represents a solid grid coverage of physical or geophysical properties
Description:	3D grid of physical or geophysical properties. Examples are seismic volume, or 3D resistivity grid from DC tomography.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: modelType	
Value type:	SolidGridModelTypeValue
Definition:	Type of solid grid model
Description:	It must be a value from the SolidGridModelTypeValue codelist
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)
Constraint: shape must be GM_Solid	
Natural language:	shape must be GM_Solid
OCL:	inv: shape.oclIsKindOf(GM_Solid)

12.3.1.1.7. SurfaceGridModel

SurfaceGridModel	
Name:	Surface Grid Model
Subtype of:	GeophModel
Definition:	Geophysical model that represents a surface grid coverage of physical or geophysical properties
Description:	Surface grid of physical or geophysical properties. Examples are seismic depth section, 2D resistivity grid from DC tomography.
Status:	Proposed
Stereotypes:	«featureType»
Identifier:	null
Attribute: modelType	
Value type:	SurfaceGridModelTypeValue
Definition:	Type of surface grid model
Description:	It must be a value from the SurfaceGridModelTypeValue codelist
Multiplicity:	1
Obligation:	Technical Guidance (recommendation)
Constraint: shape must be GM_Surface	

SurfaceGridModel	
Natural language:	shape must be GM_Surface
OCL:	inv: shape.oclIsKindOf(GM_Surface)

12.3.1.2. Data types

12.3.1.2.1. GeophResource

GeophResource	
Name:	Geoph Resource
Definition:	Resource of any geophysical information
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: resource	
Value type:	CI_OnlineResource
Definition:	Linkage to online resource with optional description
Multiplicity:	1
Attribute: resourceType	
Value type:	ResourceTypeValue
Definition:	Type of geophysical resource
Description:	Type must be one of the items in the ResourceTypeValue codelist.
Multiplicity:	1
Stereotypes:	«CodedValue»
Obligation:	Technical Guidance (recommendation)

12.3.1.2.2. GeophResult

GeophResult	
Name:	Geoph Result
Definition:	Container for geophysical measurement and processing results
Description:	To be used in place of OM_Observation result
Status:	Proposed
Stereotypes:	«dataType»
Identifier:	null
Attribute: geophResource	
Value type:	GeophResource
Definition:	Resource of any geophysical information
Description:	Any number of geophResource items can be included in *GeophResult*.
Multiplicity:	1..*

12.3.1.3. Code lists

12.3.1.3.1. CurveModelTypeValue

CurveModelTypeValue	
Name:	Curve Model Type
Definition:	Type of curve model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/CurveModelTypeValue

12.3.1.3.2. GeophProcessNameValue

GeophProcessNameValue	
Name:	Geoph Process Name
Definition:	Proposed names for geophysical processes
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeophProcessNameValue

12.3.1.3.3. GeophProcessParameterNameValue

GeophProcessParameterNameValue	
Name:	Geoph Process Parameter Name
Subtype of:	ProcessParameterNameValue
Definition:	hierarchical codelist of geophysical process parameter names
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeophProcessParameterNameValue

12.3.1.3.4. GeophPropertyNameValue

GeophPropertyNameValue	
Name:	Geoph Property Name
Subtype of:	PhenomenonTypeValue
Definition:	hierarchical codelist of geophysical property names
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/GeophPropertyNameValue

12.3.1.3.5. OtherGeophModelTypeValue

OtherGeophModelTypeValue	
Name:	Other Geoph Model Type
Definition:	Other type of geophysical model
Description:	none of the following types: curve model, surface grid model solid grid model. The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/OtherGeophModelTypeValue

12.3.1.3.6. OtherMeasurementTypeValue

OtherMeasurementTypeValue	
Name:	Other Measurement Type
Definition:	Type of geophysical measurement
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/OtherMeasurementTypeValue

12.3.1.3.7. ResourceTypeValue

ResourceTypeValue

ResourceTypeValue	
Name:	Resource Type
Definition:	Type of geophysical resource
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/ResourceTypeValue

12.3.1.3.8. SolidGridModelTypeValue

SolidGridModelTypeValue	
Name:	Solid Grid Model Type
Definition:	Type of solid grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/SolidGridModelTypeValue

12.3.1.3.9. SurfaceGridModelTypeValue

SurfaceGridModelTypeValue	
Name:	Surface Grid Model Type
Definition:	Type of surface grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Status:	Proposed
Stereotypes:	«codeList»
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codeList/SurfaceGridModelTypeValue

12.3.1.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

12.3.1.4.1. CI_OnlineResource

CI_OnlineResource	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115-All Metadata::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

12.3.1.4.2. CI_ResponsibleParty

CI_ResponsibleParty	
Package:	INSPIRE Consolidated UML Model::Foundation Schemas::ISO TC211::ISO 19115-All Metadata::ISO 19115:2006 Metadata (Corrigendum)::Citation and responsible party information [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]

12.3.1.4.3. GeophMeasurement

GeophMeasurement

GeophMeasurement	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::Geophysics::GeophysicsCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Generic feature for geophysical measurements.
Description:	Geophysical measurements collect data outside or on the boundary of the observed spatial domain.

12.3.1.4.4. GeophObject

GeophObject	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::Geophysics::GeophysicsCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.

12.3.1.4.5. GeophObjectSet

GeophObjectSet	
Package:	INSPIRE Consolidated UML Model::Themes::Annex II::Geology::Geophysics::GeophysicsCore [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	Generic class for collections of geophysical objects
Description:	It is a set of geophysical objects that are grouped by some common property. p.e: created in the same measuring campaign. GeophObjectSets are used for spatial sampling either by means of data acquisition or data processing. The produced result of a geophObjectSet is always collective, e.g. a map constructed from the results of the individual member objects.

12.3.1.4.6. Identifier

Identifier	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Types::Base Types [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

12.3.1.4.7. PhenomenonTypeValue

PhenomenonTypeValue	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Observations::Observable Properties [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A codelist of phenomena (e.g. temperature, windspeed)

PhenomenonTypeValue	
Description:	A codelist of phenomena. This codelist itself is an empty placeholder and should be extended and specified for any thematic domain.

12.3.1.4.8. ProcessParameterNameValue

ProcessParameterNameValue	
Package:	INSPIRE Consolidated UML Model::Generic Conceptual Model::Base Models::Observations::Processes [Include reference to the document that includes the package, e.g. INSPIRE data specification, ISO standard or the GCM]
Definition:	A codelist of names of process parameters.
Description:	This codelist itself is an empty placeholder and should be extended and specified for any thematic domain.

Annex D
(informative)
Code-lists values

D.1 *Code list values for the extension of geophysics*

Proposed extensions to code list CampaignTypeValue

Value	Name	Definition	Parent
processing	processing	data processing campaign	
interpretation	interpretation	interpretation campaign	

Proposed extensions to code list NetworkNameValue

Value	Name	Definition	Parent
Other	other	other network	

Proposed extensions to code list PlatformTypeValue

Value	Name	Definition	Parent
Other	other	Measurement carried out from other type of platform	

Proposed extensions to code list ProfileTypeValue

Value	Name	Definition	Parent
flightLine	flight line	Geophysical measurement carried out from a flying platform along a line	
conePenetrationTest	cone penetration test	Geotechnical and geophysical measurement carried out by pushing down an instrumented cone into the ground. Also known as CPT.	
verticalSeismicProfile	vertical seismic profile	Geophysical measurement used to record acoustic response of waves travelling between a borehole and the surface. Also known as VSP.	
georadarProfile	georadar profile	Geophysical measurement used to record electromagnetic response from a radar source along a profile in order to define EM properties in a cross section of the earth.	

Proposed extensions to code list StationRankValue

Value	Name	Definition	Parent
surveyStation	survey station	Ordinary survey station	

Proposed extensions to code list StationTypeValue

Value	Name	Definition	Parent
timeDomainEMSounding	time-domain em sounding	Geophysical station to measure underground electric resistivity changes in depth using time	

Value	Name	Definition	Parent
		domain signal. Also known as TDEM sounding.	
frequencyDomainEMSounding	frequency domain em sounding	Geophysical station to measure underground electric resistivity changes in depth using frequency domain signal , Also known as FDEM sounding.	
radiometricStation	radiometric station	Geophysical station to observe radioactive radiation intensity	

Proposed extensions to code list SurveyTypeValue

Value	Name	Definition	Description
2DSeismicSurvey	2D seismic survey	Campaign of 2D seismic measurements	A 2D seismic survey may include one or more seismic lines. Geometry is the overall bounding polygon and metadata also includes responsible parties.
3DSeismicSurvey	3D seismic survey	Campaign of 3D seismic measurements	A 3D seismic survey may include one or more 3D seismic measurements. Geometry is the overall bounding polygon and metadata also includes responsible parties.
boreholeLoggingSurvey	borehole logging survey	Campaign of borehole logging measurements	A borehole logging survey may include one or more borehole logging measurements. Geometry is the overall bounding polygon and metadata also includes responsible parties.
1DResistivitySurvey	1D resistivity survey	Campaign of Vertical Electric Sounding measurements	A 1D resistivity survey may include any number of VES stations. Geometry is the overall bounding polygon and metadata also includes responsible parties.
2DResistivitySurvey	2D resistivity survey	Campaign of 2D Multielectrode DC measurements	A 2D resistivity survey may include one or more multielectrode DC profiles. Geometry is the overall bounding

Value	Name	Definition	Description
			polygon and metadata also includes responsible parties.
timeDomainEMSurvey	time-domain EM survey	Campaign of Time domain EM sounding measurements	A time domain EM survey may include any number of TDEM soundings. Geometry is the overall bounding polygon and metadata also includes responsible parties.
frequencyDomainEMSurvey	frequency domain EM Survey	Campaign of FrequencyDomain EM sounding measurements	A frequency domain EM survey may include any number of FDEM soundings. Geometry is the overall bounding polygon and metadata also includes responsible parties.
magnetotelluricSurvey	magnetotelluric survey	Campaign of magnetotelluric sounding measurements	A magnetotelluric survey may include any number of MT soundings. Geometry is the overall bounding polygon and metadata also includes responsible parties.
geoRadarSurvey	georadar survey	Campaign of geoRadar measurements	A georadar survey may include one or more georadar profiles. Geometry is the overall bounding polygon and metadata also includes responsible parties.
CPTSurvey	CPT survey	Campaign of Cone penetration test sounding measurements	A CPT survey may include any number of CPT soundings. Geometry is the overall bounding polygon and metadata also includes responsible parties.
VSPSurevey	VSP surevey	Campaign of Vertical Seismic Profiling measurements	A VSP survey may include any number of vertical seismic profiles. Geometry is the overall bounding polygon and metadata also includes responsible

Value	Name	Definition	Description
			parties.
sonarSurvey	sonar survey	Campaign of sonar mapping measurements	A sonar survey may include any number of individual sonar measurements. Geometry is the overall bounding polygon and metadata also includes responsible parties.

Proposed extensions to code list SwathTypeValue

Value	Name	Definition	Parent
radarInterferometry	radar interferometry	Radar mapping technique used to detect centimeter-sized changes in the Earth's crust due to natural phenomena.	
sonar	sonar	Sound Navigation And Ranging system used for underwater mapping	

Values of code list CurveModelTypeValue

Value	Name	Definition	Description	Parent value
compositLog	compositLog	A set of processed or interpreted physical parameter curves along the axis of a borehole		
layerModel	layerModel	1D layer model, encoded as discrete curve coverage.	The coverage geometry is a line in 3D space, perpendicular to the layer boundaries, with start point at the surface location, end point at the depth of penetration. Layer parameters are referenced to the curve sections overlapping the layers. Similar to a borehole log.	
seismicTimeSection	seismicTimeSection	Series of seismic property - two way time functions referenced to CDP locations		

Values of code list GeophProcessNameValue

Value	Name	Definition	Description	Parent value
VES	VES	Procedure to acquire Vertical Electric Sounding data		
TDEMSounding	TDEMSounding	Procedure to acquire TDEM sounding data		
boreholeLogging	boreholeLogging	Procedure to acquire borehole logging data		
MT_Sounding	MT_Sounding	Procedure to acquire magnetotelluric Sounding data		
MT_Processing	MT_Processing	magnetotelluric data processing		
MT_Preprocessing	MT_Preprocessing	calculation of complex impedance tenzor and tipper		MT_Processing
2D_MT_Inversion	2D_MT_Inversion	2D inversion of magnetotelluric soundings	determination of 2D underground resistivity distribution by optimization	MT_Processing
3D_MT_Inversion	3D_MT_Inversion	3D inversion of magnetotelluric soundings	determination of 3D underground resistivity distribution by optimization	MT_Processing
2DseismicDataAcquisition	2DseismicDataAcquisition	Procedure to acquire 2D seismic data		
3DseismicDataAcquisition	3DseismicDataAcquisition	Procedure to acquire 3D seismic data		
airborneDataAcquisition	airborneDataAcquisition	Procedure to acquire airborne geophysical data		
2DseismicProcessing	2DseismicProcessing	2D seismic data processing		
staticCorrection	staticCorrection	static correction		2DseismicProcessing
velocityAnalysis	velocityAnalysis	velocity analysis		2DseismicProcessing
timeStacking	timeStacking	time stacking		2DseismicProcessing
timeMigration	timeMigration	time migration		2DseismicProcessing
depthMigration	depthMigration	depth migration		2DseismicProcessing
depthConversion	depthConversion	depth conversion		2DseismicProcessing
3DseismicProcessing	3DseismicProcessing	3D seismic data processing		
inversion	inversion	generic geophysical		

Value	Name	Definition	Description	Parent value
		inversion		
gravityObservation	gravityObservation	procedures to acquire gravity station data		
gravityProcessing	gravityProcessing	gravity data processing		
normalCorrection	normalCorrection	Correction of gravity field variation due to geographic latitude		gravityProcessing
heightCorrection	heightCorrection	Correction of gravity variation due to elevation difference		gravityProcessing
topoCorrection	topoCorrection	Correction of the gravity effect due to topography		gravityProcessing
bouguerCorrection	bouguerCorrection	Bouguer correction		gravityProcessing
magneticObservation	magneticObservatio n	magnetic observation		
magneticFieldMonitori ng	magneticFieldMonit oring	magnetic field monitoring		
earthquakeObservatio n	earthquakeObservat ion	earthquake observation		
ambientNoiseObserva tion	ambientNoiseObser vation	ambient noise observation		
magneticProcessing	magneticProcessing	magnetic processing		
normalCorrection	normalCorrection	Correction of magnetic field variation due to geographic latitude and longitude		magneticProcessi ng

Values of code list GeophProcessParameterNameValue

Value	Name	Definition	Description	Parent value
VES_Paramete r	VES_Parameter	Vertical Electric Sounding process parameter		
VES_ARR_TYP E	VES_ARR_TYP E	Electrode array	allowed values are narrower terms	VES_Parameter
schlumberger	schlumberger	Schlumberger array		VES_ARR_TYP E
wenner	wenner	Wenner array		VES_ARR_TYP E
AB_MIN	AB_MIN	minimum distance between A and B electrodes		VES_Parameter
AB_MAX	AB_MAX	maximum distance between A and B		VES_Parameter

Value	Name	Definition	Description	Parent value
		electrodes		
AZM	AZM	azimuth of the layout,angle between north and the AB line direction (header parameter)		VES_Parameter
AB_DIST	AB_DIST	Distance between A B current electrodes		VES_Parameter
MN_DIST	MN_DIST	Distance between M N potential electrodes		VES_Parameter
TDEM_Process Parameter	TDEM_Process Parameter	TDEM process parameters		
TDEM_ARR_TYPE	TDEM_ARR_TYPE	Layout array type	allowed values are narrower terms	TDEM_Process Parameter
CIL	CIL	Central Induction Loop sounding array		TDEM_ARR_TYPE
singleLoop	singleLoop	Singel Loop sounding array		TDEM_ARR_TYPE
offset	offset	Sounding array, RX loop is separated from Tx loop		TDEM_ARR_TYPE
AZM	AZM	Azimuth of layout		TDEM_Process Parameter
LOOP_SZ_MIN	LOOP_SZ_MIN	Smallest TX loop - side length of the equivalent square		TDEM_Process Parameter
LOOP_SZ_MAX	LOOP_SZ_MAX	Largest TX loop - side length of the equivalent square		TDEM_Process Parameter
TX_CURR	TX_CURR	current loaded into to the transmitter loop, or the earth		TDEM_Process Parameter
TM_OFFS	TM_OFFS	channel time		TDEM_Process Parameter
TOFF_TM	TOFF_TM	duration of turn off ramp in case of linear ramp		TDEM_Process Parameter
TON_TM	TON_TM	duration of turn on process		TDEM_Process Parameter
RX_DELAY	RX_DELAY	delay of Receiver in transmitter time		TDEM_Process Parameter
BASE_FREQ	BASE_FREQ	current wave base frequency in Hz		TDEM_Process Parameter
LOOP_SZ_X	LOOP_SZ_X	transmitter loop side length in X direction		TDEM_Process Parameter
LOOP_SZ_Y	LOOP_SZ_Y	transmitter loop side length in Y direction		TDEM_Process Parameter
NUM_OF_TURNS	NUM_OF_TURNS	number of turns in the transmitter loop		TDEM_Process Parameter
CURR_WAVE_FORM	CURR_WAVE_FORM	current wave form in the transmitter loop	allowed values are narrower terms	TDEM_Process Parameter

Value	Name	Definition	Description	Parent value
rectangularBipolar	rectangularBipolar	bipolar square wave with idle periods		CURR_WAVE_FORM
rectangularBipolar	rectangularBipolar	triangular wave		CURR_WAVE_FORM
RX_COIL_AREA	RX_COIL_AREA	effective area of receiver coil		TDEM_Process Parameter
boreholeLoggingParameter	boreholeLogging Parameter	Borehole logging process parameters		
WELL_ID	WELL_ID	well identifier		boreholeLogging Parameter
WELL_BTM	WELL_BTM	bottom of well		boreholeLogging Parameter
DPTH_MIN	DPTH_MIN	minimum depth of logging		boreholeLogging Parameter
DPTH_MAX	DPTH_MAX	maximum depth of logging		boreholeLogging Parameter
LOG_TYPE	LOG_TYPE	reference to log parameter name		boreholeLogging Parameter
industryStandardResource	industryStandardResource	reference to LAS, WITSML etc. files		boreholeLogging Parameter
WTR_LEV	WTR_LEV	water level		boreholeLogging Parameter
DREF	DREF	Depth Reference		boreholeLogging Parameter
STRT	STRT	First Index Value		boreholeLogging Parameter
STOP	STOP	Last Index Value		boreholeLogging Parameter
STEP	STEP	STEP		boreholeLogging Parameter
X	X	X or East-West coordinate		boreholeLogging Parameter
Y	Y	Y or North South coordinate		boreholeLogging Parameter
LATI	LATI	Latitude		boreholeLogging Parameter
LONG	LONG	Longitude		boreholeLogging Parameter
RUN_DEPTH	RUN_DEPTH	nth Run Depth Interval		boreholeLogging Parameter
NMAT_DEPTH	NMAT_DEPTH	Neutron Matrix Depth interval		boreholeLogging Parameter
DMAT_DEPTH	DMAT_DEPTH	Density Matrix Depth interval		boreholeLogging Parameter
SMAT_DEPTH	SMAT_DEPTH	Sonic Matrix Depth		boreholeLogging Parameter
DIST	DIST	Cumulative increment of drilling.		boreholeLogging Parameter

Value	Name	Definition	Description	Parent value
HRS	HRS	Hours of drilling		boreholeLogging Parameter
TBR	TBR	Total barrels returned		boreholeLogging Parameter
I_RF	I_RF	Depth Datum Elevation (from MSL)		boreholeLogging Parameter
I_DC	I_DC	Magnetic Declination (if I_AT not magnetic)		boreholeLogging Parameter
I_KO	I_KO	Kick off Depth (M.D. of kick off point)		boreholeLogging Parameter
I_ONS	I_ONS	N/S Offset of well ref point to top hole		boreholeLogging Parameter
I_OEW	I_OEW	E/W Offset of well ref point to top hole		boreholeLogging Parameter
CLSR	CLSR	Closure (horizontal) length		boreholeLogging Parameter
TIEMD	TIEMD	Tie Point Measured depth		boreholeLogging Parameter
TIETVD	TIETVD	Tie Point True Vertical depth		boreholeLogging Parameter
TIEDEV	TIEDEV	Tie Point Deviation		boreholeLogging Parameter
TSTT	TSTT	TEST Top Depth		boreholeLogging Parameter
TSTB	TSTB	TEST Bottom Depth		boreholeLogging Parameter
ISIP	ISIP	Initial Shut in pressure		boreholeLogging Parameter
FSIP	FSIP	Final Shut in pressure		boreholeLogging Parameter
RATE	RATE	Production Rate		boreholeLogging Parameter
RUN	RUN	Run Number		boreholeLogging Parameter
RUNS	RUNS	# of Runs for this well.		boreholeLogging Parameter
TSTN	TSTN	TEST Number		boreholeLogging Parameter
BS	BS	Bit Size		boreholeLogging Parameter
WRAP	WRAP	ONE LINE PER DEPTH STEP		boreholeLogging Parameter
NULL	NULL	NULL VALUE		boreholeLogging Parameter
COMP	COMP	COMPANY		boreholeLogging Parameter
WELL	WELL	WELL		boreholeLogging Parameter
FLD	FLD	FIELD		boreholeLogging Parameter
LOC	LOC	LOCATION		boreholeLogging Parameter
STAT	STAT	STATE		boreholeLogging Parameter
PROV	PROV	PROVINCE		boreholeLogging Parameter

Value	Name	Definition	Description	Parent value
CTRY	CTRY	COUNTRY		boreholeLogging Parameter
CNTY	CNTY	County		boreholeLogging Parameter
UWI	UWI	UNIQUE WELL ID		boreholeLogging Parameter
LIC	LIC	LICENSE NUMBER		boreholeLogging Parameter
SRVC	SRVC	Service Company		boreholeLogging Parameter
DATE	DATE	Service Date		boreholeLogging Parameter
GDAT	GDAT	Geodetic Datum		boreholeLogging Parameter
HZCS	HZCS	Horizontal Co-ordinate System		boreholeLogging Parameter
C_SRS	C_SRS	Core Source		boreholeLogging Parameter
C_TY	C_TY	Core Type		boreholeLogging Parameter
C_DATE	C_DATE	Recovery Date (Date Core Cut) {DD/MM/YYYY}		boreholeLogging Parameter
C_FM	C_FM	Primary Formation Cored		boreholeLogging Parameter
C_AC	C_AC	Analyzing Company		boreholeLogging Parameter
C_AD	C_AD	Analysis Date {DD/MM/YYYY}		boreholeLogging Parameter
CDES	CDES	Core description		boreholeLogging Parameter
RIG	RIG	Drilling Rig name		boreholeLogging Parameter
CONTR	CONTR	Contractor		boreholeLogging Parameter
I_DT	I_DT	SURVEY_DATE {DD/MM/YYYY}		boreholeLogging Parameter
I_CO	I_CO	Recording Company		boreholeLogging Parameter
I_AT	I_AT	Azimuth North Type (e.g. Grid/ True)		boreholeLogging Parameter
I_GD	I_GD	Geodetic datum		boreholeLogging Parameter
I_CP	I_CP	COMPUTE_METHOD (e.g. Radius of Curvature)		boreholeLogging Parameter
I_CS	I_CS	COORDINATE_SYSTEM_NAME e.g. UTM18N		boreholeLogging Parameter
TOPN	TOPN	Formation Top Name		boreholeLogging Parameter
TOPSRC	TOPSRC	Formation Top Source		boreholeLogging Parameter
TOPDR	TOPDR	Tops Depth Reference		boreholeLogging Parameter
DDES	DDES	TEST Recovery Description		boreholeLogging Parameter

Value	Name	Definition	Description	Parent value
BLOWD	BLOWD	BLOW DESCRIPTION		boreholeLogging Parameter
TESTT	TESTT	Test Type		boreholeLogging Parameter
LMF	LMF	Log Measured From		boreholeLogging Parameter
API	API	API Number		boreholeLogging Parameter
APD	APD	Above Permanent Data		boreholeLogging Parameter
EREF	EREF	Elevation of Depth Reference		boreholeLogging Parameter
PDAT	PDAT	Permanent Data		boreholeLogging Parameter
RUN_DATE	RUN_DATE	Run date		boreholeLogging Parameter
MT_Parameter	MT_Parameter	Magnetotelluric Sounding process parameters		
AZM	AZM	azimuth of the layout (direction of Ex)		MT_Parameter
FREQ_MIN	FREQ_MIN	smallest frequency		MT_Parameter
FREQ_MAX	FREQ_MAX	largest frequency		MT_Parameter
MT_MEAS_TYPE	MT_MEAS_TYPE	MT measurement type	allowed values are narrower terms	MT_Parameter
LMT	LMT	Long period Magnetotelluric Sounding		MT_MEAS_TYPE
BBMT	BBMT	Broad band Magnetotelluric Sounding		MT_MEAS_TYPE
AMT	AMT	Audio frequency Magnetotelluric Sounding		MT_MEAS_TYPE
RMT	RMT	Radio frequency Magnetotelluric Sounding		MT_MEAS_TYPE
industryStandardResource	industryStandardResource	reference to SEG-EDI file GeophResource		MT_Parameter
2DseismicDAQ_Parameter	2DseismicDAQ_Parameter	2D seismic data acquisition process parameters		
SRC_TYPE	SRC_TYPE	type of acoustic source	allowed values are narrower terms	2DseismicDAQ_Parameter
vibrator	vibrator	vibrator		SRC_TYPE
explosive	explosive	explosive		SRC_TYPE
hammer	hammer	hammer		SRC_TYPE

Value	Name	Definition	Description	Parent value
airgun	airgun	airgun		SRC_TYPE
SEN_TYPE	SEN_TYPE	type of acoustic sensor	allowed values are narrower terms	2DseismicDAQ_Parameter
geophone	geophone	geophone		SEN_TYPE
hydrophone	hydrophone	hydrophone		SEN_TYPE
seismograph	seismograph	seismograph		SEN_TYPE
SEN_SPACING	SEN_SPACING	distance between sensors (geophones)		2DseismicDAQ_Parameter
SRC_SPACING	SRC_SPACING	distance between sources		2DseismicDAQ_Parameter
NUM_CH	NUM_CH	number of channels		2DseismicDAQ_Parameter
CVRG	CVRG	coverage		2DseismicDAQ_Parameter
SAMP_RATE	SAMP_RATE	Time distance between samples		2DseismicDAQ_Parameter
TM_OFFS_MIN	TM_OFFS_MIN	time offset of the earliest sample		2DseismicDAQ_Parameter
TM_OFFS_MAX	TM_OFFS_MAX	time offset of the latest sample		2DseismicDAQ_Parameter
NRST_OFFS	NRST_OFFS	distance between the source and the nearest sensor		2DseismicDAQ_Parameter
SEIS_METHOD	SEIS_METHOD	type of seismic method	allowed values are narrower terms	2DseismicDAQ_Parameter
refraction	refraction	refraction		SEIS_METHOD
reflection	reflection	reflection		SEIS_METHOD
SEIS_WAVE_TYPE	SEIS_WAVE_TYPE	seismic wave type	allowed values are narrower terms	2DseismicDAQ_Parameter
P	P	Primary wave		SEIS_WAVE_TYPE
S	S	Secondary wave		SEIS_WAVE_TYPE
industryStandardResource	industryStandardResource	reference to SPS, UKOOA,SEG-Y etc. files		2DseismicDAQ_Parameter

Value	Name	Definition	Description	Parent value
airborneDAQ_Parameter	airborneDAQ_Parameter	Airborne geophysical data acquisition process parameter		
PAR_TYPE	PAR_TYPE	measured geophysical parameter		airborneDAQ_Parameter
AVG_SPACING	AVG_SPACING	average distance between data points		airborneDAQ_Parameter
LINE_DIST	LINE_DIST	average distance between flight lines		airborneDAQ_Parameter
TIELINE_DIST	TIELINE_DIST	average distance between tielines		airborneDAQ_Parameter
FLGT_HGT	FLGT_HGT	average flight height		airborneDAQ_Parameter
NAV_MODE	NAV_MODE	navigation mode	allowed values are narrower terms	airborneDAQ_Parameter
visual	visual	visual navigation		NAV_MODE
microfix	microfix	navigation by microfix		NAV_MODE
video	video	navigation by video		NAV_MODE
DGPS	DGPS	navigation by differencial GPS		NAV_MODE
FLGT_SPD	FLGT_SPD	average flight speed		airborneDAQ_Parameter
2DseismicProcParameter	2DseismicProcParameter	2D seismic data processing parameters		
CDP_SPACING	CDP_SPACING	distance between CDP-s		2DseismicProcParameter
CDP_FRST	CDP_FRST	serial num of first CDP		2DseismicProcParameter
CDP_LST	CDP_LST	serial num of last CDP		2DseismicProcParameter
CORR_STATIC	CORR_STATIC	static correction	allowed values are narrower terms	2DseismicProcParameter
shallowRefraction	shallowRefraction	static correction by shallow refraction seismics		CORR_STATIC
acousticLog	acousticLog	static correction by acoustic log		CORR_STATIC
automatic	automatic	automatic static correction		CORR_STATIC
industryStandardResource	industryStandardResource	reference to SPS, UKOOA,SEG-Y etc. Files		2DseismicProcParameter
inversionProcParameter	inversionProcParameter	Inversion process parameters		

Value	Name	Definition	Description	Parent value
MOD_DIM	MOD_DIM	number of model dimensions		inversionProcParameter
INV_METHOD	INV_METHOD	type of optimization method	allowed values are narrower terms	inversionProcParameter
leastSquares	leastSquares	inversion by least squares method		INV_METHOD
marquardt	marquardt	Marquardt inversion		INV_METHOD
simulatedAnnealing	simulatedAnnealing	inversion by simulated annealing		INV_METHOD
geneticAlgorithm	geneticAlgorithm	inversion by genetic algorithm		INV_METHOD
INV_TYPE	INV_TYPE	type of inversion	allowed values are narrower terms	inversionProcParameter
single	single	single inversion	inversion of a single dataset	INV_TYPE
joint	joint	joint inversion	simultaneous inversion of several datasets of different types	INV_TYPE
gravityProcessParameter	gravityProcessParameter	Gravity station process parameters		
errorOfClosure	errorOfClosure	error of closure		gravityProcessParameter
gravityDatum	gravityDatum	gravity datum	allowed values are narrower terms	gravityProcessParameter
IGSN71	IGSN71	IGSN71		gravityDatum
Potsdam	Potsdam	Potsdam		gravityDatum
MGH50	MGH50	Hungarian gravity datum 1950		gravityDatum
MGH2000	MGH2000	Hungarian gravity datum 2000		gravityDatum
normalCorrectionFormula	normalCorrectionFormula	Type of equation used for normal correction	allowed values are narrower terms	gravityProcessParameter
somigliana	somigliana	correction formula by Somigliana		normalCorrectionFormula
cassinis	cassinis	correction formula by Cassinis		normalCorrectionFormula

Value	Name	Definition	Description	Parent value
helmert	helmert	correction formula by Helmert		normalCorrectionFormula
heiskanen	heiskanen	correction formula by Heiskanen		normalCorrectionFormula
heightCorrectionFormula	heightCorrectionFormula	Type of equation used for normal correction	allowed values are narrower terms	gravityProcessParameter
firstOrderFormula	firstOrderFormula	first order formula		heightCorrectionFormula
SecondOrderFormula	SecondOrderFormula	second order formula		heightCorrectionFormula
bouguerCorrectionFormula	bouguerCorrectionFormula	Type of equation used for normal correction	allowed values are narrower terms	gravityProcessParameter
bouguerPlate	bouguerPlate	correction using Bouguer plate		bouguerCorrectionFormula
sphericalCap	sphericalCap	correction using spherical cap		bouguerCorrectionFormula
bouguerCorrectionDensity	bouguerCorrectionDensity	density used for Bouguer correction		gravityProcessParameter
topoCorrectionDensity	topoCorrectionDensity	density used for topographic correction		gravityProcessParameter
topoCorrection	topoCorrection	topoCorrection process parameters	allowed values are narrower terms	gravityProcessParameter
innerTopoCorrection	innerTopoCorrection	value of inner zone topo correction		topoCorrection
totalTopoCorrection	totalTopoCorrection	value of total topo correction		topoCorrection
magneticProcessParameter	magneticProcessParameter	Magnetic station process parameters		
IGRF_SYS	IGRF_SYS	Reference to IGRF coefficients that were used to calculate the normal magnetic field	example: http://www.ngdc.noaa.gov/IAGA/vmod/igrf11coeffs.txt	magneticProcessParameter
SAMP_RATE	SAMP_RATE	frequency of sampling in hertz for magnetic observatory time series		magneticProcessParameter
MAG_RESOL	MAG_RESOL	resolution of magnetic field measurement in picoTesla		magneticProcessParameter
GAUSS_FILT_WDTH	GAUSS_FILT_WDTH	width of convolution filter time window for magneticobservatory time series		magneticProcessParameter
GAUSS_FILT_SIGMA	GAUSS_FILT_SIGMA	scale factor (standard deviation) of Gauss convolution filter for		magneticProcessParameter

Value	Name	Definition	Description	Parent value
		magnetic observatory time series		
HIGH_CUT_FREQ	HIGH_CUT_FREQ	HighCut frequency of analogue filter for magnetic observatory time series		magneticProcessParameter

Values of code list GeophPropertyNameValue

Value	Name	Definition	Description	Parent value
VES_Property	VES_Property	Vertical Electric Sounding property		
APP_RES	APP_RES	apparent resistivity calculated by Ohms law		VES_Property
APP_CHRG	APP_CHRG	apparent chargeability		VES_Property
CURR	CURR	current of the AB current dipole		VES_Property
VOLTAGE	VOLTAGE	voltage measured no the MN electric dipole		VES_Property
TDEM_Property	TDEM_Property	TDEM sounding property		
APP_RES_LT	APP_RES_LT	apparent resistivity calculated by late time approximation		TDEM_Property
APP_RES_ET	APP_RES_ET	apparent resistivity calculated by early time approximation		TDEM_Property
APP_RES	APP_RES	apparent resistivity		TDEM_Property
VOLTAGE	VOLTAGE	voltage measured by the receiver loop or potential electrodes		TDEM_Property
DHDT	DHDT	time derivative of the magnetic field in the direction of the Rx loop axis		TDEM_Property
DHXDT	DHXDT	time derivative of the magnetic field X component		TDEM_Property
DHYDT	DHYDT	time derivative of the magnetic field Y component		TDEM_Property
DHZDT	DHZDT	time derivative of the magnetic field Z component		TDEM_Property
boreholeLogging Property	boreholeLogging Property	borehole looging property		
MATR	MATR	Neutron Porosity Matrix		boreholeLogging Property
C_TP	C_TP	Core Top Depth		boreholeLogging Property
C_BS	C_BS	Core Base Depth		boreholeLogging Property
C_RC	C_RC	Recovered Amount (Length)		boreholeLogging Property

Value	Name	Definition	Description	Parent value
C_DI	C_DI	Core Diameter		boreholeLogging Property
CORT	CORT	Core top depth		boreholeLogging Property
CORB	CORB	Core Bottom Depth		boreholeLogging Property
DDEP	DDEP	Depth		boreholeLogging Property
ROP	ROP	Rate of Penetration		boreholeLogging Property
WOB	WOB	Weight on bit		boreholeLogging Property
RPM	RPM	Rotations per minute		boreholeLogging Property
TQ	TQ	Torque on bit in amps		boreholeLogging Property
PUMP	PUMP	Mud pump pressure		boreholeLogging Property
TSPM	TSPM	Total strokes per minute		boreholeLogging Property
GPM	GPM	Gallons per minute		boreholeLogging Property
ECD	ECD	Effective circulation density		boreholeLogging Property
MD	MD	Measured Depth		boreholeLogging Property
TVD	TVD	True Vertical Depth		boreholeLogging Property
AZIM	AZIM	Borehole Azimuth		boreholeLogging Property
DEVI	DEVI	Borehole Deviation		boreholeLogging Property
RB	RB	Relative Bearing		boreholeLogging Property
NSDR	NSDR	North South drift		boreholeLogging Property
EWDR	EWDR	East West drift		boreholeLogging Property
TOPT	TOPT	Formation Top Depth		boreholeLogging Property
TOPB	TOPB	Formation Base Depth		boreholeLogging Property
DEPT	DEPT	Depth		boreholeLogging Property
DPHI	DPHI	Density Porosity		boreholeLogging Property
GR	GR	Gamma Ray		boreholeLogging Property
PEF	PEF	Photoelectric Factor		boreholeLogging Property
RHOB	RHOB	Bulk Density		boreholeLogging Property
NEUT	NEUT	Neutron Porosity		boreholeLogging Property
DEN	DEN	Density Porosity		boreholeLogging Property

Value	Name	Definition	Description	Parent value
SPOR	SPOR	Sonic Porosity		boreholeLogging Property
PERM	PERM	Core permeability		boreholeLogging Property
CPOR	CPOR	Core porosity		boreholeLogging Property
OIL	OIL	Core Oil saturation		boreholeLogging Property
SWTR	SWTR	Core water saturation		boreholeLogging Property
OILVOL	OILVOL	Core oil volume		boreholeLogging Property
WTR	WTR	Core water volume		boreholeLogging Property
MDEN	MDEN	Density Porosity Matrix		boreholeLogging Property
DTMA	DTMA	Sonic Porosity Matrix		boreholeLogging Property
seismicProperty	seismicProperty	seismic property		
seismicReflectivit y	seismicReflectivi ty	seismic reflectivity		seismicProperty
seismicVelocity	seismicVelocity	seismic velocity type	allowed values are narrower terms	seismicProperty
Vp	Vp	primary wave velocity		seismicVelocity
Vs	Vs	secondary wave velocity		seismicVelocity
seismicAmplitude	seismicAmplitud e	seismic amplitude		seismicProperty
gravimetricPrope rty	gravimetricProp erty	gravimetric property		
density	density	density used for gravity corrections		gravimetricProp erty
gravityBouguerA nomaly	gravityBouguerA nomaly	Bouguer anomaly		gravimetricProp erty
gravityFreeAirAn omaly	gravityFreeAirAn omaly	Observed gravity corrected for latitude and elevation of the station		gravimetricProp erty
observedGravity	observedGravity	Observed gravity field		gravimetricProp erty
magneticProperty	magneticPropert y	magnetometric property		
IGRF_VALUE	IGRF_VALUE	Magnetic scalar potential (V) calculated by International Geomagnetic Reference Field coefficients	The magnetic field of the earth, is the negative gradient of the magnetic scalar potential V	magneticPropert y
magneticFieldVe ctor	magneticFieldVe ctor	magnetic field vector		magneticPropert y
MAG_X	MAG_X	X (north) component of the magnetic field.		magneticFieldVe ctor
MAG_Y	MAG_Y	Y (east) component of the magnetic field.		magneticFieldVe ctor

Value	Name	Definition	Description	Parent value
MAG_Z	MAG_Z	Vertical magnetic field		magneticFieldVector
MAG_T	MAG_T	magnetic total field		magneticProperty
MAG_H	MAG_H	Horizontal magnetic field		magneticProperty
MAG_INCL	MAG_INCL	Inclination of magnetic field, downward deviation from horizontal.		magneticProperty
MAG_DECL	MAG_DECL	Declination of magnetic field, clockwise deviation from true North		magneticProperty
magneticFieldAnomaly	magneticFieldAnomaly	magnetic field anomaly		magneticProperty
MAG_DT	MAG_DT	Total magnetic field anomaly, relativ to normal magnetic field		magneticFieldAnomaly
MAG_DZ	MAG_DZ	Vertical magnetic field anomaly , relative to normal magnetic field		magneticFieldAnomaly
MAG_DH	MAG_DH	Horizontal magnetic field anomaly, relative to normal magnetic field		magneticFieldAnomaly
electromagneticProperty	electromagnetic Property	electromagnetic property		
conductivity	conductivity	Electric conductivity		electromagnetic Property
resistivity	resistivity	Electric resistivity		electromagnetic Property
chargeability	chargeability	Electric chargeability		electromagnetic Property
radiometricProperty	radiometricProperty	radiometric property		
totalGammaRadiation	totalGammaRadiation	Intensity of total gamma radiation		radiometricProperty
RAD_TC	RAD_TC	total count		radiometricProperty
RAD_EQ_TH	RAD_EQ_TH	equivalent thorium intensity		radiometricProperty
RAD_EQ_U	RAD_EQ_U	equivalent uranium intensity		radiometricProperty
RAD_K	RAD_K	kalium intensity		radiometricProperty
RAD_TH	RAD_TH	thorium intensity		radiometricProperty
RAD_U	RAD_U	uranium intensity		radiometricProperty
RAD_DR	RAD_DR	dose rate		radiometricProperty
RAD_TR	RAD_TR	total radioactivity		radiometricProperty
RAD_CS137	RAD_CS137	caesium137 intensity		radiometricProperty

Value	Name	Definition	Description	Parent value
seismologicProperty	seismologicProperty	seismologic property		
seismologyMagnitude	seismologyMagnitude	Earthquake magnitude		seismologicProperty
seismologyfocalDistribution	seismologyfocalDistribution	Distribution of earthquake focuses		seismologicProperty
MT_Property	MT_Property	MT property		
MT_Ex	MT_Ex	X (north) component of the electric field.	timeseries	MT_Property
MT_Ey	MT_Ey	Y (east) component of the electric field.	timeseries	MT_Property
MT_Hx	MT_Hx	X (north) component of the magnetic field.	timeseries	MT_Property
MT_Hy	MT_Hy	Y (east) component of the magnetic field.	timeseries	MT_Property
MT_Hz	MT_Hz	Z (vertical) component of the magnetic field.	timeseries	MT_Property
MT_impedanceTensor	MT_impedanceTensor	MT impedance tensor	function of frequency	MT_Property
MT_RE_Zxx	MT_RE_Zxx	Real part of the complex Zxx diagonal element that couples parallel electric(Ex) and magnetic(Hx) field		MT_impedanceTensor
MT_IM_Zxx	MT_IM_Zxx	Imaginary part of the complex Zxx diagonal element that couples parallel electric(Ex) and magnetic(Hx) field		MT_impedanceTensor
MT_RE_Zxy	MT_RE_Zxy	Real part of the complex Zxy off-diagonal element that couples orthogonal electric(Ex) and magnetic(Hy) field		MT_impedanceTensor
MT_IM_Zxy	MT_IM_Zxy	Imaginary part of the complex Zxy off-diagonal element that couples orthogonal electric(Ex) and magnetic(Hy) field		MT_impedanceTensor
MT_RE_Zyx	MT_RE_Zyx	Real part of the complex Zyx off-diagonal element that couples orthogonal electric(Ey) and magnetic(Hx) field		MT_impedanceTensor
MT_IM_Zyx	MT_IM_Zyx	Imaginary part of the complex Zyx off-diagonal element that couples orthogonal electric(Ey) and magnetic(Hx) field		MT_impedanceTensor
MT_RE_Zyy	MT_RE_Zyy	Real part of the complex Zyy diagonal element that couples parallel electric(Ey)		MT_impedanceTensor

Value	Name	Definition	Description	Parent value
		and magnetic(Hy) field		
MT_IM_Zyy	MT_IM_Zyy	Imaginary part of the complex Zyy diagonal element that couples parallel electric(Ey) and magnetic(Hy) field		MT_impedanceTensor
MT_RE_Tx	MT_RE_Tx	Real part of tipper Tx element, that couples Hz and Hx magnetic field		MT_impedanceTensor
MT_IM_Tx	MT_IM_Tx	Imaginary part of tipper Tx element that couples Hz and Hx magnetic field		MT_impedanceTensor
MT_RE_Ty	MT_RE_Ty	Real part of tipper Ty element that couples Hz and Hy magnetic field		MT_impedanceTensor
MT_IM_Ty	MT_IM_Ty	Imaginary part of tipper Tx element that couples Hz and Hy magnetic field		MT_impedanceTensor
MT_resistivity	MT_resistivity	MT apparent resistivity	function of frequency	MT_Property
MT_ROxx	MT_ROxx	MT resistivity calculated from Zxx		MT_Resistivity
MT_ROxy	MT_ROxy	apparent resistivity calculated from Zxy		MT_Resistivity
MT_ROyx	MT_ROyx	apparent resistivity calculated from Zyx		MT_Resistivity
MT_ROyy	MT_ROyy	apparent resistivity calculated from Zyy		MT_Resistivity
MT_phase	MT_phase	MT phase	function of frequency	MT_Property
MT_PHxx	MT_PHxx	phase of Zxx		MT_phase
MT_PHxy	MT_PHxy	phase of Zxy		MT_phase
MT_PHyx	MT_PHyx	phase of Zyx		MT_phase
MT_PHyy	MT_PHyy	phase of Zyy		MT_phase

Values of code list OtherGeophModelTypeValue

Value	Name	Definition	Description	Parent value
spotModel	spotModel	Geophysical model constructed from elements with point geometry	Representation may be a discrete point coverage	
earthquakeFocalPoint	earthquakeFocalPoint	Geophysical model representing distribution of earthquake focal points		spotModel

Value	Name	Definition	Description	Parent value
persistantScatterer	persistantScatterer	Geophysical model representing distribution of persistant scatterers identified by radar interferometry		spotModel
discreteSurfaceModel	discreteSurfaceModel	Geophysical model constructed from discrete elements with surface geometry	Representation may be a discrete surface coverage	
horizontalCrossSection	horizontalCrossSection	Geophysical model constructed from discrete surface elements in a horizontal cross section		discreteSurfaceModel
verticalCrossSection	verticalCrossSection	Geophysical model constructed from discrete surface elements in a vertical cross section		discreteSurfaceModel
discreteSolidModel	discreteSolidModel	Geophysical model constructed from discrete elements with solid geometry	Representation may be a discrete solid coverage	
geophysicalBodyReconstruction	geophysicalBodyReconstruction	Geophysical model of reconstructed 3D bodies, as a result of complex interpretation.		discreteSolidModel

Values of code list OtherMeasurementTypeValue

Value	Name	Definition	Parent
3DMultielectrodeDC	3dmultielectrodedc	DC resistivity and/or chargeability (IP) measurement carried out with a larger set of electrodes in order to define 3D electric property distribution in a volume of the earth. Also known as 3D resistivity tomography.	

Values of code list ResourceTypeValue

Value	Name	Definition	Parent
boreholeLoggingResource	boreholeloggingresource	borehole logging resource	
coverage	coverage	standard coverage defined by geometry value pairs, or domain set and range set.	
EDI	edi	SEG standard for magnetotelluric data	
IAGA2002	iaga2002	IAGA2002 data exchange format	
IMFV1.22	imfv1.22	GIN Dissemination Format for Minute Values	
INTERMAGNETResource	intermagnetresource	INTERMAGNET data resource	
LAS	las	Log ASCII Standard	
magneticResource	magneticresource	magnetic resource	
magnetotelluricRe	magnetotellu	magnetotelluric resource	

Value	Name	Definition	Parent
source	ricresource		
OGC_Resource	ogc_resource	OGC standard resource	
SEG-D	seg-d	SEG standard for seismic data	
SEG-Y	seg-y	SEG standard for seismic data	
seismicResource	seismicresource	seismic resource	
SensorML	sensorml	Sensor Model Language resource	
SPS	sps	SHELL Processing Support File	
SWE	swe	Sensor Web Enablement resource	
UKOOA	ukooa	seismic navigation file	
WITSML	witsml	Well site Information Transfer Standard Markup Language	

Values of code list SolidGridModelTypeValue

Value	Name	Definition	Parent
parameterBlock	parameterblock	Gridded distribution of physical or geophysical properties in a volume of the earth	
seismicVolume	seismicvolume	Gridded distribution of seismic properties in a volume of the earth	

Values of code list SurfaceGridModelTypeValue

Value	Name	Definition	Parent
horizontalParameterGrid	horizontalparametergrid	Gridded distribution of physical or geophysical properties over a horizontal cross section of the earth	
seismicDepthSection	seismicdepthsection	Seimic property distribution over a vertical cross section of the earth	
seismicHorizon	seismichorizon	3D surface identified by some pattern within a 3D seismic volume.	
verticalParameterGrid	verticalparametergrid	Gridded distribution of physical or geophysical properties over a vertical cross section of the earth	

Annex E
(informative)
Code-lists values of properties of the core model

This annex contains the code-list values for the properties of the core model for Geology. The code-lists are divided in 3 subdomains: Geology, Geophysics, and Hydrogeology.

E.1 *Code-lists values for Geology*

1.1.1 Values of code list AnthropogenicGeomorphologicFeatureTypeValue

Value	Name	Definition
anthropogenicGeomorphologicFeature	anthropogenic geomorphologic feature	A man-made geomorphologic feature.
anthropogenicFeature	anthropogenic feature	An artificial feature on the earth's surface (including those in shallow water),having a characteristic shape and range in composition, composed of unconsolidated earthy, organic materials, artificial materials, or rock, that is the direct result of human manipulation or activities; can be either constructional (e.g., artificial levee) or destructional (quarry).
artificialCollapsedDepression	artificial collapsed depression	A collapse basin, commonly a closed depression, which is the direct result of surficial subsidence associated with subsurface mining or tunneling.
artificialDrainage	artificial drainage	Human-made network (ditches, canals, etc.) built primarily to lower or control the local water table.
artificialLevee	artificial levee	An artificial embankment constructed along the bank of a watercourse or an arm of the sea, to protect land from inundation or to confine streamflow to its channel.
dredgedChannel	dredged channel	A roughly linear, deep water area formed by a dredging operation for navigation purposes
dump	dump	An area of smooth or uneven accumulations or piles of waste rock, earthy material, or general refuse that without major reclamation are incapable of supporting plants.
fill	fill	Human-constructed deposits of natural earth materials (e.g., soil, gravel, rock) and/or waste materials (e.g., tailings or spoil from dredging) used to fill a depression, to extend shore land into a body of water, or in building dams.
impactCraterAnthropogenic	impact crater (anthropogenic)	A generally circular or elliptical depression formed by hypervelocity impact of an experimental projectile or ordinance into earthy or rock material.

Value	Name	Definition
landfillSite	landfill site	Waste disposal site used for the controlled deposit of the waste onto or into land.
levelledLand	levelled land	A land area, usually a field, that has been mechanically flattened or smoothed to facilitate management practices such as flood irrigation.
openpitMine	openpit mine	A relatively large depression resulting from the excavation of material and redistribution of overburden associated with surficial mining operations.
pit	pit	A depression, ditch or pit excavated to furnish gravel, sand or other materials for roads or other construction purposes; a type of borrow pit.
quarry	quarry	Excavation areas, open to the sky, usually for the extraction of stone.
reclaimedLand	reclaimed land	a) A land area composed of earthy fill material that has been placed and shaped to approximate natural contours, commonly part of land-reclamation efforts after mining operations; b) A land area, commonly submerged in its native state, that has been protected by artificial structures (e.g. dikes) and drained for agricultural or other purposes (e.g. polder).
reservoirLake	reservoir lake	An inland body of permanently standing water, usually fresh, occupying a depression on the Earth's surface closed by a dam.
spoilBank	spoil bank	A bank, mound, or other artificial accumulation of rock debris and earthy dump deposits removed from ditches, strip mines, or other excavations.
subsidenceAreaAnthropogenic	subsidence area (anthropogenic)	An area subject to a process of subsidence induced by anthropogenic activities, for example subsurface mining, tunneling, hydrocarbon or groundwater production.

1.1.2 Values of code list BoreholePurposeValue

Value	Name	Definition	Parent
geologicalSurvey	geological survey	General examination of an area's geological entities	
explorationExploitationRawMaterial	exploration and exploitation of raw material	Examination of the subsurface with regard to the availability of earth-borne raw materials in general and planning the extraction thereof. Exploration: the discovery and identification of mineral resources, in the assessment of their importance and in the evaluation of the economic benefit of the eventual exploitation of the potentially economic deposit. Exploitation: All works and activities done to extract mineral resources with a view to mining and marketing them	

Value	Name	Definition	Parent
explorationExploitationEnergyResources	exploration and exploitation of energy resources	Examination of the subsurface with regard to the availability of fossil energy resources (e.g. oil, gas, coal, lignite) and planning the extraction thereof	
hydrocarbonProduction	hydrocarbon production	Production of petroleum oil and/or gas	explorationexploitationenergyresources
hydrocarbonExploration	hydrocarbon exploration	Exploration in an unproved area to test for a new field, a new pay, a deeper reservoir, or a shallower reservoir.	explorationexploitationenergyresources
hydrocarbonAppraisal	hydrocarbon appraisal	Assessment of characteristics (such as flow rate) of a proven hydrocarbon accumulation.	explorationexploitationenergyresources
geothermalEnergy	geothermal energy, geothermal heat exchangers	Exploration pertaining to the utilization of geothermal energy resources and design of geothermal heat pumps. Geothermal energy is the form of energy stored below the surface of the solid earth as heat. Borehole heat exchangers are heat exchangers which are installed vertically or oblique in the underground.	explorationexploitationenergyresources
heatStorage	heat storage	The ground is used as heat storage. E.g. water is injected and relatively cooler water is extracted in summer and relatively warmer water in winter.	geothermalenergy
mineralExplorationExtraction	mineral exploration and extraction	Well drilled for the purpose of locating and/or extracting mineral resources from the subsurface, usually through the injection and/or extraction of mineral bearing fluids.	explorationexploitationrawmaterial
explorationExploitationNonmetallicMineralDeposits	exploration and exploitation of nonmetallic mineral deposits	Prospecting with regard to the availability of nonmetallic mineral deposits such as building stones, limestone, gravel, sand, clay, kaolin, diatomite etc. (mainly for construction purposes, cement and ceramic or glass industry) and planning to be excavated	explorationexploitationrawmaterial
disposal	disposal	A well, often a depleted oil or gas well, into which waste fluids can be injected for safe disposal. Disposal wells typically are subject to regulatory requirements to avoid the contamination of freshwater aquifers. http://www.glossary.oilfield.slb.com/Display.cf	

Value	Name	Definition	Parent
		m?Term=disposal%20well	
explorationNaturalUndergroundStorage	exploration of natural underground storage space	Examination of the subsurface's ability to store various materials such as natural gas, captured carbon, etc.	
waterSupply	water supply	Water supply in general.	
drinkingWaterSupply	drinking water supply	Well construction for drinking water	watersupply
industrialWaterSupply	industrial water supply	Well construction for industrial water supply	watersupply
aquaculture	aquaculture	To supply water to aquaculture, for example fish farming	watersupply
irrigation	irrigation	Well construction for irrigation purposes	watersupply
emergencyWaterSupply	emergency water supply	Well construction for emergency water supply (e.g. extinguish a fire)	watersupply
contingencyWaterSupply	contingency water supply	Stand-by water supply in case of water deficiency.	watersupply
geophysicalSurvey	geophysical survey	Examination of the subsurface's geophysical properties such as electric resistivity, seismicity, gravity, radiation, etc.	
shotHole	shot hole	In connection with seismic surveys explosives are loaded into shot holes.	geophysicalsurvey
flowingShot	flowing shot	A flowing shot hole is a drilled (seismic) hole that has entered an underground water source that has sufficient pressure to cause the hole to "overflow". http://www.etsurvey.com/water/h20main.htm	shothole
hydrogeologicalSurvey	hydrogeological survey, water management	Examination of groundwater flow (i.e. the hydraulic characteristics of an aquifer), the chemical properties of ground water, and transport of particles, solutes, and energy, as well as the management of the sustainable use of ground water resources	
geotechnicalSurvey	geotechnical survey, construction site characterizat	Examination of the subsurface's properties with respect to slope stability, construction of building foundations, tunnels, dams etc.; Geotechnical investigations performed to obtain information on the physical and	

Value	Name	Definition	Parent
	ion	mechanical properties of soil and rock around a site to design earthworks and foundations for proposed structures and for repair of distress to earthworks and structures caused by subsurface conditions. GEUS: Geotechnical drill holes made to investigate the ground before construction work. Geotechnical: A geotechnical well is defined as a hole drilled for the exclusive purpose of collecting geotechnical data, including soil samples, vapour samples, and water samples obtained through bailing, driven sampler or other similar methods. http://www.adwr.state.az.us/dwr/Content/Find_by_Category/Laws_and_Rules/files/SPS/Well%20Construction/Well%20Construction%20and%20LIcensing%20-%20WL7.pdf	
geochemicalSurvey	geochemical survey, analyses	Examination of chemical properties of the rock formation and /or the porosity fluids (samples to be analyzed)	
pedologicalSurvey	pedological survey	Survey and characterization of soils, e.g. for agricultural purposes, ground water protection, etc.	
environmentalMonitoring	environmental monitoring	Groundwater chemistry and groundwater level is monitored.	
pollutionMonitoring	pollution monitoring	The purpose is to monitor known pollution sites (waste dumps, etc.).	environmentalmonitoring
waterQualityMonitoring	water quality monitoring	Most monitoring wells constructed today are used to assess the nature and distribution of pollutants and contaminants in groundwater; the nature and distribution of naturally occurring chemical constituents; subsurface hydrologic conditions, and hydraulic properties of strata as they relate to pollutant and contaminant movement.	environmentalmonitoring
groundwaterLevelMonitoring	groundwater level monitoring	Construction of a gauge for recording groundwater level changes	environmentalmonitoring
dewatering	dewatering	Dewatering is the removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes. Removing or draining water from a riverbed, construction site, caisson, or mine shaft, by pumping or	

Value	Name	Definition	Parent
		evaporation. This is often done during the site development phase of a major construction project due to a high water table. Usually involves the use of "dewatering" pumps. Methods of dewatering include Wellpoint, Deep Well and Eductor systems. http://en.wikipedia.org/wiki/Dewatering	
mitigation	mitigation	Lowering of the groundwater level to prevent the groundwater table to reach polluted sites.	dewatering
remediation	remediation	Remediation in general. The removal of pollution or contaminants from groundwater, soil and other rock	
thermalCleaning	sparging , thermal cleaning	A kind of remediation. In situ cleaning of soil using heat (steam).	remediation
recharge	recharge	a- Aquifer Recharge Wells (5R21) Used to recharge depleted aquifers and may inject fluids from a variety of sources such as lakes, streams, domestic wastewater treatment plants, other aquifers, etc. b- Saline Water Intrusion Barrier Wells (5B22) Used to inject water into fresh water aquifers to prevent intrusion of salt water into fresh water aquifers. Used in highly populated areas. c- Subsidence Control Wells (5S23) Used to inject fluids into a non-oil or gas-producing zone to reduce or eliminate subsidence associated with overdraft of fresh water and not used for the purpose of oil or natural gas production. a, b, c - http://www.epa.gov/Region2/water/compliance/wellclasstypetable_inventoryc_form.pdf	

1.1.3 Values of code list CollectionTypeValue

Value	Name	Definition	Parent
boreholeCollection	borehole collection		
geologicalMap	geological map		
geologicalModel	geological		

Value	Name	Definition	Parent
	model		
geophysicalObject Collection	geophysical object collection		

1.1.4 Values of code list CompositionPartRoleValue

Value	Name	Definition	Parent
bedLithosome	bed lithosome	Lithosome in lithostratigraphic unit that occurs as individual beds interleaved with other constituents on the outcrop (m) scale or larger.	lithosome
blocks	blocks	Geologic unit constituent is present as masses with generally sharp boundaries and block-like geometry within a matrix of some other material emplaced by processes at the earth's surface--e.g. volcanic eruption or mass wasting. Implication is that blocks were derived from the same source geologic unit and emplaced in the described unit.	inclusion
concretion	concretion	Hard, compact mass or aggregate of mineral matter, normally subsperical but commonly oblate, disc-shaped or irregular. Formed from precipitation from solution about a nucleus or centre. Use as a geologic unit part should be restricted to concretions that are too large to consider as constituents in the rock material that composes the unit.	inclusion
cyclicBeddingPackage	cyclic bedding package	Lithosome characterized by an internal sequence of units, which is repeated in a stacked sequence; e.g. fining-upward sequence, thickening upward sequence, bouma sequence.	lithosome
enclave	enclave	General term for a polymineralic aggregate enclosed in a granitoid.	inclusion
facies	facies	Represents a particular body of rock that is a lateral variant of a lithostratigraphic unit, or a variant of a lithodemic unit. Contrast with lithosome in being a particular, connected body of rock, as opposed to a kind of rock body that is repeated in many places in a	partof

Value	Name	Definition	Parent
		unit.	
geologicUnitMatrix	geologic unit matrix	Lithosome in a geologic unit that is generally interstitial to other constituents, e.g. in a mass wasting deposit, melange, tuff breccia.	lithosome
inclusion	inclusion	Geologic unit constituent is present as masses with generally sharp boundaries enclosed within a matrix of some other material.	partof
irregularLithosome	irregular lithosome	lithosome in a mixed/heterogeneous lithodemic unit that occurs in irregular bodies within unit	lithosome
layerLithosome	layer lithosome	lithosome in igneous or metamorphic geologic unit that occurs as layers alternating with other constituents.	lithosome
lenticularLithosome	lenticular lithosome	lithosome occurs as discrete lense-shaped bodies, not connected with other bodies.	lithosome
lithosome	lithosome	A kind of rock body that has multiple occurrences in a single geologic unit. A mass of rock of uniform character, characterized by geometry, composition, and internal structure. Generally denotes rock mass that is the product of a particular rock forming process or related sequence of processes in the containing unit. Example--bouma sequence, point bar sequence. A particular lithosome may be characterized by the presence of blocks, but blocks are not treated as kinds of lithosome because the internal character of the blocks is determined by a separate genetic sequence from the described unit. This vocabulary generalizes the concept defined in Neuendorf et al 2005 to include bodies of igneous or metamorphic rock as well as sedimentary rock. NADM SLTTs (2004) used the term 'lithotope' with similar meaning for sedimentary rocks.	partof
markerBed	marker bed	Stratigraphic part that is a thin laterally continuous bed within another unit.	stratigraphicpart
onlyPart	only part	entire described unit consists of a single part or constituent	
partOf	part of	The geologic unit part role is not known in any greater detail. Inclusion of Only_part as a separate concept implies that this concept is	

Value	Name	Definition	Parent
		the equivalent of 'proper part' in mereology.	
pendants	pendants	A block of wall rock material in an igneous intrusion. Pendants become xenoliths as the dimension becomes smaller than about 10 m in their longest dimension. Although term pendant has connotation of being suspended or supported from above, this is rarely demonstrable in geologic situations, and the concept here does not require connection to the wall of the containing intrusion.	inclusion
rafts	rafts	Pendants of pre-intrusive country rock in intrusive igneous matrix that have large horizontal extent relative to their thickness	pendants
roofPendant	roof pendant	Pendant that is demonstrably derived from the upper boundary of an igneous body.	pendants
screen	screen	Pendant that is a vertical sheet like pendant in an intrusive igneous rock body.	pendants
stratigraphicPart	stratigraphic part	A geologic unit part that occupies a particular stratigraphic position within a geologic unit. Part is a particular body of rock.	partof
tectonicBlock	tectonic block	The geologic unit part occurs as discrete masses with faulted boundaries, emplaced into the host unit by tectonic processes inside the earth, e.g. blocks in tectonic melange	inclusion
unspecifiedPartRole	unspecified part role	Geologic unit part with unspecified role; use in normative descriptions when any role is allowed.	partof
veinOrDikeLithosome	vein or dike lithosome	Lithosome occurs as intrusive, sheet-like bodies within the unit as an essential part of the unit.	lithosome
xenolith	xenolith	Inclusion of pre-intrusive country rock in intrusive igneous matrix, cm to about 10 meter diameter in longest dimension. Use term pendant for larger blocks.	inclusion
dominatConstituent	dominat constituent	The most common constituent of the geologic unit	

1.1.5 Values of code list EventEnvironmentValue

Value	Name	Definition	Parent
abandonedRiverChannelSetting	abandoned river channel setting	A drainage channel along which runoff no longer occurs, as on an alluvial fan	riverplainsystemsetting
aboveCarbonateCompensationDepthSetting	above carbonate compensation depth setting	Marine environment in which carbonate sediment does not dissolve before reaching the sea floor and can accumulate.	marinesetting
abyssalSetting	abyssal setting	The ocean environment at water depths between 3,500 and 6,000 metres	marinesetting
activeContinentalMarginSetting	active continental margin setting	Plate margin setting on continental crust.	platemarginsetting
activeSpreadingCenterSetting	active spreading center setting	Divergent plate margin at which new oceanic crust is being formed	platemarginsetting
aeolianProcessSetting	aeolian process setting	Sedimentary setting in which wind is the dominant process producing, transporting, and depositing sediment. Typically has low-relief plain or piedmont slope physiography.	subaerialsetting
agriculturalAndForestryLandSetting	agricultural and forestry land setting		
algalFlatSetting	algal flat setting	Modern "algal flats are found on rock or mud in areas flooded only by the highest tides and are often subject to high evaporation rates. Algal flats survive only when an area is salty enough to eliminate snails and other herbivorous animals that eat algae, yet is not so salty that the algae cannot survive. The most common species of algae found on algal flats are blue-green algae of the genera Scytonema and Schizothrix. These algae can tolerate the daily extremes in temperature and oxygen that typify conditions on the flats. Other plants sometimes found on algal flats include one-celled green algae, flagellates, diatoms, bacteria, and isolated scrubby red and black mangroves, as well as patches of saltwort. Animals include false cerith, cerion snails, fiddler crabs, and great land crabs. Flats with well developed algal mats are	lowenergyshorelinesetting

Value	Name	Definition	Parent
		restricted for the most part to the Keys, with Sugarloaf and Crane Keys offering prime examples of algal flat habitat." (Audubon, 1991)	
alluvialFanSetting	alluvial fan setting	A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream (esp. in a semiarid region) at the place where it issues from a narrow mountain valley upon a plain or broad valley, or where a tributary stream is near or at its junction with the main stream, or wherever a constriction in a valley abruptly ceases or the gradient of the stream suddenly decreases; it is steepest near the mouth of the valley where its apex points upstream, and it slopes gently and convexly outward with gradually decreasing gradient	piedmontslopesystemsetting
alluvialPlainSetting	alluvial plain setting	A level or gently sloping tract or a slightly undulating land surface produced by extensive deposition of alluvium, usually adjacent to a river that periodically overflows its banks; it may be situated on a floodplain, a delta, or an alluvial fan.	piedmontslopesystemsetting
anoxicSetting	anoxic setting	Setting depleted in oxygen, typically subaqueous.	earthsurfacesetting
aridOrSemiAridEnvironmentSetting	arid or semi arid environment setting	Setting characterized by mean annual precipitation of 10 inches (25 cm) or less. (Jackson, 1997, p. 172). Equivalent to SLTT 'Desert setting', but use 'Arid' to emphasize climatic nature of setting definition.	earthsurfacesetting
backArcSetting	back arc setting	Tectonic setting adjacent to a volcanic arc formed above a subduction zone. The back arc setting is on the opposite side of the volcanic arc from the trench at which oceanic crust is consumed in a subduction zone. Back arc setting includes terrane that is affected by plate margin and arc-related processes.	tectonicallydefined setting
backreefSetting	backreef setting	The landward side of a reef. The term is often used adjectivally to refer to deposits within the restricted lagoon behind a barrier reef, such as the "back-reef facies" of lagoonal deposits. In some places, as on a platform-edge reef tract, "back reef" refers to the side of the reef away from the open sea, even	biologicalreefsetting

Value	Name	Definition	Parent
		though no land may be nearby	
barrierBeachSetting	barrier beach setting	A narrow, elongate sand or gravel ridge rising slightly above the high-tide level and extending generally parallel with the shore, but separated from it by a lagoon (Shepard, 1954, p.1904), estuary, or marsh; it is extended by longshore transport and is rarely more than several kilometers long.	barrierislandcoastlinesetting
barrierIslandCoastlineSetting	barrier island coastline setting	setting meant to include all the various geographic elements typically associated with a barrier island coastline, including the barrier islands, and geomorphic/geographic elements that are linked by processes associated with the presence of the island (e.g. wash over fans, inlet channel, back barrier lagoon).	shorelinesetting
barrierLagoonSetting	barrier lagoon setting	A lagoon that is roughly parallel to the coast and is separated from the open ocean by a strip of land or by a barrier reef. Tidal influence is typically restricted and the lagoon is commonly hypersaline.	barrierislandcoastlinesetting
basinBogSetting	basin bog setting	An ombrotrophic or ombrogene peat/bog whose nutrient supply is exclusively from rain water (including snow and atmospheric fallout) therefore making nutrients extremely oligotrophic	bogsetting
basinPlainSetting	basin plain setting	Near flat areas of ocean floor, slope less than 1:1000; generally receive only distal turbidite and pelagic sediments.	marinesetting
bathyalSetting	bathyal setting	The ocean environment at water depths between 200 and 3500 metres	marinesetting
beachSetting	beach setting	The unconsolidated material at the shoreline that covers a gently sloping zone, typically with a concave profile, extending landward from the low-water line to the place where there is a definite change in material or physiographic form (such as a cliff), or to the line of permanent vegetation (usually the effective limit of the highest storm waves); at the shore of a body of water, formed and washed by waves or tides, usually covered by sand or gravel, and lacking a bare rocky surface.	shorelinesetting

Value	**Name**	**Definition**	**Parent**
belowCarbonateCompensationDepthSetting	below carbonate compensation depth setting	Marine environment in which water is deep enough that carbonate sediment goes into solution before it can accumulate on the sea floor.	marinesetting
biologicalReefSetting	biological reef setting	A ridgelike or moundlike structure, layered or massive, built by sedentary calcareous organisms, esp. corals, and consisting mostly of their remains; it is wave-resistant and stands topographically above the surrounding contemporaneously deposited sediment.	marinesetting
blanketBog	blanket bog	A bog covering a large, fairly horizontal area and depending on high rainfall or high humidity, rather than local water sources, for its supply of moisture.	bogsetting
bogSetting	bog setting	Waterlogged, spongy ground, consisting primarily of mosses, containing acidic, decaying vegetation that may develop into peat.	terrestrialsetting
braidedRiverChannelSetting	braided river channel setting	A stream that divides into or follows an interlacing or tangled network of several small branching and reuniting shallow channels separated from each other by ephemeral branch islands or channel bars, resembling in plan the strands of a complex braid. Such a stream is generally believed to indicate an inability to carry all of its load, such as an overloaded and aggrading stream flowing in a wide channel on a floodplain	riverchannelsetting
carbonateDominatedShorelineSetting	carbonate dominated shoreline setting	A shoreline setting in which terrigenous input is minor compared to local carbonate sediment production. Constructional biogenic activity is an important element in geomorphic development.	shorelinesetting
carbonateShelfSetting	carbonate shelf setting	A type of carbonate platform that is attached to a continental landmass and a region of sedimentation that is analogous to shelf environments for terrigenous clastic deposition. A carbonate shelf may receive some supply of material from the adjacent landmass.	
caveSetting	cave setting	A natural underground open space; it generally has a connection to the surface, is large enough for a person to enter, and	earthsurfacesetting

Value	Name	Definition	Parent
		extends into darkness. The most common type of cave is formed in limestone by dissolution.	
coastalDuneFieldSetting	coastal dune field setting	A dune field on low-lying land recently abandoned or built up by the sea; the dunes may ascend a cliff and travel inland.	dunefieldsetting
coastalPlainSetting	coastal plain setting	A low relief plain bordering a water body extending inland to the nearest elevated land, sloping very gently towards the water body. Distinguished from alluvial plain by presence of relict shoreline-related deposits or morphology.	shorelinesetting
collisionalSetting	collisional setting	Tectonic setting in which two continental crustal plates impact and are sutured together after intervening oceanic crust is entirely consumed at a subduction zone separating the plates. Such collision typically involves major mountain forming events, exemplified by the modern Alpine and Himalayan mountain chains.	continentalcrustalsetting
contactMetamorphicSetting	contact metamorphic setting	Metamorphism of country rock at the contact of an igneous body.	earthinteriorsetting
continentalBorderlandSetting	continental borderland setting	"An area of the continental margin between the shoreline and the continental slope that is topographically more complex than the continental shelf. It is characterized by ridges and basins, some of which are below the depth of the continental shelf. An example is the southern California continental borderland;...." (Jackson, 1997, p. 138)..	marinesetting
continentalRiftSetting	continental rift setting	Extended terrane in a zone of continental breakup, may include incipient oceanic crust. Examples include Red Sea, East Africa Rift, Salton Trough	extendedterranesetting
continentalShelfSetting	continental shelf setting	"That part of the ocean floor that is between the shoreline and the continental slope (or, when there is no noticeable continental slope, a depth of 200 m). It is characterized by its gentle slope of 0.1 degree" (Jackson, 1997, p. 138). Continental shelves have a classic shoreline-shelf-slope profile termed 'clinoform'.	marinesetting

Value	Name	Definition	Parent
continentalCrustalSetting	continental-crustal setting	That type of the Earth's crust which underlies the continents and the continental shelves; it is equivalent to the sial and continental sima and ranges in thickness from about 25 km to more than 70 km under mountain ranges, averaging ~40 km. The density of the continental crust averages ~2.8 g/cm3 and is ~2.7 g/cm3 in the upper layer. The velocities of compressional seismic waves through it average ~6.5 km/s and are less than ~7.0 km/sec.	crustalsetting
crustalSetting	crustal setting	The outermost layer or shell of the Earth, defined according to various criteria, including seismic velocity, density and composition; that part of the Earth above the Mohorovicic discontinuity, made up of the sial and the sima.	earthinteriorsetting
cutoffMeanderSetting	cutoff meander setting	The abandoned, bow- or horseshoe-shaped channel of a former meander, left when the stream formed a cutoff across a narrow meander neck. Note that these are typically lakes, thus also lacustrine.	riverplainsystemsetting
deepSeaTrenchSetting	deep sea trench setting	Deep ocean basin with steep (average 10 degrees) slope toward land, more gentle slope (average 5 degrees) towards the sea, and abundant seismic activity on landward side of trench. Does not denote water depth, but may be very deep.	marinesetting
deltaDistributaryChannelSetting	delta distributary channel setting	A divergent stream flowing away from the main stream and not returning to it, as in a delta or on an alluvial plain	deltaicsystemsetting
deltaDistributaryMouthSetting	delta distributary mouth setting	The mouth of a delta distributary channel where fluvial discharge moves from confined to unconfined flow conditions	deltaicsystemsetting
deltaFrontSetting	delta front setting	A narrow zone where deposition in deltas is most active, consisting of a continuous sheet of sand, and occurring within the effective depth of wave erosion (10 m or less). It is the zone separating the prodelta from the delta plain, and it may or may not be steep"	deltaicsystemsetting
deltaPlainSetting	delta plain setting	The level or nearly level surface composing the landward part of a large or compound	deltaicsystemsetting

Value	Name	Definition	Parent
		delta; strictly, an alluvial plain characterized by repeated channel bifurcation and divergence, multiple distributary channels, and interdistributary flood basins	
deltaSlopeSetting	delta slope setting	Slope setting within the deltaic system	
deltaicSystemSetting	deltaic system setting	Environments at the mouth of a river or stream that enters a standing body of water (ocean or lake). The delta forms a triangular or fan-shaped plain of considerable area. Subaerial parts of the delta are crossed by many distributaries of the main river, and commonly extend beyond the general trend of the coast. Subaqueous parts of the delta merge with the adjacent basin floor, and are progressively influenced by non-fluvial processes. Deltas result from the accumulation of sediment supplied by the river in such quantities that it is not removed by tides, waves, and currents.	earthsurfacesetting
dunefieldSetting	dunefield setting	Extensive deposits on sand in an area where the supply is abundant. As a characteristic, individual dunes somewhat resemble barchans but are highly irregular in shape and crowded; erg areas of the Sahara are an example.	aeolianprocesssetting
dustAccumulationSetting	dust accumulation setting	Setting in which finegrained particles accumulate, e.g. loess deposition.	aeolianprocesssetting
dwellingAreaSetting	dwelling area setting	Dwelling area setting	
earthInteriorSetting	earth interior setting	Geologic environments within the solid Earth.	
earthSurfaceSetting	earth surface setting	Geologic environments on the surface of the solid Earth. Hierarchy presented here is based on assumption that a particular setting may be specified by a combination of a climatic setting with one or more process or geomorphically defined settings.	
englacialSetting	englacial setting	Contained, embedded, or carried within the body of a glacier or ice sheet; said of meltwater streams, till, drift, moraine	glacierrelatedsetting

Value	Name	Definition	Parent
epicontinentalMarineSetting	epicontinental marine setting	Marine setting situated within the interior of the continent, rather than at the edge of a continent.	marinesetting
estuarineDeltaSetting	estuarine delta setting	A delta that has filled, or is in the process of filling, an estuary	deltaicsystemsetting
estuarineLagoonSetting	estuarine lagoon setting	A lagoon produced by the temporary sealing of a river estuary by a storm barrier. Such lagoons are usually seasonal and exist until the river breaches the barrier; they occur in regions of low or spasmodic rainfall	estuarysetting
estuarySetting	estuary setting	Environments at the seaward end or the widened funnel-shaped tidal mouth of a river valley where fresh water comes into contact with seawater and where tidal effects are evident (adapted from Glossary of Geology, Jackson, 1997, p. 217).	shorelinesetting
extendedTerraneSetting	extended terrane setting	Tectonic setting characterized by extension of the upper crust, manifested by formation of rift valleys or basin and range physiography, with arrays of low to high angle normal faults. Modern examples include the North Sea, East Africa, and the Basin and Range of the North American Cordillera. Typically applied in continental crustal settings.	tectonicallydefined setting
extraTerrestrialSetting	extra-terrestrial setting	Material originated outside of the Earth or its atmosphere.	
fanDeltaSetting	fan delta setting	A debris-flow or sheetflood-dominated alluvial fan build out into a lake or the sea.	
fastSpreadingCenterSetting	fast spreading center setting	Spreading center at which the opening rate is greater than 100 mm per year.	activespreadingcentersetting
floodplainSetting	floodplain setting	The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A river has one floodplain and may have one or more terraces representing abandoned floodplains.	riverplainsystemsetting

Value	Name	Definition	Parent
forearcSetting	forearc setting	Tectonic setting between a subduction-related trench and a volcanic arc	platemarginsetting
forelandSetting	foreland setting	The exterior area of an orogenic belt where deformation occurs without significant metamorphism. Generally the foreland is closer to the continental interior than other portions of the orogenic belt are.	continentalcrustalsetting
forereefSetting	forereef setting	The seaward side of a reef; the slope covered with deposits of coarse reef talus	biologicalreefsetting
foreshore	foreshore	A foreshore is the region between mean high water and mean low water marks of the tides. Depending on the tidal range this may be a vertical distance of anything from a few tens of centimetres to many meters. The seaward extent of the foreshore is governed also by the slope and it may be anything from a few meter, if the shelf is steeply sloping and/or the tidal range is small, to over a kilometre in places where there is a high tidal range and a gently sloping shelf. The foreshore is part of the beach environment or littoral zone	
gibberPlainSetting	gibber plain setting	A desert plain strewn with wind-abraded pebbles, or gibbers; a gravelly desert.	aridorsemiaridenvironmentsetting
glacialOutwashPlainSetting	glacial outwash plain setting	A broad, gently sloping sheet of outwash deposited by meltwater streams flowing in front of or beyond a glacier, and formed by coalescing outwahs fans; the surface of a broad body of outwash.	glacierrelatedsetting
glacierLateralSetting	glacier lateral setting	Settings adjacent to edges of confined glacier.	glacierrelatedsetting
glacierRelatedSetting	glacier related setting	Earth surface setting with geography defined by spatial relationship to glaciers (e.g. on top of a glacier, next to a glacier, in front of a glacier...). Processes related to moving ice dominate sediment transport and deposition and landform development. Includes subaqueous, shoreline, and terrestrial settings that are impacted by the presence of glaciers. Considered a geographically defined setting in that a glacier is a geographic feature.	earthsurfacesetting
glacierTerminusSe	glacier terminus	Region of sediment deposition at the glacier terminus due to melting of glacier ice, melt-	proglacialsetting

Value	Name	Definition	Parent
tting	setting	out, ablation and flow till setting.	
glaciofluvialSetting	glaciofluvial setting	A setting influenced by glacial meltwater streams. This setting can be sub- en-, supra- and proglacial.	
glaciolacustrineSetting	glaciolacustrine setting	Ice margin lakes and other lakes related to glaciers. Where meltwater streams enter the lake, sands and gravels are deposited in deltas. At the lake floor, typivally rhythmites (varves) are deposited.Ice margin lakes and other lakes related to glaciers. Varve is a typical sediment in this environment.	
glaciomarineSetting	glaciomarine setting	A marine environment influenced by glaciers. Dropstone diamictons and dropstone muds are typical deposits in this environment.	
graben	graben	An elongate trough or basin, bounded on both sides by high-angle normal faults that dip toward one another. It is a structural form that may or may not be geomorphologically expressed as a rift valley	
hadalSetting	hadal setting	The deepest oceanic environment, i.e., over 6,000 m in depth. Always in deep sea trench.	marinesetting
halfGraben	half-graben	A elongate , asymmetric trough or basin bounded on one side by a normal fault.	
highPressureLowTemperatureEarthInteriorSetting	high pressure low temperature earth interior setting	High pressure environment characterized by geothermal gradient significantly lower than standard continental geotherm; environment in which blueschist facies metamorphic rocks form. Typically associated with subduction zones.	earthinteriorsetting
hillslopeSetting	hillslope setting	Earth surface setting characterized by surface slope angles high enough that gravity alone becomes a significant factor in geomorphic development, as well as base-of-slope areas influenced by hillslope processes. Hillslope activities include creep, sliding, slumping, falling, and other downslope movements caused by slope collapse induced by gravitational influence on earth materials. May be subaerial or subaqueous.	earthsurfacesetting
hinterlandTectonicSetting	hinterland tectonic	Tectonic setting in the internal part of an orogenic belt, characterized by plastic deformation of rocks accompanied by	continentalcrustalsetting

Value	Name	Definition	Parent
	setting	significant metamorphism, typically involving crystalline basement rocks. Typically denotes the most structurally thickened part of an orogenic belt, between a magmatic arc or collision zone and a more 'external' foreland setting.	
hotSpotSetting	hot spot setting	Setting in a zone of high heat flow from the mantle. Typically identified in intraplate settings, but hot spot may also interact with active plate margins (Iceland...). Includes surface manifestations like volcanic center, but includes crust and mantle manifestations as well.	tectonicallydefined setting
humanEnvironmentSetting	human environment setting	Human environment setting	
humidTemperateClimaticSetting	humid temperate climatic setting	Setting with seasonal climate having hot to cold or humid to arid seasons.	earthsurfacesetting
humidTropicalClimaticSetting	humid tropical climatic setting	Setting with hot, humid climate influenced by equatorial air masses, no winter season.	earthsurfacesetting
hypabyssalSetting	hypabyssal setting	Igneous environment close to the Earth's surface, characterized by more rapid cooling than plutonic setting to produce generally fine-grained intrusive igneous rock that is commonly associated with co-magmatic volcanic rocks.	earthinteriorsetting
inactiveSpreadingCenterSetting	inactive spreading center setting	Setting on oceanic crust formed at a spreading center that has been abandoned.	intraplatetectonicsetting
innerNeriticSetting	inner neritic setting	The ocean environment at depths between low tide level and 30 metres	neriticsetting
interdistributaryBaySetting	interdistributary bay setting	A pronounced indentation of the delta front between advancing stream distributaries, occupied by shallow water, and either open to the sea or partly enclosed by minor distributaries	deltaicsystemsetting
intertidalSetting	intertidal	Pertaining to the benthic ocean environment or depth zone between high water and low	subaqueoussetting

Value	Name	Definition	Parent
	setting	water; also, pertaining to the organisms of that environment	
intracratonicSetting	intracratonic setting	A basin formed within the interior region of a continent, away from plate boundaries.	
intraplateTectonicSetting	intraplate tectonic setting	Tectonically stable setting far from any active plate margins.	tectonicallydefinedsetting
lacustrineDeltaSetting	lacustrine delta setting	The low, nearly flat, alluvial tract of land at or near the mouth of a river, commonly forming a triangular or fan-shaped plain of considerable area, crossed by many distributaries of the main river, perhaps extending beyond the general trend of the lake shore, resulting from the accumulation of sediment supplied by the river in such quantities that it is not removed by waves or currents. Most deltas are partly subaerial and partly below water.	deltaicsystemsetting
lacustrineSetting	lacustrine setting	Setting associated with a lake. Always overlaps with terrestrial, may overlap with subaerial, subaqueous, or shoreline.	terrestrialsetting
lagoonalSetting	lagoonal setting	A shallow stretch of salt or brackish water, partly or completely separated from a sea or lake by an offshore reef, barrier island, sand or spit (Jackson, 1997). Water is shallow, tidal and wave-produced effects on sediments; strong light reaches sediment.	shorelinesetting
landReclamationSetting	land reclamation setting		
lowEnergyShorelineSetting	low energy shoreline setting	Settings characterized by very low surface slope and proximity to shoreline. Generally within peritidal setting, but characterized by low surface gradients and generally low-energy sedimentary processes.	shorelinesetting
lowPressureHighTemperatureSetting	low pressure high temperature setting	Setting characterized by temperatures significantly higher that those associated with normal continental geothermal gradient.	earthinteriorsetting
lowerBathyalSetting	lower bathyal setting	The ocean environment at depths between 1000 and 3500 metres	bathyalsetting

Value	Name	Definition	Parent
lowerContinentalCrustalSetting	lower continental-crustal setting	Continental crustal setting characterized by upper amphibolite to granulite facies metamorphism, in situ melting, residual anhydrous metamorphic rocks, and ductile flow of rock bodies.	continentalcrustalsetting
lowerDeltaPlainSetting	lower delta plain setting	The part of a delta plain which is penetrated by saline water and is subject to tidal processes	deltaplainsetting
lowerMantleSetting	lower mantle setting	That part of the mantle that lies below a depth of about 660 km. With increasing depth, density increases from ~4.4 g/cm3 to ~5.6 g/cm3, and velocity of compressional seismic waves increases from ~10.7 km/s to ~13.7 km/s (Dziewonski and Anderson, 1981).	mantlesetting
lowerOceanicCrustalSetting	lower oceanic-crustal setting	Setting characterized by dominantly intrusive mafic rocks, with sheeted dike complexes in upper part and gabbroic to ultramafic intrusive or metamorphic rocks in lower part.	oceaniccrustalsetting
mantleSetting	mantle setting	The zone of the Earth below the crust and above the core, which is divided into the upper mantle and the lower mantle, with a transition zone separating them.	earthinteriorsetting
marginalMarineSabkhaSetting	marginal marine sabkha setting	Setting characterized by arid to semi-arid conditions on restricted coastal plains mostly above normal high tide level, with evaporite-saline mineral, tidal-flood, and eolian deposits. Boundaries with intertidal setting and non-tidal terrestrial setting are gradational (Jackson, 1997, p. 561).	aridorsemiaridenvironmentsetting
marineCarbonatePlatformSetting	marine carbonate platform setting	A shallow submerged plateau separated from continental landmasses, on which high biological carbonate production rates produce enough sediment to maintain the platform surface near sea level. Grades into atoll as area becomes smaller and ringing coral reefs become more prominent part of the setting.	marinesetting
marineSetting	marine setting	Setting characterized by location under the surface of the sea.	subaqueoussetting
meanderingRiverChannelSetting	meandering river channel setting	Produced by a mature stream swinging from side to side as it flows across its floodplain or shifts its course laterally toward the convex side of an original curve	riverchannelsetting
mediumRateSprea	medium-rate	Spreading center at which the opening rate is	activespreadingcen

Value	Name	Definition	Parent
dingCenterSetting	spreading center setting	between 50 and 100 mm per year.	tersetting
midOceanRidgeSetting	mid ocean ridge setting	Ocean highland associated with a divergent continental margin (spreading center). Setting is characterized by active volcanism, locally steep relief, hydrothermal activity, and pelagic sedimentation.	oceanhighlandsetting
middleBathyalSetting	middle bathyal setting	The ocean environment at water depths between 600 and 1000 metres	bathyalsetting
middleContinentalCrustSetting	middle continental crust setting	Continental crustal setting characterized by greenschist to upper amphibolite facies metamorphism, plutonic igneous rocks, and ductile deformation.	continentalcrustalsetting
middleNeriticSetting	middle neritic setting	The ocean environment at depths between 30 and 100 metres	neriticsetting
miningAreaSetting	mining area setting		
mudFlatSetting	mud flat setting	A relatively level area of fine grained material (e.g. silt) along a shore (as in a sheltered estuary or chenier-plain) or around an island, alternately covered and uncovered by the tide or covered by shallow water, and barren of vegetation. Includes most tidal flats, but lacks denotation of tidal influence..	lowenergyshorelinesetting
neriticSetting	neritic setting	The ocean environment at depths between low-tide level and 200 metres, or between low-tide level and approximately the edge of the continental shelf	marinesetting
oceanHighlandSetting	ocean highland setting	Broad category for subaqueous marine settings characterized by significant relief above adjacent sea floor.	marinesetting
oceanicPlateauSetting	oceanic plateau setting	Region of elevated ocean crust that commonly rises to within 2-3 km of the surface above an abyssal sea floor that lies several km deeper. Climate and water depths are such that a marine carbonate platform does not develop.	oceanhighlandsetting
oceanicCrustalSett	oceanic-crustal	That type of the Earth's crust which underlies the ocean basins. The oceanic crust is 5-10	crustalsetting

Value	Name	Definition	Parent
ing	setting	km thick; it has a density of 2.9 g/cm3, and compressional seismic-wave velocities travelling through it at 4-7.2 km/sec. Setting in crust produced by submarine volcanism at a mid ocean ridge.	
outerNeriticSetting	outer neritic setting	The ocean environment at depths between 100 meters and approximately the edge of the continental shelf or between 100 and 200 meters	neriticsetting
passiveContinentalMarginSetting	passive continental margin setting	Boundary of continental crust into oceanic crust of an oceanic basin that is not a subduction zone or transform fault system. Generally is rifted margin formed when ocean basin was initially formed.	tectonicallydefined setting
pedimentSetting	pediment setting	A gently sloping erosional surface developed at the foot of a receding hill or mountain slope. The surface may be essentially bare, exposing earth material that extends beneath adjacent uplands; or it may be thinly mantled with alluvium and colluvium, ultimately in transit from upland front to basin or valley lowland. The term has been used in several geomorphic contexts: Pediments may be classed with respect to (a) landscape positions, for example, intermontane-basin piedmont or valley-border footslope surfaces (respectively, apron and terrace pediments (Cooke and Warren, 1973)); (b) type of material eroded bedrock or regolith; or (c) combinations of the above. Compare - Piedmont slope.	piedmontslopesystemsetting
piedmontSlopeSystemSetting	piedmont slope system setting	Location on gentle slope at the foot of a mountain; generally used in terms of intermontane-basin terrain. Main components include: (a) An erosional surface on bedrock adjacent to the receding mountain front (pediment, rock pediment); (b) A constructional surface comprising individual alluvial fans and interfan valleys, also near the mountain front; and (c) A distal complex of coalescent fans (bajada), and alluvial slopes without fan form. Piedmont slopes grade to basin-floor depressions with alluvial and temporary lake plains or to surfaces associated with through drainage.	subaerialsetting

Value	Name	Definition	Parent
plateMarginSetting	plate margin setting	Tectonic setting at the boundary between two tectonic plates.	tectonicallydefined setting
plateSpreadingCenterSetting	plate spreading center setting	Tectonic setting where new oceanic crust is being or has been formed at a divergent plate boundary. Includes active and inactive spreading centers.	tectonicallydefined setting
playaSetting	playa setting	The usually dry and nearly level plain that occupies the lowest parts of closed depressions, such as those occurring on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation-runoff events.	aridorsemiaridenvironmentsetting
polarClimaticSetting	polar climatic setting	Setting with climate dominated by temperatures below the freezing temperature of water. Includes polar deserts because precipitation is generally scant at high latitude. Climatically controlled by arctic air masses, cold dry environment with short summer.	earthsurfacesetting
prodeltaSetting	prodelta setting	The part of a delta that is below the effective depth of wave erosion, lying beyond the delta front, and sloping gently down to the floor of the basin into which the delta is advancing and where clastic river sediment ceases to be a significant part of the basin-floor deposits; it is entirely below the water level	deltaicsystemsetting
proglacialSetting	proglacial setting	Immediately in front of or just beyond the outer limits of a glacier or ice sheet, generally at or near its lower end; said of lakes, streams, deposits, and other features produced by or derived from the glacier ice	glacierrelatedsetting
reefFlatSetting	reef flat setting	A stony platform of reef rock, landward of the reef crest at or above the low tide level, occasionally with patches of living coral and associated organisms, and commonly strewn with coral fragments and coral sand. It may include shallow pools, irregular gullies, low islands of sand or rubble (often vegetated, esp. by palms), and scattered colonies of the more hardy species of coral.	biologicalreefsetting
regionalMetamorphicSetting	regional metamorphic setting	Metamorphism not obviously localized along contacts of igneous bodies; includes burial metamorphism and ocean ridge metamorphism	earthinteriorsetting

Value	Name	Definition	Parent
riverChannelSetting	river channel setting	The bed where a natural body of surface water flows or may flow; a natural passageway or depression of perceptible extent containing continuously or periodically flowing water, or forming a connecting link between two bodies of water; a watercourse	riverplainsystemsetting
riverPlainSystemSetting	river plain system setting	Geologic setting dominated by a river system; river plains may occur in any climatic setting. Includes active channels, abandoned channels, levees, oxbow lakes, flood plain. May be part of an alluvial plain that includes terraces composed of abandoned river plain deposits.	terrestrialsetting
rockyCoastSetting	rocky coast setting	Shoreline with significant relief and abundant rock outcrop.	shorelinesetting
saltPan	salt pan	A small, undrained, shallow depression in which water accumulates and evaporates, leaving a salt deposit.	
sandPlainSetting	sand plain setting	A sand-covered plain dominated by aeolian processes.	aeolianprocesssetting
seamountSetting	seamount setting	Setting that consists of a conical mountain on the ocean floor (guyot). Typically characterized by active volcanism, pelagic sedimentation. If the mountain is high enough to reach the photic zone, carbonate production may result in reef building to produce a carbonate platform or atoll setting.	intraplatetectonicsetting
shorelineSetting	shoreline setting	Geologic setting characterized by location adjacent to the ocean or a lake. A zone of indefinite width (may be many kilometers), bordering a body of water that extends from the water line inland to the first major change in landform features. Includes settings that may be subaerial, intermittently subaqueous, or shallow subaqueous, but are intrinsically associated with the interface between land areas and water bodies.	earthsurfacesetting
slopeRiseSetting	slope-rise setting	The part of a subaqueous basin that is between a bordering shelf setting, which separate the basin from an adjacent landmass, and a very low-relief basin plain setting.	marinesetting
slowSpreadingCen	slow spreading	Spreading center at which the opening rate is	activespreadingcen

Value	Name	Definition	Parent
terSetting	center setting	less than 50 mm per year.	tersetting
springSetting	spring setting	Setting characterized by a place where groundwater flows naturally from a rock or the soil onto the land surface or into a water body.	riverplainsystemsetting
strandplainSetting	strandplain setting	A prograded shore built seaward by waves and currents, and continuous for some distance along the coast. It is characterized by subparallel beach ridges and swales, in places with associated dunes.	shorelinesetting
subaerialSetting	subaerial setting	Setting at the interface between the solid earth and the atmosphere, includes some shallow subaqueous settings in river channels and playas. Characterized by conditions and processes, such as erosion, transport and accumulation, that exist or operate in the open air on or immediately adjacent to the land surface.	earthsurfacesetting
subaqueousSetting	subaqueous setting	Setting situated in or under permanent, standing water. Used for marine and lacustrine settings, but not for fluvial settings.	earthsurfacesetting
subductionZoneSetting	subduction zone setting	Tectonic setting at which a tectonic plate, usually oceanic, is moving down into the mantle beneath another overriding plate.	platemarginsetting
subglacialSetting	subglacial setting	Formed or accumulated in or by the bottom parts of a glacier or ice sheet; said of meltwater streams, till, moraine, etc.	glacierrelatedsetting
submarineFanSetting	submarine fan setting	Large fan-shaped cones of sediment on the ocean floor, generally associated with submarine canyons that provide sediment supply to build the fan..	marinesetting
supraglacialSetting	supraglacial setting	"Carried upon, deposited from, or pertaining to the top surface of a glacier or ice sheet; said of meltwater streams, till, drift, etc. " (Jackson, 1997, p. 639). Dreimanis (1988, p. 39) recommendation that "supraglacial" supersede "superglacial" is followed.	glacierrelatedsetting
supratidalSetting	supratidal setting	Pertaining to the shore area marginal to the littoral zone, just above high-tide level	shorelinesetting
swampOrMarshSetting	swamp or marsh	A water-saturated, periodically wet or continually flooded area with the surface not	wetlandsetting

Value	Name	Definition	Parent
tting	setting	deeply submerged, essentially without the formation of peat. Marshes are characterized by sedges, cattails, rushes, or other aquatic and grasslike vegetation. Swamps are characterized by tree and brush vegetation.	
tectonicallyDefined Setting	tectonically defined setting	Setting defined by relationships to tectonic plates on or in the Earth.	
terrestrialSetting	terrestrial setting	Setting characterized by absence of direct marine influence. Most of the subaerial settings are also terrestrial, but lacustrine settings, while terrestrial, are not subaerial, so the subaerial settings are not included as subcategories.	earthsurfacesetting
tidalChannelSettin g	tidal channel setting	A major channel followed by the tidal currents, extending from offshore into a tidal marsh or a tidal flat.	subaqueoussetting
tidalFlatSetting	tidal flat setting	An extensive, nearly horizontal, barren tract of land that is alternately covered and uncovered by the tide, and consisting of unconsolidated sediment (mostly mud and sand). It may form the top surface of a deltaic deposit.	tidalsetting
tidalMarshSetting	tidal marsh setting	A marsh bordering a coast (as in a shallow lagoon or sheltered bay), formed of mud and of the resistant mat of roots of salt-tolerant plants, and regularly inundated during high tides; a marshy tidal flat.	swampormarshsett ing
tidalSetting	tidal setting	Setting subject to tidal processes	shorelinesetting
transformPlateBou ndarySetting	transform plate boundary setting	Plate boundary at which the adjacent plates are moving laterally relative to each other.	platemarginsetting
transitionalCrustal Setting	transitional-crustal setting	Crust formed in the transition zone between continental and oceanic crust, during the history of continental rifting that culminates in the formation of a new ocean.	crustalsetting
ultraHighPressure CrustalSetting	ultra high pressure crustal setting	Setting characterized by pressures characteristic of upper mantle, but indicated by mineral assemblage in crustal composition rocks.	earthinteriorsetting

Value	Name	Definition	Parent
upperBathyalSetting	upper bathyal setting	The ocean environment at water depths between 200 and 600 metres	bathyalsetting
upperContinentalCrustalSetting	upper continental crustal setting	Continental crustal setting dominated by non metamorphosed to low greenschist facies metamorphic rocks, and brittle deformation.	continentalcrustalsetting
upperDeltaPlainSetting	upper delta plain setting	The part of a delta plain essentially unaffected by basinal processes. They do not differ substantially from alluvial environments except that areas of swamp, marsh and lakes are usually more widespread and channels may bifurcate downstream	deltaplainsetting
upperMantleSetting	upper mantle setting	That part of the mantle which lies above a depth of about 660 km and has a density of 3.4 g/cm3 to 4.0 g/cm3 with increasing depth. Similarly, P-wave velocity increases from about 8 to 11 km/sec with depth and S wave velocity increases from about 4.5 to 6 km/sec with depth. It is presumed to be peridotitic in composition. It includes the subcrustal lithosphere, the asthenosphere, and the transition zone.	mantlesetting
upperOceanicCrustalSetting	upper oceanic crustal setting	Oceanic crustal setting dominated by extrusive rocks, abyssal oceanic sediment, with increasing mafic intrusive rock in lower part.	oceaniccrustalsetting
volcanicArcSetting	volcanic arc setting	A generally curvillinear belt of volcanoes above a subduction zone.	platemarginsetting
wasteAndMaterialDepositionAreaSetting	waste and material deposition area setting		
wetToSubHumidSetting	wet to sub-humid setting	A Wet to sub-humid climate is according Thornthwaite's climate classification system associated with rain forests (wet), forests (humid) and grassland (sub-humid).	
wetlandSetting	wetland setting	Setting characterized by gentle surface slope, and at least intermittent presence of standing water, which may be fresh, brackish, or saline. Wetland may be terrestrial setting or shoreline setting.	earthsurfacesetting

1.1.6 Values of code list EventProcessValue

Value	Name	Definition	Parent
accretion	accretion	The addition of material to a continent. Typically involves convergent or transform motion.	tectonicprocess
alteration	alteration	General term for any change in the mineralogical or chemical composition of a rock. Typically related to interaction with hydrous fluids.	metamorphicprocess
biologicalPrecipitation	biological precipitation	the deposition of minerals from solution by the agency of organisms	deposition
biologicalWeathering	biological weathering	breakdown of rocks by biological agents, e.g. the penetrating and expanding force of roots, the presence of moss and lichen causing humic acids to be retained in contact with rock, and the work of animals (worms, moles, rabbits) in modifying surface soil	weathering
bolideImpact	bolide impact	the impact of an extraterrestrial body on the surface of the earth	geologicprocess
casting	casting	covering of the surface with a material liquid during processing and solidifying afterwards	materialtransportanddeposition
chemicalPrecipitation	chemical precipitation	The deposition of mineral matter by precipitation from solution or as a result of chemical reactions. May be sedimentary or hydrothermal.	deposition
chemicalWeathering	chemical weathering	The process of weathering by which chemical reactions (hydrolysis, hydration, oxidation, carbonation, ion exchange, and solution) transform rocks and minerals into new chemical combinations that are stable under conditions prevailing at or near the Earth's surface; e.g. the alteration of orthoclase to kaolinite.	weathering
cometaryImpact	cometary impact	the impact of a comet on the surface of the earth	bolideimpact
contactMetamorphism	contact metamorphism	Metamorphism taking place in rocks at or near their contact with a genetically related body of igneous rock	metamorphicprocess
continentalBreaku	continental	Fragmentation of a continental plate into two or more smaller plates; may involve rifting or	tectonicprocess

Value	**Name**	**Definition**	**Parent**
p	breakup	strike slip faulting.	
continentalCollision	continental collision	The amalgamation of two continental plates or blocks along a convergent margin.	tectonicprocess
cryoturbation	cryoturbation	A collective term to describe the stirring and churning of unconsolidated material resulting from frost action	masswasting
debrisFlowDeposition	debris flow deposition	Laminar high-concentration, generally cohesionless deposition process. Flow types included liquefied flow, fluidized flow, grain flow, traction carpet or modified grain flow.	mechanicaldeposition
deepPloughing	deep ploughing	mixing of loose surface material by ploughing deeper than frequently done during annual soil cultivation	
deepWaterOxygenDepletion	deep water oxygen depletion	Process of removal of oxygen from from the deep part of a body of water.	geologicprocess
deformation	deformation	Movement of rock bodies by displacement on fault or shear zones, or change in shape of a body of Earth material.	geologicprocess
deformationTwinning	deformation twinning	Deformation of a crystal by gliding to produce crystallographic twinning.	ductileflow
deluviation	deluviation	process of non-linear, grain-size selective erosion	masswasting
deposition	deposition	Accumulation of material; the constructive process of accumulation of sedimentary particles, chemical precipitation of mineral matter from solution, or the accumulation of organic material on the death of plants and animals.	sedimentaryprocess
depositionByOrFromMovingIce	deposition by or from moving ice	Deposition of sediment from ice by melting or pushing. The material has been transported in the ice after entrainment in the moving ice or after deposition from other moving fluids on the ice.	
depositionFromAir	deposition from air	Deposition of sediment from air, in which the sediment has been transported after entrainment in the moving air.	
depositionFromFluid	deposition from fluid	Deposition of sediment from moving water or air, in which the sediment is transported by entrainment in the moving fluid. Constrast	mechanicaldeposition

Value	Name	Definition	Parent
		with debris flow or turbidity current deposition in which movement of fluid/sediment mixture is due to incorporation of sediment in fluid.	
depositionFromMovingFluid	deposition from moving fluid	Deposition of sediment from moving water or air, in which the sediment is transported by entrainment in the moving fluid. Constrast with debris flow or turbidity current deposition in which movement of fluid/sediment mixture is due to incorporation of sediment in fluid.	mechanicaldeposition
depositionFromWater	deposition from water	Deposition of sediment from water, in which the sediment has been transported after entrainment in the moving water or after deposition from other moving fluids.	
diageneticProcess	diagenetic process	Any chemical, physical, or biological process that affects a sedimentary EarthMaterial after initial deposition, and during or after lithification, exclusive of weathering and metamorphism. [adapt. Jackson, 1997] Example processes include compaction, cementation, authigenesis, replacement, leaching, hydration, and bacterial action. Includes processes that are normal in the surficial or outer part of the earth's crust [Jackson, 1997]. Changes in a deeply buried sedimentary rock may be continuous from diagenesis into recrystallization to form a metamorphic rock. Robertson [1999] defines the boundary between diagenesis and metamorphism in sedimentary rocks as follows: "the boundary between diagenesis and metamorphism is somewhat arbitrary and strongly dependent on the rock types involved. For example changes take place in organic materials at lower temperatures than in rocks dominated by silicate minerals. In mudrocks, a white mica (illite) crystallinity value of less than 0.42D.2U obtained by X-ray diffraction analysis, is used to define the onset of metamorphism (Kisch, 1991). In this scheme, the first appearance of glaucophane, lawsonite, paragonite, prehnite, pumpellyite or stilpnomelane is taken to indicate the lower limit of metamorphism (Frey and Kisch, 1987; Bucher and Frey, 1994; Frey and Robinson, 1998). Most workers agree that such mineral growth starts at 150 ± 50° C in silicate rocks. Many rock types may show no change in mineralogy under these conditions and hence	geologicprocess

Value	Name	Definition	Parent
		the recognition of the onset of metamorphism will vary with bulk composition."	
diffusionCreep	diffusion creep	Grain-scale, ductile deformation accomplished by the motion of atoms through crystals, along grain boundaries, and through pore fluids.	ductileflow
digging	digging	repeated mixing of loose surface material by digging with a spade or similar tool	
dislocationMetamorphism	dislocation metamorphism	Metamorphism concentrated along narrow belts of shearing or crushing without an appreciable rise in temperature	metamorphicprocess
dissolution	dissolution	The process of dissolving into a homogenous solution, as when an acidic solution dissolves limestone. In karst, refers to the process of dissolving rock to produce landforms, in contrast to solution, the chemical product of dissolution.	chemicalweathering
dissolutionCreep	dissolution creep	Deformation by dissolution under the effects of differential stress and its transport to a new location by movement of fluid in the rock body.	ductileflow
ductileFlow	ductile flow	deformation without apparent loss of continuity at the scale of observation.	deformation
dumping	dumping	heaping of mostly solid material, as in a land fill, mine dump, dredging operations	materialtransportanddeposition
effusiveEruption	effusive eruption	Eruptions characterized by low volatile content of the erupting magma relative to ambient pressure	eruption
erosion	erosion	The process of disaggregation of rock and displacement of the resultant particles (sediment) usually by the agents of currents such as, wind, water, or ice by downward or down-slope movement in response to gravity or by living organisms (in the case of bioerosion).	sedimentaryprocess
eruption	eruption	The ejection of volcanic materials (lava, pyroclasts, and volcanic gases) onto the Earth's surface, either from a central vent or from a fissure or group of fissures	magmaticprocess
excavation	excavation	removal of material, as in a mining operation	humanactivity

Value	Name	Definition	Parent
excavation	excavation	removal of material, as in a mining operation	humanactivity
extinction	extinction	Process of disappearance of a species or higher taxon, so that it no longer exists anywhere or in the subsequent fossil record.	geologicprocess
faulting	faulting	The process of fracturing, frictional slip, and displacement accumulation that produces a fault	deformation
folding	folding	deformation in which planar surfaces become regularly curviplanar surfaces with definable limbs (zones of lower curvature) and hinges (zones of higher curvature).	deformation
fracturing	fracturing	The formation of a surface of failure resulting from stress	deformation
frostShattering	frost shattering	Propagation of fractures due to expansion of freezing water in intergranular spaces and fractures in a rock body. Result is mechanical disintegration spliitting, or breakup of rock.	physicalweathering
geologicProcess	geologic process	process that effects the geologic record	
geomagneticProcess	geomagnetic process	process that results in change in Earth's magnetic field	geologicprocess
grading	grading	leveling of earth surface by rearrangement of prexisting material	humanactivity
haloclasty	haloclasty	propagation of fractures in rock due to crytallization of mineral salts (typically sodium chloride) from interstitial water, or volumetrick expansion of salts in capillaries, or hydration pressure of interstitial, trapped salts. Generally results in mechanical disintegration of the rock surface.	physicalweathering
hawaiianEruption	hawaiian eruption	Eruption in which great quantities of extremely fluid basaltic lava are poured out, mainly issuing in lava fountains from fissures on the flanks of a volcano. Explosive phenomena are rare, but much spatter and scoria are piled into cones and mounds along the vents. Characteristic of shield volcanoes	eruption
humanActivity	human activity	processes of human modification of the earth to produce geologic features	geologicprocess
hydration	hydration	The process of absorption of water into the	chemicalweatherin

Value	Name	Definition	Parent
		crystal structure of a mineral, thereby changing its volume and fracturing and loosening grains	g
hydrolysis	hydrolysis	A decomposition reaction involving water. In geology, it commonly indicates reaction between silicate minerals and either pure water or aqueous solution. In such reactions, H	chemicalweatherin g
iceErosion	ice erosion	Erosion by corrasion or plucking by moving ice.	erosion
inSituOrganismicG rowth	in-situ organismic growth	accumulation of dead organic material originating from the plants, e.g. paet accumulation in bogs	deposition
intrusion	intrusion	The process of emplacement of magma in pre-existing rock	magmaticprocess
magmaticCrystallis ation	magmatic crystallisatio n	The process by which matter becomes crystalline, from a gaseous, fluid, or dispersed state	magmaticprocess
magmaticProcess	magmatic process	A process involving melted rock (magma).	geologicprocess
magneticFieldRev ersal	magnetic field reversal	geomagnetic event	geomagneticproce ss
massWasting	mass wasting	the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses. In contrast to other erosion processes, the debris removed by mass wasting is not carried within, on, or under another medium. The mass properties of the material being transported depend on the interaction of the soil and rock particles and on the moisture content.	erosion
massWastingDepo sition	mass wasting deposition	A general term for the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses. In contrast to other erosion processes, the debris removed by mass wasting is not carried within, on, or under another medium. The mass properties of the material being transported depend on the interaction of the soil and rock particles and on the moisture content. Mass wasting includes slow displacements, such as creep	mechanicaldepositi on

Value	Name	Definition	Parent
		and solifluction, and rapid movements such as rockfalls, rockslides, and cohesive debris flows (Jackson, 1997, p. 392). Includes both subaerial mass-wasting processes and subaqueous mass-wasting processes.	
materialTransportAndDeposition	material transport and deposition	transport and heaping of material, as in a land fill, mine dump, dredging operations	humanactivity
mechanicalDeposition	mechanical deposition	process by which material that is being transported as particles by moving air, water, ice, or other fluid comes to rest and accumulates.	deposition
melting	melting	change of state from a solid to a liquid	magmaticprocess
metamorphicProcess	metamorphic process	Mineralogical, chemical, and structural adjustment of solid rocks to physical and chemical conditions that differ from the conditions under which the rocks in question originated, and are generally been imposed at depth, below the surface zones of weathering and cementation.	geologicprocess
meteoriteImpact	meteorite impact	the impact of a meteorite on the surface of the earth	bolideimpact
microfracturing	microfracturing	Development of fractures within a single grain or cutting several grains.	fracturing
mixing	mixing	Mixing	humanactivity
obduction	obduction	The overthrusting of continental crust by oceanic crust or mantle rocks at a convergent plate boundary.	tectonicprocess
organicAccumulation	organic accumulation	sediment accumulation of biologically produced organic material, as in bog, coal swamps.	deposition
orogenicProcess	orogenic process	mountain building process.	tectonicprocess
oxidation	oxidation	Chemical reaction that involve stripping of electrons from cations. Typicall reactions include converting sulfide minerals to oxide minerals, or increasing the oxidation state of cations in existing oxide minerals. The most commonly observed is the oxidation of Fe	chemicalweathering

Value	Name	Definition	Parent
partialMelting	partial melting	Process of melting involving only some of the mineral phases in a rock, to produce a mixture of melt and residual particles.	melting
physicalWeathering	physical weathering	The process of weathering by which frost action, salt-crystal growth, absorption of water, and other physical processes break down a rock to fragments, involving no chemical change	weathering
plinianEruption	plinian eruption	An explosive eruption in which a steady, turbulent stream of fragmented magma and magmatic gas is released at a high velocity from a vent. Large volumes of tephra and tall eruption columns are characteristic	pyroclasticeruption
polarWander	polar wander	process of migration of the axis of the earth's dipole field relative to the rotation axis of the Earth.	geomagneticprocess
pressureReleaseWeathering	pressure release weathering	propagation of fractures near the surface of solid rock due to expansion related to release of confining pressure when deeply buried rock is unroofed. Fractures typically propagate along surfaces close to and subparallel to the surface of the outcrop.	physicalweathering
pyroclasticEruption	pyroclastic eruption	Eruption produced by the generation and rapid expansion of a gas phase that disrupts magma, surrounding wall rock or sediment	eruption
reworking	reworking	near-range transport by water with predominantly changing the inner physical organisation of the sediment particles	masswasting
rifting	rifting	Extension of the crust to form one or more long, narrow graben of regional extent.	continentalbreakup
seaLevelChange	sea level change	process of mean sea level changing relative to some datum	geologicprocess
seaLevelFall	sea level fall	process of mean sea level falling relative to some datum	sealevelchange
seaLevelRise	sea level rise	process of mean sea level rising relative to some datum	sealevelchange
sealing	sealing	covering of the surface with a non-liquid material not or little permeable for water after processing	materialtransportanddeposition
sedimentaryProce	sedimentary	a phenomenon that changes the distribution	geologicprocess

Value	Name	Definition	Parent
ss	process	or physical properties of sediment at or near the earth's surface	
shearing	shearing	A deformation in which contiguous parts of a body are displaced relatively to each other in a direction parallel to a surface. The surface may be a discrete fault, or the deformation may be a penetrative strain and the shear surface is a geometric abstraction.	deformation
speciation	speciation	process that results inappearance of new species	geologicprocess
spreading	spreading	A process whereby new oceanic crust is formed by upwelling of magma at the center of mid-ocean ridges and by a moving-away of the new material from the site of upwelling at rates of one to ten centimeters per year.	tectonicprocess
strombolianEruption	strombolian eruption	Eruption characterized by jetting of clots or "fountains" of fluid, basaltic lava from a central crater	eruption
subduction	subduction	The process of one lithospheric plate descending beneath another	tectonicprocess
tectonicProcess	tectonic process	Processes related to the interaction between or deformation of rigid plates forming the crust of the Earth.	geologicprocess
thermalShockWeathering	thermal shock weathering	propagation of fractures near the surface of solid rock due to expansion and contraction caused by temperature changes. Fractures typically propagate along surfaces close to and subparallel to the surface of the outcrop.	physicalweathering
transformFaulting	transform faulting	A strike-slip fault that links two other faults or two other plate boundaries (e.g. two segments of a mid-ocean ridge). Transform faults often exhibit characteristics that distinguish them from transcurrent faults: (1) For transform faults formed at the same time as the faults they link, slip on the transform fault has equal magnitude at all points along the transform; slip magnitude on the transform fault can exceed the length of the transform fault, and slip does not decrease to zero at the fault termini. (2) For transform faults linking two similar features, e.g. if two mid-ocean ridge segments linked by a transform have equal spreading rates, then the length of the transform does not change	tectonicprocess

Value	Name	Definition	Parent
		as slip accrues on it.	
turbidityCurrentDeposition	turbidity current deposition	Deposition from a turbulent, low concentration sediment-water mixture.	mechanicaldeposition
vulcanianEruption	vulcanian eruption	Eruption characterized by the explosive ejection of fragments of new lava, commonly incandescent when they leave the vent but either solid or too viscous to assume any appreciable degree of rounding during their flight through the air. With these there are often breadcrust bombs or blocks, and generally large proportions of ash	pyroclasticeruption
waterErosion	water erosion	Erosion by clast impact or plucking by moving liquid water	erosion
weathering	weathering	The process or group of processes by which earth materials exposed to atmospheric agents at or near the Earth's surface are changed in color, texture, composition, firmness, or form, with little or no transport of the loosened or altered material. Processes typically include oxidation, hydration, and leaching of soluble constituents.	geologicprocess
windErosion	wind erosion	Erosion by clast impact or plucking by moving air (wind)	erosion

1.1.7 Values of code list FaultTypeValue

Value	Name	Definition
detachmentFault	detachment fault	A regional-scale, large displacement, low-angle normal fault.
dextralStrikeSlipFault	dextral strike slip fault	Fault with right-lateral strike-parallel displacement component of slip vector more than 10 times the dip-parallel component of the slip vector at at least one location along the fault, and right-lateral displacement over more than half the mapped trace of the fault.
extractionFault	extraction fault	A fault whose two sides have approached each other substantially in the direction perpendicular to the fault.
fault	fault	A discrete surface, or zone of discrete surfaces, with some thickness, separating two rock masses across which one mass has slid past the other.

Value	Name	Definition
highAngleReverse	high angle reverse	Reverse fault that dips at least 45 degrees over more than half of its recognized extent, for which slip or separation is not explicitly specified.
highAngleFault	high-angle fault	Fault that dips at least 45 degrees over more than half of its recognized extent, for which slip or separation is not explicitly specified.
highAngleNormalFault	high-angle normal fault	Fault that dips at least 45 degrees over more than half of the recognized extent of the fault with the hanging wall displaced from a structurally higher position relative to footwall rocks.
horizontalFault	horizontal fault	Fault that dips less than 10 degrees over more than half the recognized extent of the fault.
leftNormalFault	left normal fault	High angle fault with slip vector that has ratio of strike-parallel to dip-parallel displacement between 10 to 1 and 1 to 10 at at least one location along the mapped trace, with left-lateral strike-parallel component and normal dip-parallel component over at least half the mapped trace of the fault.
leftReverseFault	left reverse fault	High angle fault with slip vector that has ratio of strike-parallel to dip-parallel displacement between 10 to 1 and 1 to 10 at at least one location along the mapped trace, with left-lateral strike-parallel component and reverse dip-parallel component over at least half the mapped trace of the fault.
lowAngleFault	low angle fault	Fault that dips less than 45 degrees over more than half of the recognized extent of the fault.
lowAngleNormalFault	low-angle normal fault	Fault that dips less than 45 degrees over more than half of the recognized extent of the fault with the hanging wall displaced from a structurally higher position relative to footwall rocks.
mixedExtractionFault	mixed extraction fault	An extraction fault with some displacement within the fault plane.
normalFault	normal fault	Fault with dip-parallel displacement component of slip vector more than 10 times the strike-parallel component of the slip vector over more than half recognized extent of the fault, and for which the fault dips consistently in the same direction, and for which the hanging wall has been displaced down relative to the footwall.
obliqueSlipFault	oblique slip fault	Fault with slip vector that has ratio of strike-parallel to dip-parallel displacement between 10 to 1 and 1 to 10 at at least one location along the mapped trace of the fault.
pureExtractionFault	pure extraction fault	An extraction fault with no discernible displacement within the fault plane.

Value	Name	Definition
reverseFault	reverse fault	Fault with dip-parallel displacement component of slip vector more than 10 times the strike-parallel component of the slip vector at at least one location along the mapped trace of the fault, and the fault dips consistently in the same direction with the hanging wall displaced up relative to the footwall over at least half the mapped trace of the fault.
rightNormalFault	right normal fault	High angle fault with slip vector that has ratio of strike-parallel to dip-parallel displacement between 10 to 1 and 1 to 10 at at least one location along the mapped trace, with right-lateral strike-parallel component and normal dip-parallel component of slip over at least half the mapped trace of the fault
rightReverseFault	right reverse fault	High angle fault with slip vector that has ratio of strike-parallel to dip-parallel displacement between 10 to 1 and 1 to 10 at at least one location along the mapped trace, with a right-lateral strike-parallel component and reverse dip-parallel component of slip over at least half the mapped trace of the fault.
scissorFault	scissor fault	A fault on which there is increasing offset or separation along the strike from an initial point of no offset, with the opposite sense of offset in the opposite direction.
sinistralStrikeSlipFault	sinistral strike slip fault	Fault with left-lateral strike-parallel displacement component of slip vector more than 10 times the dip-parallel component of the slip vector at at least one location along the fault, and left-lateral displacement over more than half the mapped trace of the fault.
strikeSlipFault	strike slip fault	Fault with strike-parallel displacement component of slip vector more than 10 times the dip-parallel component of the slip vector at at least one location along the mapped trace of the fault.
thrustFault	thrust fault	Fault that dips less than 45 degrees over more than half of the recognized extent of the fault, with a hanging wall displaced from a structurally deeper position relative to footwall rocks.
wrenchFault	wrench fault	A strike slip fault in which the fault plane dips at least 45 degrees over more than half of the recognized extent of the fault.

1.1.8 Values of code list FoldProfileTypeValue

Value	Name	Definition
anticline	anticline	A fold, general convex upward, whose core contains the

Value	Name	Definition
		stratigraphically older rocks.
antiform	antiform	Any convex-upward, concave downward fold. The term is usually used when the folded layers do not possess a stratigraphic order, when the stratigraphic order of the folded layers is not known, or when the fold core also contains the stratigraphically younger rock.
syncline	syncline	A fold of which the core contains the stratigraphically younger rocks; it is generally concave upward.
synform	synform	Any fold whose limbs close at the bottom. The term is usually used when the folded layers do not possess a stratigraphic order, when the stratigraphic order of the folded layers is not known, or when the fold core also contains the stratigraphically older rock.

1.1.9 Values of code list GeneralTimeScaleValue

The values are from the ICS (International Commission on Stratigraphy) of IUGS (International Union of Geological Sciences)

Value	Name	Definition	Parent
phanerozoic	Phanerozoic	Phanerozoic (older bound-542 +/-1 Ma, younger bound-0.0 Ma)	
cenozoic	Cenozoic	Cenozoic (older bound-65.5 +/-0.3 Ma, younger bound-0.0 Ma)	phanerozoic
quaternary	Quaternary	Quaternary (older bound-2.588 Ma, younger bound-0.0 Ma)	cenozoic
holocene	Holocene	Holocene (older bound-0.0117 Ma, younger bound-0.0 Ma)	quaternary
pleistocene	Pleistocene	Pleistocene (older bound-2.588 Ma, younger bound-0.0117 Ma)	quaternary
latePleistocene	Late/Upper Pleistocene	Late/Upper Pleistocene (older bound-0.126 Ma, younger bound-0.0117 Ma)	pleistocene
ionian	Ionian	Ionian (older bound-0.781 Ma, younger bound-0.126 Ma)	pleistocene
calabrian	Calabrian	Calabrian (older bound-1.806 Ma, younger bound-0.781 Ma)	pleistocene
gelasian	Gelasian	Gelasian (older bound-2.588 Ma, younger	pleistocene

Value	Name	Definition	Parent
		bound-1.806 Ma)	
neogene	Neogene	Neogene (older bound-23.03 Ma, younger bound-2.588 Ma)	cenozoic
pliocene	Pliocene	Pliocene (older bound-5.332 Ma, younger bound-2.588 Ma)	neogene
piacenzian	Piacenzian	Piacenzian (older bound-3.6 Ma, younger bound-2.588 Ma)	pliocene
zanclean	Zanclean	Zanclean (older bound-5.332 Ma, younger bound-3.6 Ma)	pliocene
miocene	Miocene	Miocene (older bound-23.03 Ma, younger bound-5.332 Ma)	neogene
messinian	Messinian	Messinian (older bound-7.246 Ma, younger bound-5.332 Ma)	miocene
tortonian	Tortonian	Tortonian (older bound-11.608 Ma, younger bound-7.246 Ma)	miocene
serravallian	Serravallian	Serravallian (older bound-13.82 Ma, younger bound-11.608 Ma)	miocene
langhian	Langhian	Langhian (older bound-15.97 Ma, younger bound-13.82 Ma)	miocene
burdigalian	Burdigalian	Burdigalian (older bound-20.43 Ma, younger bound-15.97 Ma)	miocene
aquitanian	Aquitanian	Aquitanian (older bound-23.03 Ma, younger bound-20.43 Ma)	miocene
paleogene	Paleogene	Paleogene (older bound-65.5 +/-0.3 Ma, younger bound-23.03 Ma)	cenozoic
oligocene	Oligocene	Oligocene (older bound-33.9 +/-0.1 Ma, younger bound-23.03 Ma)	cenozoic
chattian	Chattian	Chattian (older bound-28.4 +/-0.1 Ma, younger bound-23.03 Ma)	oligocene
rupelian	Rupelian	Rupelian (older bound-33.9 +/-0.1 Ma, younger bound-28.4 +/-0.1 Ma)	oligocene
eocene	Eocene	Eocene (older bound-55.8 +/-0.2 Ma, younger bound-33.9 +/-0.1 Ma)	cenozoic
priabonian	Priabonian	Priabonian (older bound-37.2 +/-0.1 Ma, younger bound-33.9 +/-0.1 Ma)	eocene

Value	Name	Definition	Parent
bartonian	Bartonian	Bartonian (older bound-40.4 +/-0.2 Ma, younger bound-37.2 +/-0.1 Ma)	eocene
lutetian	Lutetian	Lutetian (older bound-48.6 +/-0.2 Ma, younger bound-40.4 +/-0.2 Ma)	eocene
ypresian	Ypresian	Ypresian (older bound-55.8 +/-0.2 Ma, younger bound-48.6 +/-0.2 Ma)	eocene
paleocene	Paleocene	Paleocene (older bound-65.5 +/-0.3 Ma, younger bound-55.8 +/-0.2 Ma)	paleogene
thanetian	Thanetian	Thanetian (older bound-58.7 +/-0.2 Ma, younger bound-55.8 +/-0.2 Ma)	paleocene
selandian	Selandian	Selandian (older bound-61.1 Ma, younger bound-58.7 +/-0.2 Ma)	paleocene
danian	Danian	Danian (older bound-65.5 +/-0.3 Ma, younger bound-61.1 Ma)	paleocene
mesozoic	Mesozoic	Mesozoic (older bound-251 +/-0.4 Ma, younger bound-65.5 +/-0.3 Ma)	phanerozoic
cretaceous	Cretaceous	Cretaceous (older bound-145.5 +/-4 Ma, younger bound-65.5 +/-0.3 Ma)	mesozoic
lateCretaceous	Late/Upper Cretaceous	Late/Upper Cretaceous (older bound-99.6 +/-0.9 Ma, younger bound-65.5 +/-0.3 Ma)	cretaceous
maastrichtian	Maastrichtian	Maastrichtian (older bound-70.6 +/-0.6 Ma, younger bound-65.5 +/-0.3 Ma)	lateCretaceous
campanian	Campanian	Campanian (older bound-83.5 +/-0.7 Ma, younger bound-70.6 +/-0.6 Ma)	lateCretaceous
santonian	Santonian	Santonian (older bound-85.8 +/-0.7 Ma, younger bound-83.5 +/-0.7 Ma)	lateCretaceous
coniacian	Coniacian	Coniacian (older bound-88.6 Ma, younger bound-85.8 +/-0.7 Ma)	lateCretaceous
turonian	Turonian	Turonian (older bound-93.6 +/-0.8 Ma, younger bound-88.6 Ma)	lateCretaceous
cenomanian	Cenomanian	Cenomanian (older bound-99.6 +/-0.9 Ma, younger bound-93.6 +/-0.8 Ma)	lateCretaceous
earlyOrLowerCretaceous	Early/Lower Cretaceous	Early/Lower Cretaceous (older bound-145.5 +/-4 Ma, younger bound-99.6 +/-0.9 Ma)	cretaceous
albian	Albian	Albian (older bound-112 +/-1 Ma, younger bound-99.6 +/-0.9 Ma)	earlyOrLowerCretaceous

Value	Name	Definition	Parent
aptian	Aptian	Aptian (older bound-125 +/-1 Ma, younger bound-112 +/-1 Ma)	earlyOrLowerCretaceous
barremian	Barremian	Barremian (older bound-130 +/-1.5 Ma, younger bound-125 +/-1 Ma)	earlyOrLowerCretaceous
hauterivian	Hauterivian	Hauterivian (older bound-133.9 Ma, younger bound-130 +/-1.5 Ma)	earlyOrLowerCretaceous
valanginian	Valanginian	Valanginian (older bound-140.2 +/-3 Ma, younger bound-133.9 Ma)	earlyOrLowerCretaceous
berriasian	Berriasian	Berriasian (older bound-145.5 +/-4 Ma, younger bound-140.2 +/-3 Ma)	earlyOrLowerCretaceous
jurassic	Jurassic	Jurassic (older bound-199.6 +/-0.6 Ma, younger bound-145.5 +/-4 Ma)	mesozoic
lateJurassic	Late/Upper Jurassic	Late/Upper Jurassic (older bound-161.2 +/-4 Ma, younger bound-145.5 +/-4 Ma)	jurassic
tithonian	Tithonian	Tithonian (older bound-150.8 +/-4 Ma, younger bound-145.5 +/-4 Ma)	lateJurassic
kimmeridgian	Kimmeridgian	Kimmeridgian (older bound-155.6 Ma, younger bound-150.8 +/-4 Ma)	lateJurassic
oxfordian	Oxfordian	Oxfordian (older bound-161.2 +/-4 Ma, younger bound-155.6 Ma)	lateJurassic
middleJurassic	Middle Jurassic	Middle Jurassic (older bound-175.6 +/-2 Ma, younger bound-161.2 +/-4 Ma)	jurassic
callovian	Callovian	Callovian (older bound-164.7 +/-4 Ma, younger bound-161.2 +/-4 Ma)	middleJurassic
bathonian	Bathonian	Bathonian (older bound-167.7 +/-3.5 Ma, younger bound-164.7 +/-4 Ma)	middleJurassic
bajocian	Bajocian	Bajocian (older bound-171.6 +/-3 Ma, younger bound-167.7 +/-3.5 Ma)	middleJurassic
aalenian	Aalenian	Aalenian (older bound-175.6 +/-2 Ma, younger bound-171.6 +/-3 Ma)	middleJurassic
earlyJurassic	Early/Lower Jurassic	Early/Lower Jurassic (older bound-199.6 +/-0.6 Ma, younger bound-175.6 +/-2 Ma)	jurassic
toarcian	Toarcian	Toarcian (older bound-183 +/-1.5 Ma, younger bound-175.6 +/-2 Ma)	earlyJurassic
pliensbachian	Pliensbachian	Pliensbachian (older bound-189.6 +/-1.5 Ma, younger bound-183 +/-1.5 Ma)	earlyJurassic

Value	Name	Definition	Parent
sinemurian	Sinemurian	Sinemurian (older bound-196.5 +/-1 Ma, younger bound-189.6 +/-1.5 Ma)	earlyJurassic
hettangian	Hettangian	Hettangian (older bound-199.6 +/-0.6 Ma, younger bound-196.5 +/-1 Ma)	earlyJurassic
triassic	Triassic	Triassic (older bound-251 +/-0.4 Ma, younger bound-199.6 +/-0.6 Ma)	mesozoic
lateTriassic	Late/Upper Triassic	Late/Upper Triassic (older bound-228.7 Ma, younger bound-199.6 +/-0.6 Ma)	triassic
rhaetian	Rhaetian	Rhaetian (older bound-203.6 +/-1.5 Ma, younger bound-199.6 +/-0.6 Ma)	lateTriassic
norian	Norian	Norian (older bound-216.5 +/-2 Ma, younger bound-203.6 +/-1.5 Ma)	lateTriassic
carnian	Carnian	Carnian (older bound-228.7 Ma, younger bound-216.5 +/-2 Ma)	lateTriassic
middleTriassic	Middle Triassic	Middle Triassic (older bound-245.9 Ma, younger bound-228.7 Ma)	middleTriassic
ladinian	Ladinian	Ladinian (older bound-237 +/-2 Ma, younger bound-228.7 Ma)	middleTriassic
anisian	Anisian	Anisian (older bound-245.9 Ma, younger bound-237 +/-2 Ma)	middleTriassic
earlyTriassic	Early/Lower Triassic	Early/Lower Triassic (older bound-251 +/-0.4 Ma, younger bound-245.9 Ma)	triassic
olenekian	Olenekian	Olenekian (older bound-249.5 Ma, younger bound-245.9 Ma)	earlyTriassic
induan	Induan	Induan (older bound-251 +/-0.4 Ma, younger bound-249.5 Ma)	earlyTriassic
paleozoic	Paleozoic	Paleozoic (older bound-542 +/-1 Ma, younger bound-251 +/-0.4 Ma)	phanerozoic
permian	Permian	Permian (older bound-299 +/-0.8 Ma, younger bound-251 +/-0.4 Ma)	paleozoic
lopingian	Lopingian	Lopingian (older bound-260.4 +/-0.7 Ma, younger bound-251 +/-0.4 Ma)	permian
changhsingian	Changhsingian	Changhsingian (older bound-253.8 +/-0.7 Ma, younger bound-251 +/-0.4 Ma)	lopingian
wuchiapingian	Wuchiapingian	Wuchiapingian (older bound-260.4 +/-0.7 Ma, younger bound-253.8 +/-0.7 Ma)	lopingian

Value	Name	Definition	Parent
guadalupian	Guadalupian	Guadalupian (older bound-270.6 +/-0.7 Ma, younger bound-260.4 +/-0.7 Ma)	permian
capitanian	Capitanian	Capitanian (older bound-265.8 +/-0.7 Ma, younger bound-260.4 +/-0.7 Ma)	guadalupian
wordian	Wordian	Wordian (older bound-268 +/-0.7 Ma, younger bound-265.8 +/-0.7 Ma)	guadalupian
roadian	Roadian	Roadian (older bound-270.6 +/-0.7 Ma, younger bound-268 +/-0.7 Ma)	guadalupian
cisuralian	Cisuralian	Cisuralian (older bound-299 +/-0.8 Ma, younger bound-270.6 +/-0.7 Ma)	permian
kungurian	Kungurian	Kungurian (older bound-275.6 +/-0.7 Ma, younger bound-270.6 +/-0.7 Ma)	cisuralian
artinskian	Artinskian	Artinskian (older bound-284.4 +/-0.7 Ma, younger bound-275.6 +/-0.7 Ma)	cisuralian
sakmarian	Sakmarian	Sakmarian (older bound-294.6 +/-0.8 Ma, younger bound-284.4 +/-0.7 Ma)	cisuralian
asselian	Asselian	Asselian (older bound-299 +/-0.8 Ma, younger bound-294.6 +/-0.8 Ma)	cisuralian
carboniferous	Carboniferou s	Carboniferous (older bound-359.2 +/-2.5 Ma, younger bound-299 +/-0.8 Ma)	paleozoic
pennsylvanian	Pennsylvani an	Pennsylvanian (older bound-318.1 +/-1.3 Ma, younger bound-299 +/-0.8 Ma)	carboniferous
latePennsylvanian	Late/Upper Pennsylvani an	Late/Upper Pennsylvanian (older bound-307.2 +/-1 Ma, younger bound-299 +/-0.8 Ma)	pennsylvanian
gzhelian	Gzhelian	Gzhelian (older bound-303.4 +/-0.9 Ma, younger bound-299 +/-0.8 Ma)	latePennsylvanian
kasimovian	Kasimovian	Kasimovian (older bound-307.2 +/-1 Ma, younger bound-303.4 +/-0.9 Ma)	latePennsylvanian
moscovian	Moscovian	Moscovian (older bound-311.7 +/-1.1 Ma, younger bound-307.2 +/-1 Ma)	pennsylvanian
bashkirian	Bashkirian	Bashkirian (older bound-318.1 +/-1.3 Ma, younger bound-311.7 +/-1.1 Ma)	pennsylvanian
mississippian	Mississippia n	Mississippian (older bound-359.2 +/-2.5 Ma, younger bound-318.1 +/-1.3 Ma)	carboniferous
serpukhovian	Serpukhovia	Serpukhovian (older bound-328.3 +/-1.6 Ma,	mississippian

Value	Name	Definition	Parent
	n	younger bound-318.1 +/-1.3 Ma)	
visean	Visean	Visean (older bound-345.3 +/-2.1 Ma, younger bound-328.3 +/-1.6 Ma)	mississippian
tournaisian	Tournaisian	Tournaisian (older bound-359.2 +/-2.5 Ma, younger bound-345.3 +/-2.1 Ma)	mississippian
devonian	Devonian	Devonian (older bound-416 +/-2.8 Ma, younger bound-359.2 +/-2.5 Ma)	paleozoic
lateDevonian	Late/Upper Devonian	Late/Upper Devonian (older bound-385.3 +/-2.6 Ma, younger bound-359.2 +/-2.5 Ma)	devonian
famennian	Famennian	Famennian (older bound-374.5 +/-2.6 Ma, younger bound-359.2 +/-2.5 Ma)	lateDevonian
frasnian	Frasnian	Frasnian (older bound-385.3 +/-2.6 Ma, younger bound-374.5 +/-2.6 Ma)	lateDevonian
middleDevonian	Middle Devonian	Middle Devonian (older bound-397.5 +/-2.7 Ma, younger bound-385.3 +/-2.6 Ma)	devonian
givetian	Givetian	Givetian (older bound-391.8 +/-2.7 Ma, younger bound-385.3 +/-2.6 Ma)	middleDevonian
eifelian	Eifelian	Eifelian (older bound-397.5 +/-2.7 Ma, younger bound-391.8 +/-2.7 Ma)	middleDevonian
earlyDevonian	Early/Lower Devonian	Early/Lower Devonian (older bound-416 +/-2.8 Ma, younger bound-397.5 +/-2.7 Ma)	devonian
emsian	Emsian	Emsian (older bound-407 +/-2.8 Ma, younger bound-397.5 +/-2.7 Ma)	earlyDevonian
pragian	Pragian	Pragian (older bound-411.2 +/-2.8 Ma, younger bound-407 +/-2.8 Ma)	earlyDevonian
lochkovian	Lochkovian	Lochkovian (older bound-416 +/-2.8 Ma, younger bound-411.2 +/-2.8 Ma)	earlyDevonian
silurian	Silurian	Silurian (older bound-443.7 +/-1.5 Ma, younger bound-416 +/-2.8 Ma)	paleozoic
pridoli	Pridoli	Pridoli (older bound-418.7 +/-2.7 Ma, younger bound-416 +/-2.8 Ma)	silurian
ludlow	Ludlow	Ludlow (older bound-422.9 +/-2.5 Ma, younger bound-418.7 +/-2.7 Ma)	silurian
ludfordian	Ludfordian	Ludfordian (older bound-421.3 +/-2.6 Ma, younger bound-418.7 +/-2.7 Ma)	ludlow

Value	Name	Definition	Parent
gorstian	Gorstian	Gorstian (older bound-422.9 +/-2.5 Ma, younger bound-421.3 +/-2.6 Ma)	ludlow
wenlock	Wenlock	Wenlock (older bound-428.2 +/-2.3 Ma, younger bound-422.9 +/-2.5 Ma)	silurian
homerian	Homerian	Homerian (older bound-426.2 +/-2.4 Ma, younger bound-422.9 +/-2.5 Ma)	wenlock
sheinwoodian	Sheinwoodian	Sheinwoodian (older bound-428.2 +/-2.3 Ma, younger bound-426.2 +/-2.4 Ma)	wenlock
llandovery	Llandovery	Llandovery (older bound-443.7 +/-1.5 Ma, younger bound-428.2 +/-2.3 Ma)	silurian
telychian	Telychian	Telychian (older bound-436 +/-1.9 Ma, younger bound-428.2 +/-2.3 Ma)	llandovery
aeronian	Aeronian	Aeronian (older bound-439 +/-1.8 Ma, younger bound-436 +/-1.9 Ma)	llandovery
rhuddanian	Rhuddanian	Rhuddanian (older bound-443.7 +/-1.5 Ma, younger bound-439 +/-1.8 Ma)	llandovery
ordovician	Ordovician	Ordovician (older bound-488.3 +/-1.7 Ma, younger bound-443.7 +/-1.5 Ma)	paleozoic
lateOrdovician	Late/Upper Ordovician	Late/Upper Ordovician (older bound-460.9 +/-1.6 Ma, younger bound-443.7 +/-1.5 Ma)	ordovician
hirnantian	Hirnantian	Hirnantian (older bound-445.6 +/-1.5 Ma, younger bound-443.7 +/-1.5 Ma)	lateOrdovician
katian	Katian	Katian (older bound-455.8 +/-1.6 Ma, younger bound-445.6 +/-1.5 Ma)	lateOrdovician
sandbian	Sandbian	Sandbian (older bound-460.9 +/-1.6 Ma, younger bound-455.8 +/-1.6 Ma)	lateOrdovician
middleOrdovician	Middle Ordovician	Middle Ordovician (older bound-471.8 +/-1.6 Ma, younger bound-460.9 +/-1.6 Ma)	ordovician
darriwilian	Darriwilian	Darriwilian (older bound-468.1 +/-1.6 Ma, younger bound-460.9 +/-1.6 Ma)	middleOrdovician
dapingian	Dapingian	Dapingian (older bound-471.8 +/-1.6 Ma, younger bound-468.1 +/-1.6 Ma)	middleOrdovician
earlyOrdovician	Early/Lower Ordovician	Early/Lower Ordovician (older bound-488.3 +/-1.7 Ma, younger bound-471.8 +/-1.6 Ma)	ordovician
floian	Floian	Floian (older bound-478.6 +/-1.7 Ma, younger bound-471.8 +/-1.6 Ma)	earlyOrdovician

Value	Name	Definition	Parent
tremadocian	Tremadocian	Tremadocian (older bound-488.3 +/-1.7 Ma, younger bound-478.6 +/-1.7 Ma)	earlyOrdovician
cambrian	Cambrian	Cambrian (older bound-542 +/-1 Ma, younger bound-488.3 +/-1.7 Ma)	paleozoic
furongian	Furongian	Furongian (older bound-499.0 Ma, younger bound-488.3 +/-1.7 Ma)	cambrian
cambrianStage10	Cambrian-Stage 10	Cambrian-Stage 10 (older bound-492.0 Ma, younger bound-488.3 +/-1.7 Ma)	furongian
cambrianStage9	Cambrian-Stage 9	Cambrian-Stage 9 (older bound-496.0 Ma, younger bound-492.0 Ma)	furongian
paibian	Paibian	Paibian (older bound-499.0 Ma, younger bound-496.0 Ma)	furongian
cambrianSeries3	Cambrian-Series 3	Cambrian-Series 3 (older bound-510.0 Ma, younger bound-499.0 Ma)	cambrian
guzhangian	Guzhangian	Guzhangian (older bound-503.0 Ma, younger bound-499.0 Ma)	cambrianSeries3
drumian	Drumian	Drumian (older bound-506.5 Ma, younger bound-503.0 Ma)	cambrianSeries3
cambrianSeries3Stage5	Cambrian-Series 3-Stage 5	Cambrian-Series 3-Stage 5 (older bound-510.0 Ma, younger bound-506.5 Ma)	cambrianSeries3
cambrianSeries2	Cambrian-Series 2	Cambrian-Series 2 (older bound-521.0 Ma, younger bound-510.0 Ma)	cambrian
cambrianStage4	Cambrian-Stage 4	Cambrian-Stage 4 (older bound-515.0 Ma, younger bound-510.0 Ma)	cambrianSeries2
cambrianStage3	Cambrian-Stage 3	Cambrian-Stage 3 (older bound-521.0 Ma, younger bound-515.0 Ma)	cambrianSeries2
terreneuvian	Terreneuvian	Terreneuvian (older bound-542 +/-1 Ma, younger bound-521.0 Ma)	cambrian
cambrianStage2	Cambrian-Stage 2	Cambrian-Stage 2 (older bound-528.0 Ma, younger bound-521.0 Ma)	terreneuvian
fortunian	Fortunian	Fortunian (older bound-542 +/-1 Ma, younger bound-528.0 Ma)	terreneuvian
precambrian	Precambrian	Precambrian (older bound-4600.0 Ma, younger bound-542.0 Ma)	
proterozoic	Proterozoic	Proterozoic (older bound-2500.0 Ma, younger	precambrian

Value	Name	Definition	Parent
		bound-542.0 Ma)	
neoproterozoic	Neoproterozoic	Neoproterozoic (older bound-1000.0 Ma, younger bound-542.0 Ma)	proterozoic
ediacaran	Ediacaran	Ediacaran (older bound-635.0 Ma, younger bound-542.0 Ma)	neoproterozoic
cryogenian	Cryogenian	Cryogenian (older bound-850.0 Ma, younger bound-635.0 Ma)	neoproterozoic
tonian	Tonian	Tonian (older bound-1000.0 Ma, younger bound-850.0 Ma)	neoproterozoic
tonian2	Tonian 2 *	Tonian 2 * (older bound-910.0 Ma, younger bound-850.0 Ma)	tonian
tonian1	Tonian 1 *	Tonian 1 * (older bound-1000.0 Ma, younger bound-910.0 Ma)	tonian
mesoproterozoic	Mesoproterozoic	Mesoproterozoic (older bound-1600.0 Ma, younger bound-1000.0 Ma)	proterozoic
stenian	Stenian	Stenian (older bound-1200.0 Ma, younger bound-1000.0 Ma)	mesoproterozoic
stenian2	Stenian 2 *	Stenian 2 * (older bound-1130.0 Ma, younger bound-1000.0 Ma)	stenian
stenian1	Stenian 1 *	Stenian 1 * (older bound-1200.0 Ma, younger bound-1130.0 Ma)	stenian
ectasian	Ectasian	Ectasian (older bound-1400.0 Ma, younger bound-1200.0 Ma)	mesoproterozoic
ectasian4	Ectasian 4 *	Ectasian 4 * (older bound-1250.0 Ma, younger bound-1200.0 Ma)	ectasian
ectasian3	Ectasian 3 *	Ectasian 3 * (older bound-1270.0 Ma, younger bound-1250.0 Ma)	ectasian
ectasian2	Ectasian 2 *	Ectasian 2 * (older bound-1360.0 Ma, younger bound-1270.0 Ma)	ectasian
ectasian1	Ectasian 1 *	Ectasian 1 * (older bound-1400.0 Ma, younger bound-1360.0 Ma)	ectasian
calymmian	Calymmian	Calymmian (older bound-1600.0 Ma, younger bound-1400.0 Ma)	mesoproterozoic
calymmian4	Calymmian 4 *	Calymmian 4 * (older bound-1440.0 Ma, younger bound-1400.0 Ma)	calymmian

Value	Name	Definition	Parent
calymmian3	Calymmian 3 *	Calymmian 3 * (older bound-1470.0 Ma, younger bound-1440.0 Ma)	calymmian
calymmian2	Calymmian 2 *	Calymmian 2 * (older bound-1520.0 Ma, younger bound-1470.0 Ma)	calymmian
calymmian1	Calymmian 1 *	Calymmian 1 * (older bound-1600.0 Ma, younger bound-1520.0 Ma)	calymmian
paleoproterozoic	Paleoproterozoic	Paleoproterozoic (older bound-2500.0 Ma, younger bound-1600.0 Ma)	proterozoic
statherian	Statherian	Statherian (older bound-1800.0 Ma, younger bound-1600.0 Ma)	paleoproterozoic
statherian4	Statherian 4 *	Statherian 4 * (older bound-1660.0 Ma, younger bound-1600.0 Ma)	statherian
statherian3	Statherian 3 *	Statherian 3 * (older bound-1740.0 Ma, younger bound-1660.0 Ma)	statherian
statherian2	Statherian 2 *	Statherian 2 * (older bound-1770.0 Ma, younger bound-1740.0 Ma)	statherian
statherian1	Statherian 1 *	Statherian 1 * (older bound-1800.0 Ma, younger bound-1770.0 Ma)	statherian
orosirian	Orosirian	Orosirian (older bound-2050.0 Ma, younger bound-1800.0 Ma)	paleoproterozoic
orosirian7	Orosirian 7 *	Orosirian 7 * (older bound-1820.0 Ma, younger bound-1800.0 Ma)	orosirian
orosirian6	Orosirian 6 *	Orosirian 6 * (older bound-1840.0 Ma, younger bound-1820.0 Ma)	orosirian
orosirian5	Orosirian 5 *	Orosirian 5 * (older bound-1870.0 Ma, younger bound-1840.0 Ma)	orosirian
orosirian4	Orosirian 4 *	Orosirian 4 * (older bound-1880.0 Ma, younger bound-1870.0 Ma)	orosirian
orosirian3	Orosirian 3 *	Orosirian 3 * (older bound-1920.0 Ma, younger bound-1880.0 Ma)	orosirian
orosirian2	Orosirian 2 *	Orosirian 2 * (older bound-1960.0 Ma, younger bound-1920.0 Ma)	orosirian
orosirian1	Orosirian 1 *	Orosirian 1 * (older bound-2050.0 Ma, younger bound-1960.0 Ma)	orosirian
rhyacian	Rhyacian	Rhyacian (older bound-2300.0 Ma, younger bound-2050.0 Ma)	paleoproterozoic

Value	Name	Definition	Parent
siderian	Siderian	Siderian (older bound-2500.0 Ma, younger bound-2300.0 Ma)	paleoproterozoic
siderian2	Siderian 2 *	Siderian 2 * (older bound-2400.0 Ma, younger bound-2300.0 Ma)	siderian
siderian1	Siderian 1 *	Siderian 1 * (older bound-2500.0 Ma, younger bound-2400.0 Ma)	siderian
archean	Archean	Archean (older bound-4000.0 Ma, younger bound-2500.0 Ma)	precambrian
neoarchean	Neoarchean	Neoarchean (older bound-2800.0 Ma, younger bound-2500.0 Ma)	archean
neoarchean2	Neoarchean 2 *	Neoarchean 2 * (older bound-2650.0 Ma, younger bound-2500.0 Ma)	neoarchean
neoarchean1	Neoarchean 1 *	Neoarchean 1 * (older bound-2800.0 Ma, younger bound-2650.0 Ma)	neoarchean
mesoarchean	Mesoarchean	Mesoarchean (older bound-3200.0 Ma, younger bound-2800.0 Ma)	archean
paleoarchean	Paleoarchean	Paleoarchean (older bound-3600.0 Ma, younger bound-3200.0 Ma)	archean
eoarchean	Eoarchean	Eoarchean (older bound-4000.0 Ma, younger bound-3600.0 Ma)	archean
hadean	Hadean (informal)	Hadean (informal Ma) (older bound-4600.0 Ma, younger bound-4000.0 Ma)	precambrian

1.1.10 Values of code list GeologicUnitTypeValue

Value	Name	Definition	Parent
allostratigraphicUnit	allostratigraphic unit	Geologic unit defined by bounding surfaces. Not necessarily stratified. Donovon (2004, IUGS abstract Florence) makes good case for use of a noncommittal term for the bounding surface. “While there may be no agreement that a given stratal boundary is a discontinuity, there is consensus that all the identified boundaries are stratal surfaces.” Includes: 1. Unconformity bounded units (Salvador 1994), defined by bounding stratigraphic discontinuities ('significant unconformities'; unconformity is defined as surface of erosion in Salvador 1994). 2.	geologicunit

Value	Name	Definition	Parent
		Sequence stratigraphic unit, an allostratigraphic unit that is used to interpret the depositional origin of sedimentary strata and assumes, though this is not always stated, an implicit connection to base level change. It does this by establishing how the sequence of strata accumulated in order in the sedimentary section over a subdividing framework of surfaces.	
alterationUnit	alteration unit	Geologic unit defined by alteration process.	geologicunit
artificialGround	artificial ground	Geologic unit defined by genesis involving direct human action to deposit or modify material.	lithogeneticunit
biostratigraphicUnit	biostratigraphic unit	Geologic unit defined based on fossil content. Five kinds of biozones are recognized by the revised NACSN (Lenz et al., 2000, Note 64, a recommended complete replacement of Articles 48 through 54 of the North American Stratigraphic Code (NACSN, 1983) accepted for publication 2000.): range biozone, interval biozone, lineage biozone, assemblage biozone, and abundance biozone. These represent different approaches to defining and recognizing biozones.	geologicunit
chronostratigraphicUnit	chronostratigraphic unit	Geologic unit that includes all rocks formed during a specific interval of geologic time	geologicunit
deformationUnit	deformation unit	Lithotectonic unit defined by deformation style or characteristic geologic structure observable in outcrop.	lithotectonicunit
excavationUnit	excavation unit	Geologic unit defined by human-made genesis involving excavation. Not necessarily defined by landform (a hole...), as they could have been subsequently filled/landscaped etc. If the excavation is filled becomes an excavation with artificial ground wholly or partly superimposed on it. This sort of thing can become quite important in urban geology where an excavation can be filled and landscaped.	lithogeneticunit
geologicUnit	geologic unit	Type of geologic unit is unknown, unspecified, irrelevant, or some type not included in the vocabulary. Type makes no implication for required properties or	

Value	Name	Definition	Parent
		cardinalities. This is the root concept for the type hierarchy.	
geomorphologicUnit	geomorphologic unit	Geologic unit defined by surface landform, e.g. hummocky moraine	geologicunit
geophysicalUnit	geophysical unit	Geologic unit defined by its geophysical characteristics. Denotes that the properties used to define the unit are measured by intrumental techniques, not directly observable by humans, e.g. density, magnetic susceptibility, magnetization, electrical conductivity.	geologicunit
lithodemicUnit	lithodemic unit	Lithostratigraphic unit that lacks stratification	lithostratigraphicunit
lithogeneticUnit	lithogenetic unit	Geologic unit defined by genesis. The genesis is manifested by material properties, but the material is not the defining property. Example-- alluvial deposits, glacial deposits.	geologicunit
lithologicUnit	lithologic unit	Geologic unit defined by lithology independent of relationships to other units. Denotes a \'kind\' of rock body characterized by lithology, e.g. basaltic rocks.	geologicunit
lithostratigraphicUnit	lithostratigraphic unit	Geologic unit defined on the basis of observable and distinctive lithologic properties or combination of lithologic properties and stratigraphic relationships. Denotes a particular body of rock.	geologicunit
lithotectonicUnit	lithotectonic unit	Geologic unit defined defined on basis of structural or deformation features, mutual relations, origin or historical evolution. Contained material may be igneous, sedimentary, or metamorphic.	geologicunit
magnetostratigraphicUnit	magnetostratigraphic unit	Geologic unit defined by magnetic characteristics.	geophysicalunit
massMovementUnit	mass movement unit	Geologic unit produced by gravity driven, down-slope displacemnt of material, and characterized by the type of movement giving rise to the deposit, and by how the individual movement types present in the deposit are related in time and space.	lithogeneticunit
pedostratigraphicUnit	pedostratigraphic unit	Geologic unit that represents a single pedologic horizon in a sequence of strata (consolidated or non-consolidated). The	geologicunit

Value	Name	Definition	Parent
		presence of an overlying geologic unit is required, but locally the soil horizon may be at the Earth surface (in which case is may be coincident with a Pedoderm). See discussion at https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/PedostratigraphicUnit	
polarityChronostratigraphicUnit	polarity chronostratigraphic unit	Geologic unit defined by primary magnetic-polarity record imposed whien the rock was deposited or crystallized during a specific interval of geolgoic time. Kind of chronostratigraphic unit and kind of geophysical unit.	geologicunit

1.1.11 Values of code list GeomorphologicActivityValue

Value	Name	Definition
active	active	A geomorphologic process that is currently in a state of action, or that has been reactivated since a conventionally short period of time
dormant	dormant	A geomorphologic process that has not showed signs of activity since a conventionally short period of time, and that could be reactivated by their original causes, or by triggered by induced causes (as anthropogenic activites).
reactivated	reactivated	A reactivated geomorphologic process is an active geomorphologic process which has been dormant.
stabilised	stabilised	A stabilised geomorphologic process is an inactive process which has been protected from its original causes by remedial measures (i.e. a stabilised landslide)
inactive	inactive	A relict or fossil geomorphologic process

1.1.12 Values of code list LithologyValue

Value	Name	Definition	Parent
acidicIgneousMaterial	acidic igneous material	Igneous material with more than 63 percent SiO2.	igneousmaterial
acidicIgneousRock	acidic	Igneous rock with more than 63 percent	acidicigneousmater

Value	Name	Definition	Parent
	igneous rock	SiO2.	ial
alkaliFeldsparGranite	alkali feldspar granite	Granitic rock that has a plagioclase to total feldspar ratio less than 0.1. QAPF field 2.	granitoid
alkaliFeldsparRhyolite	alkali feldspar rhyolite	Rhyolitoid in which the ratio of plagioclase to total feldspar is less than 0.1. QAPF field 2.	rhyolitoid
alkaliFeldsparSyenite	alkali feldspar syenite	Alkali feldspar syenitic rock that contains 0-5 percent quartz and no feldspathoid in the QAPF fraction. QAPF field 6.	alkalifeldsparsyeniticrock
alkaliFeldsparSyeniticRock	alkali feldspar syenitic rock	Syenitoid with a plagioclase to total feldspar ratio of less than 0.1. QAPF fields 6, 6*, and 6'.	syenitoid
alkaliFeldsparTrachyte	alkali feldspar trachyte	Trachytoid that has a plagioclase to total feldspar ratio less than 0.1, between 0 and 5 percent quartz in the QAPF fraction, and no feldspathoid minerals. QAPF field 6.	alkalifeldspartrachyticrock
alkaliFeldsparTrachyticRock	alkali feldspar trachytic rock	Trachytoid that has a plagioclase to total feldspar ratio less than 0.1. QAPF fields 6, 6', and 6*.	trachytoid
alkaliOlivineBasalt	alkali olivine basalt	Alkali olivine basalt is silica-undersaturated, characterized by the absence of orthopyroxene, absence of quartz, presence of olivine, and typically contains some feldspathoid mineral, alkali feldspar or phlogopite in the groundmass. Feldspar phenocrysts typically are labradorite to andesine in composition. Augite is rich in titanium compared to augite in tholeiitic basalt. Alkali olivine basalt is relatively rich in sodium.	basalt
amphibolite	amphibolite	Metamorphic rock mainly consisting of green, brown or black amphibole and plagioclase (including albite), which combined form 75 percent or more of the rock, and both of which are present as major constituents. The amphibole constitutes 50 percent or more of the total mafic constituents and is present in an amount of 30 percent or more; other common minerals include quartz, clinopyroxene, garnet, epidote-group minerals, biotite, titanite and scapolite.	metamorphicrock

Value	Name	Definition	Parent
andesite	andesite	Fine-grained igneous rock with less than 20 percent quartz and less than 10 percent feldspathoid minerals in the QAPF fraction, in which the ratio of plagioclase to total feldspar is greater 0.65. Includes rocks defined modally in QAPF fields 9 and 10 or chemically in TAS field O2 as andesite. Basalt and andesite, which share the same QAPF fields, are distinguished chemically based on silica content, with basalt defined to contain less than 52 weight percent silica. If chemical data are not available, the color index is used to distinguish the categories, with basalt defined to contain greater than 35 percent mafic minerals by volume or greater than 40 percent mafic minerals by weight. Typically consists of plagioclase (frequently zoned from labradorite to oligoclase), pyroxene, hornblende and/or biotite. Fine grained equivalent of dioritic rock.	finegrainedigneous rock
anorthosite	anorthosite	Anorthositic rock that contains between 0 and 5 percent quartz and no feldspathoid mineral in the QAPF fraction. QAPF field 10.	anorthositicrock
anorthositicRock	anorthositic rock	Leucocratic phaneritic crystalline igneous rock consisting essentially of plagioclase, often with small amounts of pyroxene. By definition, colour index M is less than 10, and plagiclase to total feldspar ratio is greater than 0.9. Less than 20 percent quartz and less than 10 percent feldspathoid in the QAPF fraction. QAPF field 10, 10*, and 10'.	phaneriticigneousr ock
anthrazit	anthrazit	Coal that has vitrinite mean random reflectance greater than 2.0% (determined in conformance with ISO 7404-5). Less than 12-14 percent volatiles (dry, ash free), greater than 91 percent fixed carbon (dry, ash free basis). The highest rank coal; very hard, glossy, black, with semimetallic luster, semi conchoidal fracture.	kohle
anthropogenicConsolidatedMaterial	anthropogenic consolidated material	Consolidated material known to have artificial (human-related) origin.	anthropogenicmaterial
anthropogenicMaterial	anthropogenic material	Material known to have artificial (human-related) origin; insufficient information to	compoundmaterial

Value	Name	Definition	Parent
		classify in more detail.	
anthropogenicUnconsolidatedMaterial	anthropogenic unconsolidated material	Unconsolidated material known to have artificial (human-related) origin.	anthropogenicmaterial
aphanite	aphanite	Rock that is too fine grained to categorize in more detail.	rock
aplite	aplite	Light coloured crystalline rock, characterized by a fine grained allotriomorphic-granular (aplitic, saccharoidal or xenomorphic) texture; typically granitic composition, consisting of quartz, alkali feldspar and sodic plagioclase.	phaneriticigneousrock
arenit	arenit	Clastic sandstone that contains less than 10 percent matrix. Matrix is mud-size silicate minerals (clay, feldspar, quartz, rock fragments, and alteration products) of detrital or diagenetic nature.	sandstone
ashAndLapilli	ash and lapilli	Tephra in which less than 25 percent of fragments are greater than 64 mm in longest dimension	tephra
ashBreccia,Bomb,OrBlockTephra	ash breccia, bomb, or block tephra	Tephra in which more than 25 percent of particles are greater than 64 mm in largest dimension. Includes ash breccia, bomb tephra and block tephra of Gillespie and Styles (1999)	tephra
ashTuff,Lapillistone,AndLapilliTuff	ash tuff, lapillistone, and lapilli tuff	Pyroclastic rock in which less than 25 percent of rock by volume are more than 64 mm in longest diameter. Includes tuff, lapilli tuff, and lapillistone.	pyroclasticrock
basalt	basalt	Fine-grained or porphyritic igneous rock with less than 20 percent quartz, and less than 10 percent feldspathoid minerals, in which the ratio of plagioclase to total feldspar is greater 0.65. Typically composed of calcic plagioclase and clinopyroxene; phenocrysts typically include one or more of calcic plagioclase, clinopyroxene, orthopyroxene, and olivine. Includes rocks defined modally in QAPF fields 9 and 10 or chemically in TAS field B as basalt. Basalt and andesite are distinguished chemically based on silica content, with basalt defined to contain less than 52 weight percent silica. If chemical data are not available, the color index is used to	basicigneousrock

Value	Name	Definition	Parent
		distinguish the categories, with basalt defined to contain greater than 35 percent mafic minerals by volume or greater than 40 percent mafic minerals by weight.	
basanite	basanite	Tephritoid that has a plagioclase to total feldspar ratio greater than 0.9, and contains more than 10 percent normative (CIPW) olivine.	tephritoid
basaniticFoidite	basanitic foidite	Foiditoid that contains less than 90 percent feldspathoid minerals in the QAPF fraction, and has a plagioclase to total feldspar ratio that is greater than 0.5, with greater than 10 percent normative olivine.	foiditoid
basicIgneousMaterial	basic igneous material	Igneous material with between 45 and 52 percent SiO2.	igneousmaterial
basicIgneousRock	basic igneous rock	Igneous rock with between 45 and 52 percent SiO2.	basicigneousmaterial
bauxite	bauxite	Highly aluminous material containing abundant aluminium hydroxides (gibbsite, less commonly boehmite, diaspore) and aluminium-substituted iron oxides or hydroxides and generally minor or negligible kaolin minerals; may contain up to 20 percent quartz. Commonly has a pisolitic or nodular texture, and may be cemented.	materialformedinsurficialenvironment
biogenicSediment	biogenic sediment	Sediment composed of greater than 50 percent material of biogenic origin. Because the biogenic material may be skeletal remains that are not organic, all biogenic sediment is not necessarily organic-rich.	sediment
biogenicSilicaSedimentaryRock	biogenic silica sedimentary rock	Sedimentary rock that consists of at least 50 percent silicate mineral material, deposited directly by biological processes at the depositional surface, or in particles formed by biological processes within the basin of deposition.	nonclasticsiliceous sedimentaryrock
bitumen	bitumen	A composite material composed primarily of bitumen and mineral aggregates, e.g. gravel	
bituminousCoal	bituminous coal	Coal that has vitrinite mean random reflectance greater than 0.6% and less than 2.0% (determined in conformance with ISO 7404-5), or has a gross calorific value greater	kohle

Value	**Name**	**Definition**	**Parent**
		than 24 MJ/kg (determined in conformance with ISO 1928). Hard, black, organic rich sedimentary rock; contains less than 91 percent fixed carbon on a dry, mineral-matter-free basis, and greater than 13-14 percent volatiles (dry, ash free). Formed from the compaction or induration of variously altered plant remains similar to those of peaty deposits.	
boninite	boninite	andesitic rock that contains more than 8 percent MgO. Typically consists of phenocrysts of protoenstatite, orthopyroxene, clinopyroxene, and olivine in a glassy base full of crystallites, and exhibits textures characterisitc of rapid crystal growth.	andesite
boulderGravelSize Sediment	boulder gravel size sediment	Sediment containing greater than 30 percent boulder-size particles (greater than 256 mm in diameter)	gravelsizesediment
boundstone	boundstone	Sedimentary carbonate rock with preserved biogenic texture, whose original components were bound and encrusted together during deposition by the action of plants and animals during deposition, and remained substantially in the position of growth.	carbonatesediment aryrock
breccia	breccia	Coarse-grained material composed of angular broken rock fragments; the fragments typically have sharp edges and unworn corners. The fragments may be held together by a mineral cement or in a fine-grained matrix, and consolidated or nonconsolidated. Clasts may be of any composition or origin. In sedimentary environments, breccia is used for material that consists entirely of angular fragments, mostly derived from a single source rock body, as in a rock avalanche deposit, and matrix is interpreted to be the product of comminution of clasts during transport. Diamictite or diamicton is used when the material reflects mixing of rock from a variety of sources, some sub angular or subrounded clasts may be present, and matrix is pre-existing fine grained material that is not a direct product of the brecciation/deposition process.	compoundmaterial
brecciaGougeSeri	breccia-	Fault material with features such as void spaces (filled or unfilled), or unconsolidated	faultrelatedmaterial

Value	**Name**	**Definition**	**Parent**
es	gouge series	matrix material between fragments, indicating loss of cohesion during deformation. Includes fault-related breccia and gouge.	
buildingRubble	building rubble	Material of various size originating from broken down buildings or former road coatings	
calcareousCarbonateSediment	calcareous carbonate sediment	Carbonate sediment with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1. Includes lime-sediments.	calcareouscarbonatesedimentarymaterial
calcareousCarbonateSedimentaryMaterial	calcareous carbonate sedimentary material	Carbonate sedimentary material of unspecified consolidation state with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1. Includes lime-sediments, limestone and dolomitic limestone.	carbonatesedimentarymaterial
calcareousCarbonateSedimentaryRock	calcareous carbonate sedimentary rock	Carbonate sedimentary rock with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1. Includes limestone and dolomitic limestone.	calcareouscarbonatesedimentarymaterial
carbonateMud	carbonate mud	Carbonate sediment composed of less than 25 percent clasts that have a maximum diameter more than 2 mm, and the ratio of sand size to mud size clasts is less than one.	carbonatesediment
carbonateMudstone	carbonate mudstone	Mudstone that consists of greater than 50 percent carbonate minerals of any origin in the mud size fraction.	carbonatesedimentaryrock
carbonateOoze	carbonate ooze	ooze that consists of more than 50 percent carbonate skeletal remains	carbonatemud
carbonateRichMud	carbonate rich mud	Mud size sediment that contains between 10 and 50 percent carbonate minerals in any size fraction. Carbonate origin is not specified.	mudsizesediment
carbonateRichMudstone	carbonate rich mudstone	Mudstone that contains between 10 and 50 percent carbonate minerals in the mud size fraction. Carbonate origin is not specified.	genericmudstone
carbonateSediment	carbonate sediment	Sediment in which at least 50 percent of the primary and/or recrystallized constituents are composed of one (or more) of the carbonate minerals calcite, aragonite and dolomite, in particles of intrabasinal origin.	carbonatesedimentarymaterial
carbonateSedimen	carbonate sedimentary	Sedimentary material in which at least 50 percent of the primary and/or recrystallized	sedimentarymateri

Value	Name	Definition	Parent
taryMaterial	material	constituents are composed of one (or more) of the carbonate minerals calcite, aragonite and dolomite, in particles of intrabasinal origin.	al
carbonateSedimentaryRock	carbonate sedimentary rock	Sedimentary rock in which at least 50 percent of the primary and/or recrystallized constituents are composed of one (or more) of the carbonate minerals calcite, aragonite, magnesite or dolomite.	carbonatesedimentarymaterial
carbonateWackestone	carbonate wackestone	Carbonate sedimentary rock with discernible mud supported depositional texture and containing greater than 10 percent allochems, and constituent particles are of intrabasinal origin. If particles are not intrabasinal, categorization as a mudstone or wackestone should be considered.	carbonatesedimentaryrock
carbonatite	carbonatite	Igneous rock composed of more than 50 percent modal carbonate minerals.	exoticcompositionigneousrock
cataclasiteSeries	cataclasite series	Fault-related rock that maintained primary cohesion during deformation, with matrix comprising greater than 10 percent of rock mass; matrix is fine-grained material formed through grain size reduction by fracture as opposed to crystal plastic process that operate in mylonitic rock. Includes cataclasite, protocataclasite and ultracataclasite.	compositegenesisrock
chalk	chalk	A generally soft, white, very fine-grained, extremely pure, porous limestone. It forms under marine conditions from the gradual accumulation of skeletal elements from minute planktonic green algae (cocoliths), associated with varying proportions of larger microscopic fragments of bivalves, foraminifera and ostracods. It is common to find flint and chert nodules embedded in chalk.	limestone
chemicalSedimentaryMaterial	chemical sedimentary material	Sedimentary material that consists of at least 50 percent material produced by inorganic chemical processes within the basin of deposition. Includes inorganic siliceous, carbonate, evaporite, iron-rich, and phosphatic sediment classes.	sedimentarymaterial
chloriteActinoliteEp	chlorite	Metamorphic rock characterized by 50	metamorphicrock

Value	Name	Definition	Parent
idoteMetamorphic Rock	actinolite epidote metamorphic rock	percent or more of combined chlorite, actinolite and epidote. Category for rocks generally named greenschist or greenstone.	
clasticSediment	clastic sediment	Sediment in which at least 50 percent of the constituent particles were derived from erosion, weathering, or mass-wasting of pre-existing earth materials, and transported to the place of deposition by mechanical agents such as water, wind, ice and gravity.	clasticsedimentary material
clasticSedimentary Material	clastic sedimentary material	Sedimentary material of unspecified consolidation state in which at least 50 percent of the constituent particles were derived from erosion, weathering, or mass-wasting of pre-existing earth materials, and transported to the place of deposition by mechanical agents such as water, wind, ice and gravity.	sedimentarymateri al
clasticSedimentary Rock	clastic sedimentary rock	Sedimentary rock in which at least 50 percent of the constituent particles were derived from erosion, weathering, or mass-wasting of pre-existing earth materials, and transported to the place of deposition by mechanical agents such as water, wind, ice and gravity.	clasticsedimentary material
clay	clay	Mud that consists of greater than 50 percent particles with grain size less than 0.004 mm	mud
claystone	claystone	Mudstone that contains no detectable silt, inferred to consist virtually entirely of clay-size particles.	mudstone
cobbleGravelSizeS ediment	cobble gravel size sediment	Sediment containing greater than 30 percent cobble-size particles (64-256 mm in diameter)	gravelsizesediment
compositeGenesis Material	composite genesis material	Material of unspecified consolidation state formed by geological modification of pre-existing materials outside the realm of igneous and sedimentary processes. Includes rocks formed by impact metamorphism, standard dynamothermal metamorphism, brittle deformation, weathering, metasomatism and hydrothermal alteration (diagenesis is a sedimentary process in this context).	compoundmaterial
compositeGenesis	composite	Rock formed by geological modification of pre-existing rocks outside the realm of	compositegenesis

Value	Name	Definition	Parent
Rock	genesis rock	igneous and sedimentary processes. Includes rocks formed by impact metamorphism, standard dynamothermal metamorphism, brittle deformation, weathering, metasomatism and hydrothermal alteration (diagenesis is a sedimentary process in this context).	material
compoundMaterial	compound material	An Earth Material composed of an aggregation of particles of Earth Material, possibly including other Compound Materials. This is 'top' of lithology category hierarchy, and should be used to indicate 'any rock or unconsolidated material'.	
concrete	concrete	Hardening composite construction material composed primarily of coarse gravel, cement and water	
conglomerate	conglomerate	Clastic sedimentary rock composed of at least 30 percent rounded to subangular fragments larger than 2 mm in diameter; typically contains finer grained material in interstices between larger fragments. If more than 15 percent of the fine grained matrix is of indeterminant clastic or diagenetic origin and the fabric is matrix supported, may also be categorized as wackestone. If rock has unsorted or poorly sorted texture with a wide range of particle sizes, may also be categorized as diamictite.	clasticsedimentaryrock
crystallineCarbonate	crystalline carbonate	Carbonate rock of indeterminate mineralogy in which diagenetic processes have obliterated any original depositional texture.	carbonatesedimentaryrock
dacite	dacite	Fine grained or porphyritic crystalline rock that contains less than 90 percent mafic minerals, between 20 and 60 percent quartz in the QAPF fraction, and has a plagioclase to total feldspar ratio greater than 0.65. Includes rocks defined modally in QAPF fields 4 and 5 or chemically in TAS Field O3. Typcially composed of quartz and sodic plagioclase with minor amounts of biotite and/or hornblende and/or pyroxene; fine-grained equivalent of granodiorite and tonalite.	acidicigneousrock
diamictite	diamictite	Unsorted or poorly sorted, clastic sedimentary rock with a wide range of particle	clasticsedimentaryr

Value	**Name**	**Definition**	**Parent**
		sizes including a muddy matrix. Biogenic materials that have such texture are excluded. Distinguished from conglomerate, sandstone, mudstone based on polymodality and lack of structures related to transport and deposition of sediment by moving air or water. If more than 10 percent of the fine grained matrix is of indeterminant clastic or diagenetic origin and the fabric is matrix supported, may also be categorized as wacke.	ock
diamicton	diamicton	Unsorted or poorly sorted, clastic sediment with a wide range of particle sizes, including a muddy matrix. Biogenic materials that have such texture are excluded. Distinguished from conglomerate, sandstone, mudstone based on polymodality and lack of structures related to transport and deposition of sediment by moving air or water. Assignment to an other size class can be used in conjunction to indicate the dominant grain size.	clasticsediment
diorite	diorite	Phaneritic crystalline rock consisting of intermediate plagioclase, commonly with hornblende and often with biotite or augite; colour index M less than 90, sodic plagioclase (An0-An50), no feldspathoid, and between 0 and 5 percent quartz. Includes rocks defined modally in QAPF field 10 as diorite.	dioriticrock
dioriticRock	dioritic rock	Phaneritic crystalline rock with M less than 90, consisting of intermediate plagioclase, commonly with hornblende and often with biotite or augite. A dioritoid with a plagioclase to total feldspar ratio (in the QAPF fraction) greater than 0.9. Includes rocks defined modally in QAPF fields 10, 10' and 10*.	dioritoid
dioritoid	dioritoid	Phaneritic crystalline igneous rock with M less than 90, consisting of intermediate plagioclase, commonly with hornblende and often with biotite or augite. Plagioclase to total feldspar ratio is greater that 0.65, and anorthite content of plagioclase is less than 50 percent. Less than 10 percent feldspathoid mineral and less than 20 percent quartz in the QAPF fraction. Includes rocks defined modally in QAPF fields 9 and 10 (and their	intermediatecompositionigneousrock

Value	Name	Definition	Parent
		subdivisions).	
doleriticRock	doleritic rock	Dark colored gabbroic (basaltic) or dioritic (andesitic) rock intermediate in grain size between basalt and gabbro and composed of plagioclase, pyroxene and opaque minerals; often with ophitic texture. Typically occurs as hypabyssal intrusions. Includes dolerite, microdiorite, diabase and microgabbro.	igneousrock
dolomite	dolomite	Pure carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1.	dolomiticormagnesiansedimentaryrock
dolomiticOrMagnesianSedimentaryMaterial	dolomitic or magnesian sedimentary material	Carbonate sedimentary material of unspecified consolidation degree with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1. Includes dolomite sediment, dolostone, lime dolostone and magnesite-stone.	carbonatesedimentarymaterial
dolomiticOrMagnesianSedimentaryRock	dolomitic or magnesian sedimentary rock	Carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1. Includes dolostone, lime dolostone and magnesite-stone.	carbonatesedimentaryrock
dolomiticSediment	dolomitic sediment	Carbonate sediment with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1.	carbonatesediment
duricrust	duricrust	Rock forming a hard crust or layer at or near the Earth's surface at the time of formation, e.g. in the upper horizons of a soil, characterized by structures indicative of pedogenic origin.	compositegenesisrock
eclogite	eclogite	Metamorphic rock composed of 75 percent or more (by volume) omphacite and garnet, both of which are present as major constituents, the amount of neither of them being higher than 75 percent (by volume); the presence of plagioclase precludes classification as an eclogite.	metamorphicrock
evaporite	evaporite	Nonclastic sedimentary rock composed of at least 50 percent non-carbonate salts, including chloride, sulfate or borate minerals; formed through precipitation of mineral salts from a saline solution (non-carbonate salt rock).	chemicalsedimentarymaterial

Value	Name	Definition	Parent
exoticAlkalineRock	exotic alkaline rock	Kimberlite, lamproite, or lamprophyre. Generally are potassic, mafic or ultramafic rocks. Olivine (commonly serpentinized in kimberlite), and phlogopite are significant constituents.	exoticcompositionigneousrock
exoticCompositionIgneousRock	exotic composition igneous rock	Rock with 'exotic' mineralogical, textural or field setting characteristics; typically dark colored, with abundant phenocrysts. Criteria include: presence of greater than 10 percent melilite or leucite, or presence of kalsilite, or greater than 50 percent carbonate minerals. Includes Carbonatite, Melilitic rock, Kalsilitic rocks, Kimberlite, Lamproite, Leucitic rock and Lamprophyres.	igneousrock
exoticEvaporite	exotic evaporite	Evaporite that is not 50 percent halite or 50 percent gypsum or anhydrite.	evaporite
faultRelatedMaterial	fault-related material	Material formed as a result brittle faulting, composed of greater than 10 percent matrix; matrix is fine-grained material caused by tectonic grainsize reduction. Includes cohesive (cataclasite series) and non-cohesive (breccia-gouge series) material.	compositegenesismaterial
fineGrainedIgneousRock	fine grained igneous rock	Igneous rock in which the framework of the rock consists of crystals that are too small to determine mineralogy with the unaided eye; framework may include up to 50 percent glass. A significant percentage of the rock by volume may be phenocrysts. Includes rocks that are generally called volcanic rocks.	igneousrock
foidBearingAlkaliFeldsparSyenite	foid bearing alkali feldspar syenite	Alkali feldspar syenitic rock that contains 0-10 percent feldspathoid mineral and no quartz in the QAPF fraction. QAPF field 6'.	alkalifeldsparsyeniticrock
foidBearingAlkaliFeldsparTrachyte	foid bearing alkali feldspar trachyte	Alkali feldspar trachytic rock that contains no quartz and between 0 and 10 percent feldspathoid mineral in the QAPF fraction. QAPF field 6'.	alkalifeldspartrachyticrock
foidBearingAnorthosite	foid bearing anorthosite	Anorthositic rock that contains between 0 and 10 percent feldspathoid mineral and no quartz in the QAPF fraction. QAPF field 10'.	anorthositicrock
foidBearingDiorite	foid bearing diorite	Dioritic rock that contains between 0 and 10 percent feldspathoid minerals in the QAPF fraction. QAPF field 10'.	dioriticrock

Value	**Name**	**Definition**	**Parent**
foidBearingGabbro	foid bearing gabbro	Gabbroic rock that contains 0-10 percent feldspathoid minerals and no quartz in the QAPF fraction. QAPF field 10'.	gabbroicrock
foidBearingLatite	foid bearing latite	Latitic rock that contains no quartz and between 0 and 10 percent feldspathoid minerals in the QAPF fraction. QAPF field 8'.	latiticrock
foidBearingMonzodiorite	foid bearing monzodiorite	Monzodioritic rock that contains between 0 and 10 percent feldspathoid mineral.	monzodioriticrock
foidBearingMonzogabbro	foid bearing monzogabbro	Monzogabbroic rock that contains 0 to 10 percent feldspathoid mineral in the QAPF fraction. QAPF field 9'.	monzogabbroicrock
foidBearingMonzonite	foid bearing monzonite	Monzonitic rock that contains 0-10 percent feldspathoid mineral and no quartz in the QAPF fraction. Includes rocks defined modally in QAPF Field 8'.	monzoniticrock
foidBearingSyenite	foid bearing syenite	Syenitic rock that contains between 0 and 10 percent feldspathoid mineral and no quartz in the QAPF fraction. Defined modally in QAPF Field 7'.	syeniticrock
foidBearingTrachyte	foid bearing trachyte	Trachytic rock that contains between 0 and 10 percent feldspathoid in the QAPF fraction, and no quartz. QAPF field 7'.	trachyticrock
foidDiorite	foid diorite	Foid dioritoid in which the plagioclase to total feldspar ratio is greater than 0.9. Includes rocks defined modally in QAPF field 14.	foiddioritoid
foidDioritoid	foid dioritoid	Phaneritic crystalline igneous rock in which M is less than 90, the plagioclase to total feldspar ratio is greater than 0.5, feldspathoid minerals form 10-60 percent of the QAPF fraction, plagioclase has anorthite content less than 50 percent. These rocks typically contain large amounts of mafic minerals. Includes rocks defined modally in QAPF fields 13 and 14.	phaneriticigneousrock
foidGabbro	foid gabbro	Foid gabbroid that has a plagioclase to total feldspar ratio greater than 0.9. Includes rocks defined modally in QAPF field 14.	foidgabbroid
foidGabbroid	foid gabbroid	Phaneritic crystalline igneous rock in which M is less than 90, the plagioclase to total feldspar ratio is greater than 0.5, feldspathoids form 10-60 percent of the QAPF fraction, and plagioclase has anorthite	phaneriticigneousrock

Value	Name	Definition	Parent
		content greater than 50 percent. These rocks typically contain large amounts of mafic minerals. Includes rocks defined modally in QAPF fields 13 and 14.	
foidMonzodiorite	foid monzodiorite	Foid dioritoid in which the plagioclase to total feldspar ratio is between 0.1 and 0.9. Includes rocks defined modally in QAPF field 13.	foiddioritoid
foidMonzogabbro	foid monzogabbro	Foid gabbroid that has a plagioclase to total feldspar ratio between 0.5 and 0.9. Includes rocks defined modally in QAPF field 13.	foidgabbroid
foidMonzosyenite	foid monzosyenite	Foid syenitoid rock that has a plagioclase to total feldspar ratio of between 0.1 and 0.5. Includes rocks defined modally in QAPF Field 12.	foidsyenitoid
foidSyenite	foid syenite	Foid syenitoid that has a plagioclase to total feldspar ratio of less than 0.1. Includes rocks defined modally in QAPF field 11.	foidsyenitoid
foidSyenitoid	foid syenitoid	Phaneritic crystalline igneous rock with M less than 90, contains between 10 and 60 percent feldspathoid mineral in the QAPF fraction, and has a plagioclase to total feldspar ratio less than 0.5. Includes QAPF fields 11 and 12.	phaneriticigneousrock
foidite	foidite	Foiditoid that contains greater than 90 percent feldspathoid minerals in the QAPF fraction.	foiditoid
foiditoid	foiditoid	Fine grained crystalline rock containing less than 90 percent mafic minerals and more than 60 percent feldspathoid minerals in the QAPF fraction. Includes rocks defined modally in QAPF field 15 or chemically in TAS field F.	finegrainedigneous rock
foidolite	foidolite	Phaneritic crystalline rock containing more than 60 percent feldspathoid minerals in the QAPF fraction. Includes rocks defined modally in QAPF field 15	phaneriticigneousrock
foliatedMetamorphicRock	foliated metamorphic rock	Metamorphic rock in which 10 percent or more of the contained mineral grains are elements in a planar or linear fabric. Cataclastic or glassy character precludes classification with this concept.	metamorphicrock

Value	Name	Definition	Parent
fragmentalIgneousMaterial	fragmental igneous material	igneous_material of unspecified consolidation state in which greater than 75 percent of the rock consists of fragments produced as a result of igneous rock-forming process.	igneousmaterial
fragmentalIgneousRock	fragmental igneous rock	Igneous rock in which greater than 75 percent of the rock consists of fragments produced as a result of igneous rock-forming process. Includes pyroclastic rocks, autobreccia associated with lava flows and intrusive breccias. Excludes deposits reworked by epiclastic processes (see Tuffite)	fragmentaligneousmaterial
framestone	framestone	Carbonate reef rock consisting of a rigid framework of colonies, shells or skeletons, with internal cavities filled with fine sediment; usually created through the activities of colonial organisms.	carbonatesedimentaryrock
gabbro	gabbro	Gabbroic rock that contains between 0 and 5 percent quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF Field 10 as gabbro.	gabbroicrock
gabbroicRock	gabbroic rock	Gabbroid that has a plagioclase to total feldspar ratio greater than 0.9 in the QAPF fraction. Includes QAPF fields 10*, 10, and 10'. This category includes the various categories defined in LeMaitre et al. (2002) based on the mafic mineralogy, but apparently not subdivided based on the quartz/feldspathoid content.	basicigneousrock
gabbroid	gabbroid	Phaneritic crystalline igneous rock that contains less than 90 percent mafic minerals, and up to 20 percent quartz or up to 10 percent feldspathoid in the QAPF fraction. The ratio of plagioclase to total feldspar is greater than 0.65, and anorthite content of the plagioclase is greater than 50 percent. Includes rocks defined modally in QAPF fields 9 and 10 and their subdivisions.	phaneriticigneousrock
genericConglomerate	generic conglomerate	Sedimentary rock composed of at least 30 percent rounded to subangular fragments larger than 2 mm in diameter; typically contains finer grained material in interstices between larger fragments. If more than 15 percent of the fine grained matrix is of indeterminant clastic or diagenetic origin and the fabric is matrix supported, may also be	sedimentaryrock

Value	Name	Definition	Parent
		categorized as wackestone. If rock has unsorted or poorly sorted texture with a wide range of particle sizes, may also be categorized as diamictite.	
genericMudstone	generic mudstone	Sedimentary rock consisting of less than 30 percent gravel-size (2 mm) particles and with a mud to sand ratio greater than 1. Clasts may be of any composition or origin.	sedimentaryrock
genericSandstone	generic sandstone	Sedimentary rock in which less than 30 percent of particles are greater than 2 mm in diameter (gravel) and the sand to mud ratio is at least 1.	sedimentaryrock
glassRichIgneousRock	glass rich igneous rock	Igneous rock that contains greater than 50 percent massive glass.	igneousrock
glassyIgneousRock	glassy igneous rock	Igneous rock that consists of greater than 80 percent massive glass.	glassrichigneousrock
glaukophanschiefer	glaukophanschiefer	A metamorphic rock of roughly basaltic composition, defined by the presence of glaucophane with lawsonite or epidote. Other minerals that may be present include jadeite, albite, chlorite, garnet, and muscovite (phengitic white mica). Typically fine-grained, dark colored. Category for rocks commonly referred to as blueschist.	metamorphicrock
gneiss	gneiss	Foliated metamorphic rock with bands or lenticles rich in granular minerals alternating with bands or lenticles rich in minerals with a flaky or elongate prismatic habit. Mylonitic foliation or well developed, continuous schistosity (greater than 50 percent of the rock consists of grains participate in a planar or linear fabric) precludes classification with this concept.	foliatedmetamorphicrock
grainstone	grainstone	Carbonate sedimentary rock with recognizable depositional fabric that is grain-supported, and constituent particles are of intrabasinal origin; contains little or no mud matrix. Distinction from sandstone is based on interpretation of intrabasinal origin of clasts and grain-supported fabric, but grainstone definition does not include a grain size criteria.	carbonatesedimentaryrock
granite	granite	Phaneritic crystalline rock consisting of quartz, alkali feldspar and plagioclase	granitoid

Value	Name	Definition	Parent
		(typically sodic) in variable amounts, usually with biotite and/or hornblende. Includes rocks defined modally in QAPF Field 3.	
granitoid	granitoid	Phaneritic crystalline igneous rock consisting of quartz, alkali feldspar and/or plagioclase. Includes rocks defined modally in QAPF fields 2, 3, 4 and 5 as alkali feldspar granite, granite, granodiorite or tonalite.	acidicigneousrock
granodiorite	granodiorite	Phaneritic crystalline rock consisting essentially of quartz, sodic plagioclase and lesser amounts of alkali feldspar with minor hornblende and biotite. Includes rocks defined modally in QAPF field 4.	granitoid
granofels	granofels	Metamorphic rock with granoblastic fabric and very little or no foliation (less than 10 percent of the mineral grains in the rock are elements in a planar or linear fabric). Grainsize not specified.	metamorphicrock
granulite	granulite	Metamorphic rock of high metamorphic grade in which Fe-Mg silicate minerals are dominantly hydroxl-free; feldspar must be present, and muscovite is absent; rock contains less than 90 percent mafic minerals, less than 75 percent calcite and/or dolomite, less than 75 percent quartz, less than 50 percent iron-bearing minerals (hematite, magnetite, limonite-group, siderite, iron-sulfides), and less than 50 percent calc-silicate minerals.	metamorphicrock
gravel	gravel	Clastic sediment containing greater than 30 percent gravel-size particles (greater than 2.0 mm diameter). Gravel in which more than half of the particles are of epiclastic origin	clasticsediment
gravelSizeSediment	gravel size sediment	Sediment containing greater than 30 percent gravel-size particles (greater than 2.0 mm diameter). Composition or gensis of clasts not specified.	sediment
gypsumOrAnhydrite	gypsum or anhydrite	Evaporite composed of at least 50 percent gypsum or anhydrite.	evaporite
highMagnesiumFineGrainedIgneousRock	high magnesium fine grained igneous rock	fine-grained igneous rock that contains unusually high concentration of MgO. For rocks that contain greater than 52 percent silica, MgO must be greater than 8 percent. For rocks containing less than 52 percent	finegrainedigneous rock

Value	Name	Definition	Parent
		silica, MgO must be greater than 12 percent.	
hornblendite	hornblendite	Ultramafic rock that consists of greater than 40 percent hornblende plus pyroxene and has a hornblende to pyroxene ratio greater than 1. Includes olivine hornblendite, olivine-pyroxene hornblendite, pyroxene hornblendite, and hornblendite.	phaneriticigneousr ock
hornfels	hornfels	Granofels formed by contact metamorphism, composed of a mosaic of equidimensional grains in a characteristically granoblastic or decussate matrix; porphyroblasts or relict phenocrysts may be present. Typically fine grained.	granofels
hybridSediment	hybrid sediment	Sediment that does not fit any of the other sediment composition/genesis categories. Sediment consisting of three or more components which form more than 5 percent but less than 50 precent of the material.	sediment
hybridSedimentary Rock	hybrid sedimentary rock	Sedimentary rock that does not fit any of the other composition/genesis categories. Sedimentary rock consisting of three or more components which form more than 5 percent but less than 50 precent of the material.	sedimentaryrock
igneousMaterial	igneous material	Earth material formed as a result of igneous processes, eg. intrusion and cooling of magma in the crust, volcanic eruption.	compoundmaterial
igneousRock	igneous rock	rock formed as a result of igneous processes, for example intrusion and cooling of magma in the crust, or volcanic eruption.	igneousmaterial
impactGeneratedM aterial	impact generated material	Material that contains features indicative of shock metamorphism, such as microscopic planar deformation features within grains or shatter cones, interpreted to be the result of extraterrestrial bolide impact. Includes breccias and melt rocks.	compositegenesis material
impureCalcareous CarbonateSedime nt	impure calcareous carbonate sediment	Carbonate sediment in which between 50 and 90 percent of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin, and a calcite (plus aragonite) to dolomite ratio greater than 1 to 1.	calcareouscarbona tesediment
impureCarbonateS	impure carbonate	Carbonate sediment in which between 50 and 90 percent of the constituents are composed	carbonatesediment

Value	Name	Definition	Parent
ediment	sediment	of one (or more) of the carbonate minerals in particles of intrabasinal origin.	
impureCarbonateSedimentaryRock	impure carbonate sedimentary rock	Sedimentary rock in which between 50 and 90 percent of the primary and/or recrystallized constituents are composed of carbonate minerals.	carbonatesedimentaryrock
impureDolomite	impure dolomite	Impure carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1.	dolomiticormagnesiansedimentaryrock
impureDolomiticSediment	impure dolomitic sediment	Carbonate sediment in which between 50 and 90 percent of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin, and the ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1.	dolomiticsediment
impureLimestone	impure limestone	Impure carbonate sedimentary rock with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1.	calcareouscarbonatesedimentaryrock
intermediateCompositionIgneousMaterial	intermediate composition igneous material	Igneous material with between 52 and 63 percent SiO2.	igneousmaterial
intermediateCompositionIgneousRock	intermediate composition igneous rock	Igneous rock with between 52 and 63 percent SiO2.	igneousrock
ironRichSediment	iron rich sediment	Sediment that consists of at least 50 percent iron-bearing minerals (hematite, magnetite, limonite-group, siderite, iron-sulfides), as determined by hand-lens or petrographic analysis. Corresponds to a rock typically containing 15 percent iron by weight.	ironrichsedimentarymaterial
ironRichSedimentaryMaterial	iron rich sedimentary material	Sedimentary material of unspecified consolidation state that consists of at least 50 percent iron-bearing minerals (hematite, magnetite, limonite-group, siderite, iron-sulfides), as determined by hand-lens or petrographic analysis. Corresponds to a rock typically containing 15 percent iron by weight.	chemicalsedimentarymaterial
ironRichSedimentaryRock	iron rich sedimentary rock	Sedimentary rock that consists of at least 50 percent iron-bearing minerals (hematite, magnetite, limonite-group, siderite, iron-sulfides), as determined by hand-lens or petrographic analysis. Corresponds to a rock	ironrichsedimentarymaterial

Value	Name	Definition	Parent
		typically containing 15 percent iron by weight.	
kalsiliticAndMelilitic Rocks	kalsilitic and melilitic rocks	Igneous rock containing greater than 10 percent melilite or kalsilite. Typically undersaturated, ultrapotassic (kalsilitic rocks) or calcium-rich (melilitic rocks) mafic or ultramafic rocks.	exoticcompositioni gneousrock
kohle	kohle	A consolidated organic sedimentary material having less than 75% moisture. This category includes low, medium, and high rank coals according to International Classification of In-Seam Coal (United Nations, 1998), thus including lignite. Sapropelic coal is not distinguished in this category from humic coals. Formed from the compaction or induration of variously altered plant remains similar to those of peaty deposits.	organicrichsedime ntaryrock
komatiiticRock	komatiitic rock	Ultramafic, magnesium-rich volcanic rock, typically with spinifex texture of intergrown skeletal and bladed olivine and pyroxene crystals set in abundant glass. Includes komatiite and meimechite.	highmagnesiumfin egrainedigneousro ck
latite	latite	Latitic rock that contains between 0 and 5 percent quartz and no feldspathoid in the QAPF fraction. QAPF field 8.	latiticrock
latiticRock	latitic rock	Trachytoid that has a plagioclase to total feldspar ratio between 0.35 and 0.65. QAPF fields 8, 8' and 8*.	trachytoid
lignite	lignite	Coal that has a gross calorific value less than 24 MJ/kg (determined in conformance with ISO 1928), and vitrinite mean random reflectance less than 0.6% (determined in conformance with ISO 7404-5). Gross calorific value is recalculated to a moist, ash free basis using bed moisture (determined according to ISO 1015 or ISO 5068). Includes all low-rank coals, including sub-bitiminous coal. A consolidated, dull, soft brown to black coal having many readily discernible plant fragments set in a finer grained organic matrix. Tends to crack and fall apart on drying. Operationally sub-bituminous and bitiminous coal are qualitatively distinguished based on brown streak for sub-bitiminous coal and black streak for bituminous coal.	kohle

Value	Name	Definition	Parent
limestone	limestone	Pure carbonate sedimentary rock with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1. Includes limestone and dolomitic limestone.	calcareouscarbonatesedimentaryrock
marble	marble	Metamorphic rock consisting of greater than 75 percent fine- to coarse-grained recrystallized calcite and/or dolomite; usually with a granoblastic, saccharoidal texture.	metamorphicrock
materialFormedInSurficialEnvironment	material formed in surficial environment	Material that is the product of weathering processes operating on pre-existing rocks or deposits, analogous to hydrothermal or metasomatic rocks, but formed at ambient Earth surface temperature and pressure.	compositegenesis material
metamorphicRock	metamorphic rock	Rock formed by solid-state mineralogical, chemical and/or structural changes to a pre-existing rock, in response to marked changes in temperature, pressure, shearing stress and chemical environment.	compositegenesisrock
metasomaticRock	metasomatic rock	Rock that has fabric and composition indicating open-system mineralogical and chemical changes in response to interaction with a fluid phase, typically water rich.	compositegenesisrock
micaSchist	mica schist	A schist that consists of more than 50 percent mica minerals, typically muscovite or biotite. Special type included to distinguish this common variety of schist.	schist
migmatite	migmatite	Silicate metamorphic rock that is pervasively heterogeneous on a decimeter to meter scale that typically consists of darker and lighter parts; the darker parts usually exhibit features of metamorphic rocks whereas the lighter parts are of igneous-looking appearance.	metamorphicrock
mineDumpMaterial	mine dump material	spoil, overburden and other material excavated in mining	
monzodiorite	monzodiorite	Phaneritic crystalline igneous rock consisting of sodic plagioclase (An0 to An50), alkali feldspar, hornblende and biotite, with or without pyroxene, and 0 to 5 percent quartz. Includes rocks defined modally in QAPF field 9.	monzodioriticrock
monzodioriticRock	monzodioritic rock	Phaneritic crystalline igneous rock consisting of sodic plagioclase (An0 to An50), alkali feldspar, hornblende and biotite, with or	dioritoid

Value	Name	Definition	Parent
		without pyroxene, and 0 to 10 percent feldspathoid or 0 to 20 percent quartz in the QAPF fraction. Plagioclase to total feldspar ratio in the QAPF fraction is between 0.65 and 0.9. Includes rocks defined modally in QAPF field 9, 9' and 9* as monzodiorite, foid-beaing monzodiorite, and quartz monzodiorite.	
monzogabbro	monzogabbr o	Monzogabbroic rock that contains between 0 an 5 percent quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF field 9 .	monzogabbroicroc k
monzogabbroicRo ck	monzogabbr oic rock	Gabbroid with a plagioclase to total feldspar ratio between 0.65 and 0.9. QAPF field 9, 9 prime and 9 asterisk	gabbroid
monzogranite	monzogranit e	Granite that has a plagiolcase to total feldspar ratio between 0.35 and 0.65. QAPF field 3b.	granite
monzonite	monzonite	Monzonitic rock that contains 0-5 percent quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF Field 8.	monzoniticrock
monzoniticRock	monzonitic rock	Syenitoid with a plagioclase to total feldspar ratio between 0.35 and 0.65. Includes rocks in QAPF fields 8, 8*, and 8'.	syenitoid
mud	mud	Clastic sediment consisting of less than 30 percent gravel-size (2 mm) particles and with a mud-size to sand-size particle ratio greater than 1. More than half of the particles are of epiclastic origin.	clasticsediment
mudSizeSediment	mud size sediment	Sediment consisting of less than 30 percent gravel-size (2 mm) particles and with a mud-size to sand-size particle ratio greater than 1. Clasts may be of any composition or origin.	sediment
mudstone	mudstone	Clastic sedimentary rock consisting of less than 30 percent gravel-size (2 mm) particles and with a mud to sand ratio greater than 1.	clasticsedimentaryr ock
myloniticRock	mylonitic rock	Metamorphic rock characterised by a foliation resulting from tectonic grain size reduction, in which more than 10 percent of the rock volume has undergone grain size reduction. Includes protomylonite, mylonite,	faultrelatedmaterial

Value	Name	Definition	Parent
		ultramylonite, and blastomylonite.	
naturalUnconsolidatedMaterial	natural unconsolidated material	Unconsolidated material known to have natural, ie. not human-made, origin.	unconsolidatedmaterial
nonClasticSiliceousSediment	non-clastic siliceous sediment	Sediment that consists of at least 50 percent silicate mineral material, deposited directly by chemical or biological processes at the depositional surface, or in particles formed by chemical or biological processes within the basin of deposition.	nonclasticsiliceoussedimentarymaterial
nonClasticSiliceousSedimentaryMaterial	non-clastic siliceous sedimentary material	Sedimentary material that consists of at least 50 percent silicate mineral material, deposited directly by chemical or biological processes at the depositional surface, or in particles formed by chemical or biological processes within the basin of deposition.	sedimentarymaterial
nonClasticSiliceousSedimentaryRock	non-clastic siliceous sedimentary rock	Sedimentary rock that consists of at least 50 percent silicate mineral material, deposited directly by chemical or biological processes at the depositional surface, or in particles formed by chemical or biological processes within the basin of deposition.	nonclasticsiliceoussedimentarymaterial
ooze	ooze	Biogenic sediment consisting of less than 1 percent gravel-size (greater than or equal to 2 mm) particles, with a sand to mud ratio less than 1 to 9, and less than 50 percent carbonate minerals.	biogenicsediment
organicBearingMudstone	organic bearing mudstone	Mudstone that contains a significant amount of organic carbon, typically kerogen. Commonly finely laminated, brown or black in color.	genericmudstone
organicRichSediment	organic rich sediment	Sediment with color, composition, texture and apparent density indicating greater than 50 percent organic content by weight on a moisture-free basis.	biogenicsediment
organicRichSedimentaryMaterial	organic rich sedimentary material	Sedimentary material in which 50 percent or more of the primary sedimentary material is organic carbon.	sedimentarymaterial
organicRichSedimentaryRock	organic rich sedimentary rock	Sedimentary rock with color, composition, texture and apparent density indicating greater than 50 percent organic content by weight on a moisture-free basis.	organicrichsedimentarymaterial

Value	Name	Definition	Parent
orthogneiss	orthogneiss	A gneiss with mineralogy and texture indicating derivation from a phaneritic igneous rock protolith. Typically consists of abundant feldspar, with quartz, and variable hornblende, biotite, and muscovite, with a relatively homogeneous character.	gneiss
packstone	packstone	Carbonate sedimentary rock with discernible grain supported depositional texture, containing greater than 10 percent grains, and constituent particles are of intrabasinal origin; intergranular spaces are filled by matrix.	carbonatesedimentaryrock
paragneiss	paragneiss	A gneiss with mineralogy and texture indicating derivation from a sedimentary rock protolith. Typically consists of abundant quartz, mica, or calcsilicate minerals; aluminosilicate minerals or garnet commonly present. Composition of rock tends to be more variable on a decimetric scale that in orthogneiss.	gneiss
peat	peat	Unconsolidated organic-rich sediment composed of at least 50 percent semi-carbonised plant remains; individual remains commonly seen with unaided eye; yellowish brown to brownish black; generally fibrous texture; can be plastic or friable. In its natural state it can be readily cut and has a very high moisture content, generally greater than 90 percent. Liptinite to Inertinite ratio is less than one (Economic Commission for Europe, Committee on Sustainable Energy- United Nations (ECE-UN), 1998, International Classification of in-Seam Coals: Energy 19, 41 pp.)	organicrichsediment
pebbleGravelSize Sediment	pebble gravel size sediment	Sediment containing greater than 30 percent pebble-size particles (2.0 -64 mm in diameter)	gravelsizesediment
pegmatite	pegmatite	Exceptionally coarse grained crystalline rock with interlocking crystals; most grains are 1cm or more diameter; composition is generally that of granite, but the term may refer to the coarse grained facies of any type of igneous rock;usually found as irregular dikes, lenses, or veins associated with plutons or batholiths.	phaneriticigneousrock

Value	Name	Definition	Parent
peridotite	peridotite	Ultramafic rock consisting of more than 40 percent (by volume) olivine with pyroxene and/or amphibole and little or no feldspar. Commonly altered to serpentinite. Includes rocks defined modally in the ultramafic rock classification as dunite, harzburgite, lherzolite, wehrlite, olivinite, pyroxene peridotite, pyroxene hornblende peridotite or hornblende peridotite.	phaneriticigneousrock
phaneriticIgneousRock	phaneritic igneous rock	Igneous rock in which the framework of the rock consists of individual crystals that can be discerned with the unaided eye. Bounding grain size is on the order of 32 to 100 microns. Igneous rocks with 'exotic' composition are excluded from this concept.	igneousrock
phonolite	phonolite	Phonolitoid in which the plagioclase to total feldspar ratio is less than 0.1. Rock consists of alkali feldspar, feldspathoid minerals, and mafic minerals.	phonolitoid
phonoliticBasanite	phonolitic basanite	Tephritoid that has a plagioclase to total feldspar ratio between 0.5 and 0.9, and contains more than 10 percent normative (CIPW) olivine.	tephritoid
phonoliticFoidite	phonolitic foidite	Foiditoid that contains less than 90 percent feldspathoid minerals in the QAPF fraction, and has a plagioclase to total feldspar ratio that is less than 0.5	foiditoid
phonoliticTephrite	phonolitic tephrite	Tephritoid that has a plagioclase to total feldspar ratio between 0.5 and 0.9, and contains less than 10 percent normative (CIPW) olivine.	tephritoid
phonolitoid	phonolitoid	Fine grained igneous rock than contains less than 90 percent mafic minerals, between 10 and 60 percent feldspathoid mineral in the QAPF fraction and has a plagioclase to total feldspar ratio less than 0.5. Includes rocks defined modally in QAPF fields 11 and 12, and TAS field Ph.	finegrainedigneousrock
phosphateRichSediment	phosphate rich sediment	Sediment in which at least 50 percent of the primary and/or recrystallized constituents are phosphate minerals.	phosphaterichsedimentarymaterial
phosphateRichSedimentaryMaterial	phosphate rich sedimentary	Sedimentary material in which at least 50 percent of the primary and/or recrystallized	sedimentarymaterial

Value	Name	Definition	Parent
	material	constituents are phosphate minerals.	
phosphorite	phosphorite	Sedimentary rock in which at least 50 percent of the primary or recrystallized constituents are phosphate minerals. Most commonly occurs as a bedded primary or reworked secondary marine rock, composed of microcrystalline carbonate fluorapatite in the form of lamina, pellets, oolites and nodules, and skeletal, shell and bone fragments.	phosphaterichsedimentarymaterial
phyllite	phyllite	Rock with a well developed, continuous schistosity, an average grain size between 0.1 and 0.5 millimeters, and a silvery sheen on cleavage surfaces. Individual phyllosilicate grains are barely visible with the unaided eye.	foliatedmetamorphicrock
phyllonite	phyllonite	Mylonitic rock composed largely of fine-grained mica that imparts a sheen to foliation surfaces; may have flaser lamination, isoclinal folding, and deformed veins, which indicate significant shearing. Macroscopically resembles phyllite, but formed by mechanical degradation of initially coarser rock.	myloniticrock
porphyry	porphyry	Igneous rock that contains conspicuous phenocrysts in a finer grained groundmass; groundmass itself may be phaneritic or fine-grained.	igneousrock
pureCalcareousCarbonateSediment	pure calcareous carbonate sediment	Carbonate sediment in which greater than 90 percent of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin, and a calcite (plus aragonite) to dolomite ratio greater than 1 to 1.	calcareouscarbonatesediment
pureCarbonateMudstone	pure carbonate mudstone	Mudstone that consists of greater than 90 percent carbonate minerals of intrabasinal orign in the mud fraction, and contains less than 10 percent allochems. The original depositional texture is preserved and fabric is matrix supported. Carbonate mudstone of Dunham (1962)	carbonatemudstone
pureCarbonateSediment	pure carbonate sediment	Carbonate sediment in which greater than 90 percent of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin.	carbonatesediment
pureCarbonateSed	pure carbonate	Sedimentary rock in which greater than 90 percent of the primary and/or recrystallized	carbonatesediment

Value	**Name**	**Definition**	**Parent**
imentaryRock	sedimentary rock	constituents are carbonate minerals.	aryrock
pureDolomiticSediment	pure dolomitic sediment	Carbonate sediment in which greater than 90 percent of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin, and a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1 to 1.	dolomiticsediment
pyroclasticMaterial	pyroclastic material	Fragmental igneous material that consists of more than 75 percent of particles formed by disruption as a direct result of volcanic action.	fragmentaligneous material
pyroclasticRock	pyroclastic rock	Fragmental igneous rock that consists of greater than 75 percent fragments produced as a direct result of eruption or extrusion of magma from within the earth onto its surface. Includes autobreccia associated with lava flows and excludes deposits reworked by epiclastic processes.	fragmentaligneousrock
pyroxenite	pyroxenite	Ultramafic phaneritic igneous rock composed almost entirely of one or more pyroxenes and occasionally biotite, hornblende and olivine. Includes rocks defined modally in the ultramafic rock classification as olivine pyroxenite, olivine-hornblende pyroxenite, pyroxenite, orthopyroxenite, clinopyroxenite and websterite.	phaneriticigneousrock
quartzAlkaliFeldsparSyenite	quartz alkali feldspar syenite	Alkali feldspar syenitic rock that contains 5 to 20 percent quartz and no feldspathoid in the QAPF fraction. QAPF field 6*.	alkalifeldsparsyeniticrock
quartzAlkaliFeldsparTrachyte	quartz alkali feldspar trachyte	Alkali feldspar trachytic rock that contains and between 5 and 20 percent quartz mineral in the QAPF fraction. QAPF field 6*.	alkalifeldspartrachyticrock
quartzAnorthosite	quartz anorthosite	Anorthositic rock that contains between 5 and 20 percent quartz in the QAPF fraction. QAPF field 10*.	anorthositicrock
quartzDiorite	quartz diorite	Dioritic rock that contains between 5 to 20 percent quartz in the QAPF fraction. QAPF field 10*.	dioriticrock
quartzGabbro	quartz gabbro	Gabbroic rock that contains between 5 and 20 percent quartz in the QAPF fraction. QAPF field 10*.	gabbroicrock

Value	Name	Definition	Parent
quartzLatite	quartz latite	Latitic rock that contains between 5 and 20 percent quartz in the QAPF fraction. QAPF field 8*.	latiticrock
quartzMonzodiorite	quartz monzodiorite	Monzodioritic rock that contains between 5 and 20 percent quartz.	monzodioriticrock
quartzMonzogabbro	quartz monzogabbro	Monzogabbroic rock that contains between 5 and 20 percent quartz in the QAPF fraction. QAPF field 9*.	monzogabbroicrock
quartzMonzonite	quartz monzonite	Monzonitic rock that contains 5-20 percent quartz iin the QAPF fraction. Includes rocks defined modally in QAPF Field 8*.	monzoniticrock
quartzRichIgneousRock	quartz rich igneous rock	Phaneritic crystalline igneous rock that contains less than 90 percent mafic minerals and contains greater than 60 percent quartz in the QAPF fraction.	acidicigneousrock
quartzSyenite	quartz syenite	Syenitic rock that contains between 5 and 20 percent quartz in the QAPF fraction. Defined modally in QAPF Field 7*.	syeniticrock
quartzTrachyte	quartz trachyte	Trachytic rock that contains between 5 and 20 percent quartz in the QAPF fraction. QAPF field 7*.	trachyticrock
quartzite	quartzite	Metamorphic rock consisting of greater than or equal to 75 percent quartz; typically granoblastic texture.	metamorphicrock
residualMaterial	residual material	Material of composite origin resulting from weathering processes at the Earth's surface, with genesis dominated by removal of chemical constituents by aqueous leaching. Miinor clastic, chemical, or organic input may also contribute. Consolidation state is not inherent in definition, but typically material is unconsolidated or weakly consolidated.	materialformedinsurficialenvironment
rhyolite	rhyolite	rhyolitoid in which the ratio of plagioclase to total feldspar is between 0.1 and 0.65.	rhyolitoid
rhyolitoid	rhyolitoid	fine_grained_igneous_rock consisting of quartz and alkali feldspar, with minor plagioclase and biotite, in a microcrystalline, cryptocrystalline or glassy groundmass. Flow texture is common. Includes rocks defined modally in QAPF fields 2 and 3 or chemically in TAS Field R as rhyolite. QAPF normative definition is based on modal mineralogy thus:	acidicigneousrock

Value	Name	Definition	Parent
		less than 90 percent mafic minerals, between 20 and 60 percent quartz in the QAPF fraction, and ratio of plagioclse to total feldspar is less than 0.65.	
rock	rock	Consolidated aggregate of one or more EarthMaterials, or a body of undifferentiated mineral matter, or of solid organic material. Includes mineral aggregates such as granite, shale, marble; glassy matter such as obsidian; and organic material such a coal. Excludes unconsolidated materials.	compoundmaterial
rockSalt	rock salt	Evaporite composed of at least 50 percent halite.	evaporite
sand	sand	Clastic sediment in which less than 30 percent of particles are gravel (greater than 2 mm in diameter) and the sand to mud ratio is at least 1. More than half of the particles are of epiclastic origin.	clasticsediment
sandSizeSediment	sand size sediment	Sediment in which less than 30 percent of particles are gravel (greater than 2 mm in diameter) and the sand to mud ratio is at least 1. Composition or genesis of clasts not specified.	sediment
sandstone	sandstone	Clastic sedimentary rock in which less than 30 percent of particles are greater than 2 mm in diameter (gravel) and the sand to mud ratio is at least 1.	clasticsedimentaryrock
sapropel	sapropel	Jelly like organic rich sediment composed of plant remains, usually algal. Liptinite to Inertinite ratio is greater than one (Economic Commission for Europe, Committee on Sustainable Energy- United Nations (ECE-UN), 1998, International Classification of in-Seam Coals: Energy 19, 41 pp.)	organicrichsediment
schist	schist	Foliated phaneritic metamorphic rock with well developed, continuous schistosity, meaning that greater than 50 percent of the rock by volume is mineral grains with a thin tabular, lamellar, or acicular prismatic crystallographic habit that are oriented in a continuous planar or linear fabric.	foliatedmetamorphicrock
sediment	sediment	Unconsolidated material consisting of an aggregation of particles transported or deposited by air, water or ice, or that	naturalunconsolidatedmaterial

Value	Name	Definition	Parent
		accumulated by other natural agents, such as chemical precipitation, and that forms in layers on the Earth's surface. Includes epiclastic deposits.	
sedimentaryMaterial	sedimentary material	Material formed by accumulation of solid fragmental material deposited by air, water or ice, or material that accumulated by other natural agents such as chemical precipitation from solution or secretion by organisms. Includes both sediment and sedimentary rock. Includes epiclastic deposits. All stated composition criteria are based on the mineral/ compound material (GeoSciML term)/particulate fraction of the material, irrespective of porosity or the pore-fluid. No distinctions are made based on porosity or pore fluid composition (except organic rich sediment in which liquid hydrocarbon content may be considered).	compoundmaterial
sedimentaryRock	sedimentary rock	Rock formed by accumulation and cementation of solid fragmental material deposited by air, water or ice, or as a result of other natural agents, such as precipitation from solution, the accumulation of organic material, or from biogenic processes, including secretion by organisms. Includes epiclastic deposits.	rock
serpentinite	serpentinite	Rock consisting of more than 75 percent serpentine-group minerals, eg. antigorite, chrysotile or lizardite; accessory chlorite, talc and magnetite may be present; derived from hydration of ferromagnesian silicate minerals such as olivine and pyroxene.	metamorphicrock
sewageSludge	sewage sludge	more or less liquid (when disposed) by-products of wastewater treatment	
shale	shale	Laminated mudstone that will part or break along thin, closely spaced layers parallel to stratification.	mudstone
silicateMud	silicate mud	Mud size sediment that consists of less than 50 percent carbonate minerals.	mudsizesediment
silicateMudstone	silicate mudstone	Mudstone that contains less than 10 percent carbonate minerals.	genericmudstone
siliceousOoze	siliceous	ooze that consists of more than 50 percent	nonclasticsiliceous

Value	Name	Definition	Parent
	ooze	siliceous skeletal remains	sediment
silt	silt	Mud that consists of greater than 50 percent silt-size grains.	mud
siltstone	siltstone	Mudstone that contains detectable silt. (see comments)	mudstone
skarn	skarn	Metasomatic rock consisting mainly of Ca-, Mg-, Fe-, or Mn-silicate minerals, which are free from or poor in water. Typically formed at the contact between a silicate rock or magma and a carbonate rock.	metasomaticrock
slag	slag	by-product of smelting ore and processing metals	
slate	slate	Compact, fine grained rock with an average grain size less than 0.032 millimeter and a well developed schistosity (slaty cleavage), and hence can be split into slabs or thin plates.	foliatedmetamorphicrock
sludge	sludge	More or less liquid (when disposed) by-products of industrial processes	
soilImprover	soil improver	Material added to soil to improve plant growth and health	
spilite	spilite	Altered basic to intermediate composition fine-grained igneous rock in which the feldspar is partially or completely composed of of albite, typically accompanied by chlorite, calcite, quartz, epidote, prehnite, and low-tempaerature hydrous crystallization products. Preservation of eruptive volcanic features is typical.	metasomaticrock
syenite	syenite	Syenitic rock that contains between 0 and 5 percent quartz and no feldspathoid mineral in the QAPF fraction. Defined modally in QAPF Field 7.	syeniticrock
syeniticRock	syenitic rock	Syenitoid with a plagioclase to total feldspar ratio between 0.1 and 0.35. Includes rocks in QAPF fields 7, 7*, and 7'.	syenitoid
syenitoid	syenitoid	Phaneritic crystalline igneous rock with M less than 90, consisting mainly of alkali feldspar and plagioclase; minor quartz or nepheline may be present, along with pyroxene, amphibole or biotite. Ratio of	phaneriticigneousrock

Value	**Name**	**Definition**	**Parent**
		plagioclase to total feldspar is less than 0.65, quartz forms less than 20 percent of QAPF fraction, and feldspathoid minerals form less than 10 percent of QAPF fraction. Includes rocks classified in QAPF fields 6, 7 and 8 and their subdivisions.	
syenogranite	syenogranite	Granite that has a plagiolcase to total feldspar ratio between 0.10 and 0.35. QAPF field 3a.	granite
tephra	tephra	Unconsolidated pyroclastic material in which greater than 75 percent of the fragments are deposited as a direct result of volcanic processes and the deposit has not been reworked by epiclastic processes. Includes ash, lapilli tephra, bomb tephra, block tephra and unconsolidated agglomerate.	naturalunconsolidatedmaterial
tephrite	tephrite	Tephritoid that has a plagioclase to total feldspar ratio greater than 0.9, and contains less than 10 percent normative (CIPW) olivine.	tephritoid
tephriticFoidite	tephritic foidite	Foiditoid that contains less than 90 percent feldspathoid minerals in the QAPF fraction, and has a plagioclase to total feldspar ratio that is greater than 0.5, with less than 10 percent normative olivine	foiditoid
tephriticPhonolite	tephritic phonolite	Phonolitoid that has a plagioclase to total feldspar ratio between 0.1 and 0.5. Broadly corresponds to TAS tephriphonolite of TAS field U3.	phonolitoid
tephritoid	tephritoid	Fine grained igneous rock than contains less than 90 percent mafic minerals, between 10 and 60 percent feldspathoid mineral in the QAPF fraction and has a plagioclase to total feldspar ratio greater than 0.5. Includes rocks classified in QAPF field 13 and 14 or chemically in TAS field U1 as basanite or tephrite.	finegrainedigneous rock
tholeiiticBasalt	tholeiitic basalt	Tholeiitic basalt is defined here to contain 2 pyroxene phases and interstitial quartz or tridymite or cristobalite in the groundmass. Pyroxene (augite and orthopyroxene or pigeonite) and calcium-rich plagioclase are common phenocryst minerals. Olivine may also be a phenocryst, and when present, may	basalt

Value	**Name**	**Definition**	**Parent**
		have rims of pigeonite. Only in tholeiitic basalt is olivine in reaction relationship with melt. Interstitial siliceous residue may be present, and is often glassy. Tholeiitic basalt is relatively poor in sodium. This category includes most basalts of the ocean floor, most large oceanic islands, and continental flood basalts such as the Columbia River Plateau.	
tonalite	tonalite	Granitoid consisting of quartz and intermediate plagioclase, usually with biotite and amphibole. Includes rocks defined modally in QAPF field 5; ratio of plagioclase to total feldspar is greater than 0.9.	granitoid
topsoil	topsoil	The dark-colored upper portion af a soil, varying in depth according to soil type.	
trachyte	trachyte	Trachytoid that has a plagioclase to total feldspar ratio between 0.1 and 0.35, between 0 and 5 percent quartz in the QAPF fraction, and no feldspathoid minerals. QAPF field 7.	trachyticrock
trachyticRock	trachytic rock	Trachytoid that has a plagioclase to total feldspar ratio between 0.1 and 0.35. QAPF fields 7, 7', and 7*.	trachytoid
trachytoid	trachytoid	Fine grained igneous rock than contains less than 90 percent mafic minerals, less than 10 percent feldspathoid mineral and less than 20 percent quartz in the QAPF fraction and has a plagioclase to total feldspar ratio less than 0.65. Mafic minerals typically include amphibole or mica; typically porphyritic. Includes rocks defined modally in QAPF fields 6, 7 and 8 (with subdivisions) or chemically in TAS Field T as trachyte or latite.	finegrainedigneous rock
travertine	travertine	Biotically or abiotically precipitated calcium carbonate, from spring-fed, heated, or ambient-temperature water. May be white and spongy, various shades of orange, tan or gray, and ranges to dense, banded or laminated rock. Macrophytes, bryophytes, algae, cyanobacteria and other organisms often colonize the surface of travertine and may be preserved, to produce the porous varieties.	chemicalsedimentarymaterial
tuffBreccia,AgglomerateOrPyroclastic	tuff-breccia, agglomerate	Pyroclastic rock in which greater than 25 percent of particles are greater than 64 mm in	pyroclasticrock

Value	Name	Definition	Parent
Breccia	, or pyroclastic breccia	largest dimension. Includes agglomerate, pyroclastic breccia of Gillespie and Styles (1999)	
tuffit	tuffit	Rock consists of more than 50 percent particles of indeterminate pyroclastic or epiclastic origin and less than 75 percent particles of clearly pyroclastic origin. Commonly the rock is laminated or exhibits size grading. (based on LeMaitre et al. 2002; Murawski and Meyer 1998).	rock
ultrabasicIgneousRock	ultrabasic igneous rock	Igneous rock with less than 45 percent SiO2.	igneousrock
ultramaficIgneousRock	ultramafic igneous rock	Igneous rock that consists of greater than 90 percent mafic minerals.	igneousrock
unconsolidatedMaterial	unconsolidated material	CompoundMaterial composed of an aggregation of particles that do not adhere to each other strongly enough that the aggregate can be considered a solid in its own right.	compoundmaterial
wacke	wacke	Clastic sandstone with more than 10 percent matrix of indeterminate detrital or diagenetic nature. Matrix is mud size silicate minerals (clay, feldspar, quartz, rock fragments, and alteration products).	sandstone
waste	waste	Disposed, non-liquid by-products of any kind, e.g. domestic or industrial waste	

1.1.13 Values of code list MappingFrameValue

Value	Name	Definition
baseOfQuaternary	base of quaternary	Base of the predominantely unconsolidated sedimentary material of Quaternary age.
surfaceGeology	surface geology	Bedrock and superficial deposits that would be visible if the overlying soil was removed or are exposed at the topographic surface.
topOfBasement	top of basement	The surface in the crust of the Earth below sedimentary or volcanic deposits, or tectonically transported rock unit.
topOfBedrock	top of bedrock	Top surface of the usually solid rock that may either be exposed at the topographic surface or covered by other unconsolidated deposits.

1.1.14 Values of code list NaturalGeomorphologicFeatureTypeValue

Value	Name	Definition	Description
naturalGeomorphologicFeature	natural geomorphologic feature	A geomorphologic feature produced by the natural dynamics.	
drainagePattern	drainage pattern	The configuration or arrangement, in map view, of stream courses in an area, including gullies or first-order channelized flow areas, higher order tributaries, and main streams. Also called drainage network.	Drainage pattern is related to the local geologic materials and structure, the geomorphologic features, and the geomorphic history of an area. Drainage pattern types include annular drainage pattern, centripetal drainage pattern, dendritic drainage pattern, deranged drainage pattern, integrated drainage pattern, karst drainage pattern, lack of drainage pattern, parallel drainage pattern, radial drainage pattern, rectangular drainage pattern, thermokarst drainage pattern and trellis drainage pattern.
constructionalFeature	constructional feature	Said of a landform that owes its origin, form, position, or general character to depositional (aggradational) processes, such as the accumulation of sediment (e.g., alluvial fan, volcanic cone).	
destructionalFeature	destructional feature	Said of a landform that owes its origin, form, position, or general character to the removal of material by erosion and weathering (degradation) processes resulting from the wearing-down or away of the land surface.	
degradationFeature	degradation feature	A geomorphologic feature resulting from the wearing down or away, and the general lowering or reduction, of the Earth's surface by natural processes of weathering and erosion, and may infer the processes of tranportation of sediment.	A degradation feature is sometimes related to the process of transportation; and sometimes the term is used synonimously with denudation feature, or used to signify the results of denudation.

Value	Name	Definition	Description
relic	relic	A landform that has survived decay or disintegration, or one that has been left behind after the dissapareance of the greater part of its substance such as a remnant island.	Relic features include the surface landforms, geomorphologic surfaces, and paleosols that have never been buried and yet are predominantly products of past environments. Erosion remnant landforms, or topographic features that remain or are left satnding above the general land surface after erosion has reduced the surrounding areas, as for instance monadnock, butte, mesa or stack, are examples of relic features.
exhumedFeature	exhumed feature	Formerly buried landforms, geomorphologic surfaces, or paleosols that have been reexposed by erosion of the covering mantle.	Surfaces, landscapes or geomorphologic features (i.e a mountain,a peneplain or a fault scarp) that have been restored by exhumation to their previous status in the existing relief are also named resurrected features.
buriedFeature	buried feature	Landforms, geomorphologic surfaces, or paleosols covered by younger sediments.	
pediment	pediment	A gently sloping erosional surface developed at the foot of a receding hill or mountain slope, commonly with a slightly concave-upward profile, that cross-cuts rock or sediment strata that extend beneath adjacent uplands.	A pediment has typically developed by subaerial agents (including running water) in an arid or semiarid region and is underlain by bedrock (occasionally by older alluvial deposits) that may be bare but are more often partly mantled with a thin discontinuous veneer of alluvium derived from the upland masses and transit across the surface. Examples include rock pediment, pedisediment, intermontane basin piedmont and terrace pediment.
erosional	erosional features	A land surface shaped by the action of erosion, especially by running water.	

Value	Name	Definition	Description
hill	hill	A generic term for an elevated area of the land surface, rising at least 30 metres to as much as 300 metres above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent.	A hill can occur as a single, isolated mass or in a group. A hill can be further specified based on the magnitude of local relief: low hill (30 – 90 m) or high hill (90 - 300 m). Informal distinctions between a hill and a mountain are often arbitrary and dependent on local convention.
interfluve	interfluve	A geomorphologic component of hills consisting of the uppermost, comparatively level or gently sloped area of a hill; shoulders of backwearing hillslopes can narrow the upland (e.g., ridge) or merge (e.g., crest, saddle) resulting in a strongly convex shape.	
crest	crest	A geomorphologic component of hills consisting of the convex slopes (perpendicular to the contour) that form the narrow, roughly linear top area of a hill, ridge, or other upland where shoulders have converged to the extent that little or no summit remains; dominated by erosion, slope wash and mass movement processes and sediments (e.g., slope alluvium, creep). Commonly, soils on crests are more similar to those on side slopes than to soils on adjacent interfluves.	
headSlope	head slope	A geomorphologic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway, resulting in converging overland water flow.	Head slopes are dominated by colluvium and slope wash sediments (e.g., slope alluvium); contour lines form concave curves. Slope complexity (downslope shape) can range from simple to complex. Head slopes are comparatively moister portions of hillslopes and tend to accumulate sediments (e.g., cumulic soil profiles) where they are not directly contributing materials to channel flow.

Value	Name	Definition	Description
sideSlope	side slope	A geomorphologic component of hills consisting of a laterally planar area of a hillside, resulting in predominantly parallel overland water flow. Contour lines generally form straight lines.	Side slopes are dominated by colluvium and slope wash sediments. Slope complexity (downslope shape) can range from simple to complex. The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve. It is generally linear along the slope width.
noseSlope	nose slope	A geomorphologic component of hills consisting of the projecting end (laterally convex area) of a hillside, resulting in predominantly divergent overland water flow; contour lines generally form convex curves.	Nose slopes are dominated by colluvium and slope wash sediments (e.g., slope alluvium). Slope complexity (downslope shape) can range from simple to complex. Nose slopes are comparatively drier portions of hillslopes and tend to have thinner colluvial sediments and profiles.
freeFace	free face	A geomorphologic component of hills and mountains consisting of an outcrop of bare rock that sheds rock fragments and other sediments to, and commonly stands more steeply than the angle of repose of, the colluvial slope immediately below; most commonly found on shoulder and backslope positions, and can comprise part or all of a nose slope or side slope.	
baseSlope	base slope	A geomorphologic component of hills consisting of the concave to linear slope (perpendicular to the contour) which, regardless of the lateral shape is an area that forms an apron or wedge at the bottom of a hillside dominated by colluvial and slope wash processes and sediments (e.g., colluvium and slope alluvium). Distal base slope sediments commonly grade to, or interfinger with, alluvial fills, or gradually thin to form pedisediment over residuum.	

Value	Name	Definition	Description
mountain	mountain	A generic term for an elevated area of the land surface, rising more than 300 metres above surrounding lowlands, usually with a nominal summit area relative to bounding slopes and generally with steep sides (greater than 25 percent slope) with or without considerable bare-rock exposed.	A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are primarily formed by tectonic activity and/or volcanic action and secondarily by differential erosion.
mountaintop	mountaintop	A geomorphologic component of mountains consisting of the uppermost, comparatively level or gently sloped area of mountains, characterized by relatively short, simple slopes composed of bare rock, residuum, or short-transport colluvial sediments. In humid environments, mountaintop soils can be quite thick and well developed.	
mountainslope	mountainslope	A part of a mountain between the summit and the foot.	
mountainflank	mountainflank	A geomorphologic component of mountains characterized by very long, complex backslopes with comparatively high slope gradients and composed of highly-diverse colluvial sediment mantles, rock outcrops or structural benches. Complex near-surface hydrology, mass movement processes and related features may be present. The mountainflank can be subdivided by the general location along the mountainside.	
mountainbase	mountainbase	A geomorphologic component of mountains consisting of the strongly to slightly concave colluvial apron or wedge at the bottom of mountain slopes. It is composed of longtransport colluvium and slope alluvium sediments.	

Value	Name	Definition	Description
depression	depression	Any relatively sunken part of the Earth's surface; especially a low-lying area surrounded by higher ground.	
plain	plain	Any flat area, large or small, at a low elevation; specifically an extensive region of comparatively smooth and level or gently undulaing land, having few or no prominent surface irregularities but sometimes having a considerable slope, and usually at a low elevation with reference to surrounding areas.	The geomorphic components of a simple, flat plain are the rise [a broad, slightly elevated area with comparatively greater gradients (e.g., 1-3% slopes], the talf [a comparatively level (e.g., 0-1% slopes), laterally extensive, non-fluvial area], and dip [a slight depression that is not a permanent water body nor part of an integrated drainage network].
tectonicStructural	tectonic and structural features	Geomorphologic landscapes and landforms related to regional or local bedrock structures, or crustal movement; and geomorphologic landscapes and landforms related dominantly to water erosion but excluding perennial, channel flow (i.e. fluvial, glaciofluvial), or eolian erosion.	Landscape-scale tectonic and structural geomorphologic features include mountain systems, mountain ranges, plateaux, batholiths, fault-block mountains or rift valleys. Landform-scale tectonic and structural geomorphologic features include the geomorphologic expressions of folds, faults or diapirs, and other landforms as mesas, cuestas, scarps and escarpments, faceted spurs, hogbacks or strike valleys.
volcanic	volcanic features	Geomorphologic landscapes and landforms related to the deep seated (igneous) processes by which magma and associated gases rise through the crust and are extruded onto the earth's surface and into the atmosphere.	Landscape-scale volcanic geomorphologic features include volcanic and lava fields, lava plateaux or lava fields. Landform-scale, volcanic geomorphologic features include lava flows and related features (diverse types of scarps, levees, and lava flow surface features); lahars, calderas, the diverse types of cones and related rims, necks, domes, tubes, trenches, fissures and scarps. Volcanic geomorphologic features include also microfeatures as pressure ridges, tumuli, spatter cones or spiracles.

Value	Name	Definition	Description
hydrothermal	hydrothermal features	Geomorphologic landscapes and landforms related to hydrotermal processes.	Examples of landscape-scale hydrothermal geomorphologic features are geyser basins. Landform-scale hydrothermal geomorphologic features include geysers, their cones and other geyser-related landforms. Examples of microfeature-scale hydrothermal features related to hot springs are for instance mud pots.
erosionSurface	erosion surface	Geomorphologic landscapes and landforms related dominantly to water erosion but excluding perennial channel flow (i.e. fluvial, glaciofluvial) or eolian erosion.	Landscape-scale erosional geomorphologic features include badlands, canyonlands, plains, and remnant features, as for example valley floor and eroded fan remnants. Landform-scale erosional geomorphologic features include inselbergs, monadnocks, knobs, knolls, stacks, buttes, cols, gaps, wind gaps or saddles.
slopeGravitational	slope and gravitational features	Geomorphologic landscapes and landforms related to slope environments; geomorphologic landscapes and landforms developed under the action of the gravitational force.	Examples of slope and gravitational features include landforms as colluvial aprons, scree slopes, talus cones, talus slopes, landslides, as falls (rockfall, debris fall or soil fall), topples (rock topple, debris topple, earth topple) and their related features (main and minor scarps, sag, toe), slides (rotational slide, rotational debris slide, rotational earth slide, rotational rock slide, toreva block, translational slide, translational debris slide, translational earth slide, translational rock slide, block glide), flows (debris flow, debris avalanche, earth flow, rockfall avalanche, mudflow, sand flow, block stream), the diverse types of creep, spreads (lateral spread, debris spread, earth spread, rock spread) and complex landslides. Include natural subsidence areas.

Value	Name	Definition	Description
nivalPeriglacialPermafrost	nival, periglacial and permafrost features	Geomorphologic landscapes and landforms related to snow, non-glacial, cold climate environments; geomorphologic landscapes and landforms occurring in the vicinity of glaciers and ice sheets; geomorphologic landscapes and landforms related to ground, soil, or rock that remains at or below 0º C for at least two years.	Landscape-scale, natural geomorphologic features related to periglacial and nival environments include the large-scale features occurring in permafrost areas (i.e. thermokarst). Landform-scale, natural geomorphologic features related to periglacial and nival environments include patterned grounds, some peat-related landforms (i.e. peat plateaux, muskegs and string bogs); mound-like landforms, as pingos; rock glaciers and diverse soliflucion features; and snow-related features, as for example snow fields, avalanche chutes and avalanche cones. Microfeature-scale, natural geomorphologic features related to periglacial and nival environments include the circles or poligons in patterned grounds (stripes, sorted and non-sorted circles, low center and high center polygons); hummock and mound-like microfeatures, as turf hummocks and palsen; and snow-related microfeatures, as for example snow hollows.

Value	Name	Definition	Description
glacial	glacial, glaciofluvial, glaciolacustrine and glaciomarine features	Geomorphologic landscapes and landforms related to to glacial, glaciofluvial, glaciolacustrine and glaciomarine environments.	Landscape-scale, natural geomorphologic features related to glacial, glaciofluvial, glaciolacustrine, glaciomarine and outwash environments include ice sheets and continental and alpine-type glaciers; fjords; ice-margin complexes; outwash plains and till plains; drumlin fields and glaciokarst areas. Landform-scale, natural geomorphologic features related to glacial, glaciofluvial, glaciolacustrine, glaciomarine and outwash environments include glacial cirques and their related features (aretes, cirque platform, cirque floor and cirque walls); glacial valleys and their related landforms (i.e. U-shaped valley; hanging valley; glacial-valley floor and glacial-valley wall features; nunatak); erratic blocks, diverse types of moraines (i.e. ground, lateral, medial and end moraines; hummocky moraines; terminal and desintegration moraines; esker and recessional moraines, and ice-pushed ridges) and relatd landforms, as kame and kettle; glacial drainage channels, tunnel valleys and ice-marginal streams; glacial, pro-glacial and tunnel-valley lakes and tarn; collapsed and reworked lacustrine features (i.e. collapsed lakeplains and collapsed ice floored or ice-walled lakebeds); and outwash plain-related landforms (head-of-outwash, outwash fans, outwash deltas, valley trains and outwash terraces; outwash plain collapse features and pitted outwash plain and terraces; fosse, drumlins, interdrumlins and drumlinoid riges; crag-and-tail and stoss-and-lee features), and other features as for example glacial potholes and swales, ice wedges, ice-wedge casts and ice-contact slopes, and roches moutonées, glacial flutes and glacial grooves.

Value	**Name**	**Definition**	**Description**
eolian	eolian features	Geomorphologic landscapes and landforms related to wind-dominated environments.	Landscape-scale, natural geomorphologic features related to eolian environments include desert pavement (reg) and gibber, deflation basins, sand plains, sand hills, dune fields and loess landscapes. Landform-scale features related to eolian environments include sand ramps and sand sheets; dune lakes, dune ponds, dune slacks and blowout depressions; diverse types of dunes (i.e. barchan dune, climbing dune, falling dune, parabolic dune, parna dune, longitudinal dune, seif dune, star dune, transverse dune, and stabilised and relict dunes) and related lanforms, as interdunes and foredunes; and loess-related landforms, as loess hills and loess bluffs. Minor features include dune features (windward slope, dune crest and slip face); small dunes, as shrub-coppice dunes and zibar; eolian ripples; yardang and yardang throughs; faceted stones and remnant features, as dune traces.

Value	Name	Definition	Description
marineLittoralCoastalWetland	marine, littoral and coastal wetlands features	Geomorphologic landscapes and landforms related to wave or tidal dynamics developed in marine, shallow marine, near-shore and littoral zone environments, and those related to vegetated and / or shallow wet areas	Marine, Littoral and Coastal Wetlands features include landscape-scale geomorphologic features as for example islands and barrier-islands, penninsulas and capes; atolls; coastal plain complexes; shore, shoreline and shore-complexes; deltas and delta-plain complexes; tidal flats complexes; marine terraces, lowlands and beach complexes; and their respective relict geomorphologic features. Landform-scale geomorphpologic features include delta plain-related landforms (i.e. channel bifurcation and divergence; distributary channels and interdistributary flood basins) and deltaic submerged landforms (i.e. mouth bars); spits and tomboloes; strand plains; beaches and their related landforms (i.e. berm, beach ridge, swash zone, washover fans) and relict landforms (i.e. raised beaches); barrier beaches and their related landforms (i.e. back-barrier beach, barrier flat, back-barrier flat, barrier cove, tidal inlets; ebb and flood tidal deltas);chenier plains, mud flats, swamps, marshes (i.e. tidal or salt marshes) and related landforms (i.e tidal channel complexes and drainhead complexes); reefs; sea cliffs and headlands; wave-cut platforms, wave-cut terraces and their respective raised and submerged relicts; and shallow water subaqueous landforms (i.e. submerged back-barrier beach, shoals and longshore bars). Other features are wave and current ripples, dune slacks, some potholes or vernal pools.

Value	Name	Definition	Description
karstChemicalWeathering	karst and chemical weathering features	Geomorphologic landscapes and landforms dominated by mineral dissolution, and commonly, subsurface drainage. Excludes glaciokarstic and thermokarstic features.	Landscape-scale features include karst landscapes developed on carbonate or evaporitic rocks (i.e. cockpit karst, cone karst, kegel karst, sinkhole karst and tower karst) and landscapes developed on siliceous cristalline and metamorphic rocks (i.e. granite landscapes). Landform-scale, natural geomorphologic karstic and chemical weathering-related features include solution platforms, pavement karst, karst valleys or uvala (i.e. blind valleys, and interior valleys or polje), caves, sinkholes/dolines (i.e. solution sinkholes, collapse sinkholes, and cockpits), swallow holes, karst cones and towers, pinnacles, boulder piles, tors and chemical weathering yardangs. Other karst and chemical weathering features are for example karren, cutter, and solution pipes, chimneys, fisures and corridors. Tafoni and weathering pits, related to salt weathering, are common microfeatures developed on the exposed surfaces of siliceous clastic sedimentary rocks, and of siliceous cristalline and metamorphic rocks.

Value	Name	Definition	Description
alluvialFluvial	alluvial and fluvial features	Geomorphologic landscapes and landforms dominantly related to concentrated water flow (channel flow), excluding glaciofluvial and deltaic geomorphologic landscapes and landforms.	Landscape-scale, natural geomorphologic alluvial and fluvial features include alluvial plains, fan piedmonts, bajadas, river valleys, meander belts, canyonlands, and their respective remnants. Landform-scale, natural geomorphologic alluvial and fluvial features include V-shaped valleys and their related landforms (i.e.valley floor, valley border surfaces, diverse types of terraces, including paleoterraces, strath terraces, and stream terraces, and their related scarps) ephemeral and intermittent stream channels; draw and ravines; braided streams and related bars; natural levees and crevasse splays; alluvial flats; alluvial cones, alluvial fans and related features (i.e. fan skirt, fan collar, inset fan, fanhead trench); fan aprons; canyons (i.e. box and slot canyons); flood plains and related features (i.e. overflow stream channels, flood-plain playas, flood-plain splays, flood-plain steps and giant ripples); meanders and their related features (i.e. meander scars, meander scrolls, cutoffs, point bars, and ephemeral oxbow lakes); and their respective remnants. Other natural geomorphologic alluvial and fluvial features are bar-and-channels, grooves, gullies, diverse types of minor scarps, and current ripple marks.

Value	Name	Definition	Description
lacustrine	lacustrine features	Geomorphologic landscapes and landforms related to inland permanent water bodies (lakes).	Landscape-scale, natural geomorphologic features related to lakes are lake plains, lacustrine shore complexes and relict features as pluvial lakes. Landform-scale, natural geomorphologic features related to lakes are the lacustrine backshore, including wetlands and related landforms (i.e. peat bogs and raised peat bogs); lacustrine beach plains; lacustrine beaches; lacustrine deltas and lacustrine delta plains; playas and related features (i.e. flood-plain playa, playa floor, playa rim, playa slopes and playa steps); and relict lacustrine features, as relict lakebeds, lacustrine terraces and their related scarps, and reworked lake plains. Other features include playettes, lacustrine shorelines and lacustrine strandlines.
impact	impact features	Geomorphologic landscapes and landforms related to the impact of extraterrestrial material on the Earth's surface.	Geomorphologic impact features include meteorite craters and related features, as crater rim, crater slopes, crater bottom and ejecta-related landforms, and cometary impact features.

1.1.15 Values of code list QuaternaryTimeScaleValue

Value	Name	Definition	Parent
weichselian	Weichselian	Weichselian	
eemian	Eemian	Eemian	
saalian	Saalian	Saalian	
holsteinian	Holsteinian	Holsteinian	
elsterian	Elsterian	Elsterian	
cromerian	"Cromerian complex"	"Cromerian complex"	
bavelian	Bavelian	Bavelian	

E.2 *Code-lists values for Geophysics*

1.1.16 Values of code list CampaignTypeValue

Value	Name	Definition
measurement	measurement	field data acquisition campaign

1.1.17 Values of code list NetworkNameValue

Value	Name	Definition
GSN	gsn	Global Seismographic Network
IMS	ims	IMS Seismological network
INTERMAGNET	intermagnet	International Real-time Magnetic Observatory Network
UEGN	uegn	Unified European Gravity Network
WDC	wdc	World Data Center

1.1.18 Values of code list PlatformTypeValue

Value	Name	Definition
ground	ground	Ground based measurement
landVehicle	land vehicle	Measurement carried out from a land vehicle
fixedWingAirplane	fixed-wing airplane	Measurement carried out from fixed-wing airplane
helicopter	helicopter	Measurement carried out from helicopter
seafloor	seafloor	Seafloor based measurement
researchVessel	research vessel	Measurement carried out from a ship
satellite	satellite	Measurement carried out from satellite

1.1.19 Values of code list ProfileTypeValue

Value	Name	Definition
boreholeLogging	borehole logging	Geophysical measurement along the axis of a borehole carried out with a special logging device
multielectrodeDCProfile	multi-electrode dc profile	DC resistivity and/or chargability (IP) measurement carried out along a profile with a larger set of electrodes. Also known as 2D resistivity tomography.
seismicLine	seismic line	Geophysical measurement used to record acoustic response of seismic sources along a line in order to define seismic properties in a cross section of the earth

1.1.20 Values of code list StationRankValue

Value	Name	Definition
observatory	observatory	Permanent monitoring facility with continuous observation scedule.
secularStation	secular station	Base station to record long term time variations of the observed physical field.
1stOrderBase	1st order base	Highest precision base station maintained by some authority. It is used to tie relative measurements to absolute network by

Value	Name	Definition
		third party observers.
2ndOrderBase	2nd order base	High precision base station of lower importance maintained by some authority.It is used to tie relative measurements to absolute network by third party observers.

1.1.21 Values of code list StationTypeValue

Value	Name	Definition
gravityStation	gravity station	Geophysical station to observe gravitational field
magneticStation	magnetic station	Geophysical station to observe magnetic field
seismologicalStation	seismological station	Geophysical station to observe strong motion seismological events (earthquake) or ambient noise
verticalElectricSounding	vertical electric sounding	Geophysical station to measure underground electric resistiviy and/or chargability (IP) changes in depth using 4 electrodes (AMNB) and direct current. Also known as VES.
magnetotelluricSounding	magnetotelluric sounding	Geophysical station to measure underground electric resistiviy changes using natural electromagnetic field variations. Also known as MT sounding.

1.1.22 Values of code list SurveyTypeValue

Value	Name	Definition	Description
airborneGeophysicalSurvey	airborne geophysical survey	Campaign of airborne geophysical measurements	An airborne geophysical survey may include any number of flight lines. Geometry is the overall bounding polygon and metadata also includes responsible parties.
groundGravitySurvey	ground gravity survey	Campaign of ground gravity measurements	A ground gravity survey may include any number of gravity stations. Geometry is the overall bounding polygon and metadata also includes responsible parties.
groundMagneticSurvey	ground magnetic survey	Campaign of ground magnetic measurements	A ground magnetic survey may include any number of magnetic stations. Geometry is the overall bounding polygon and metadata also includes responsible parties.
3DResistivitySurvey	3D resistivity survey	Campaign of 3D Multielectrode DC measurements	A 3D resistivity survey may include one or more 3D multielectrode DC measurements. Geometry is the overall bounding polygon and metadata also includes responsible parties.
seismologicalSurvey	seismological survey	Campaign of seismological measurements	A seismological survey may include any number of seismological stations. Geometry is the overall bounding polygon and

Value	Name	Definition	Description
			metadata also includes responsible parties.

1.1.23 Values of code list SwathTypeValue

Value	Name	Definition
3DSeismics	3d seismics	Geophysical measurement used to record acoustic response of seismic sources over an area in order to define 3D seismic property distribution in a volume of the earth

E.3 *Code-lists values for Hydrogeology*

1.1.24 Values of code list ActiveWellTypeValue

Value	Name	Definition
exploitation	exploitation	To extract groundwater from aquifer for various purposes (domestic, industrial, water supply intake and other)
recharge	recharge	a- Aquifer Recharge Wells: Used to recharge depleted aquifers and may inject fluids from a variety of sources such as lakes, streams, domestic wastewater treatment plants, other aquifers, etc. b- Saline Water Intrusion Barrier Wells: Used to inject water into fresh water aquifers to prevent intrusion of salt water into fresh water aquifers. Used in highly populated areas. c- Subsidence Control Wells: Used to inject fluids into a non-oil or gas-producing zone to reduce or eliminate subsidence associated with overdraft of fresh water and not used for the purpose of oil or natural gas production.
dewatering	dewatering	The removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes. This is often done during the site development phase of a major construction project due to a high water table. Usually involves the use of "dewatering" pumps.
decontamination	decontamination	Well used in remediation schemes that reduce the pollution in an aquifer.
disposal	disposal	A well, often a depleted oil or gas well, into which waste fluids can be injected for safe disposal. Disposal wells typically are subject to regulatory requirements to avoid the contamination of freshwater aquifers.
waterExploratory	water xploratory	A well drilled to seach for new groundwater.
waterSupply	water supply	Well used to supply water for various usages.
withdrawal	withdrawal	A well used to remove water from aquifers.
thermal	thermal	A well used to supply water for thermal purposes.
other	Other	Any other usage of a well.

1.1.25 Values of code list AquiferMediaTypeValue

Value	Name	Definition
fractured	fractured	Fractured aquifers are rocks in which the groundwater moves through cracks, joints or fractures in otherwise solid rock. Examples of fractured aquifers include granite and basalt. Porous media such as sandstone may become so highly cemented or recrystallized that all of the original space is filled. In this case, the rock is no longer a porous medium. However, if it contains cracks it can still act as a fractured aquifer.
porous	porous	Porous media are those aquifers consisting of aggregates of individual particles such as sand or gravel. The groundwater occurs in and moves through the openings between the individual grains. Porous media where the grains are not connected to each other are considered unconsolidated. If the grains are cemented together, such aquifers are called consolidated. Sandstones are examples of consolidated porous media.
karstic	karstic	Karstic aquifers are fractured aquifers where the cracks and fractures may be enlarged by solution, forming large channels or even caverns. Limestone terrain where solution has been very active is termed karst.
compound	compound	A combination of a porous, karstic and/or fractured aquifer.
karsticAndFractured	karstic and fractured	A combination of both karstic and fractured aquifer.
porousAndFractured	porous and fractured	A combination of both porous and fractured aquifer.
other	other	Aquifer is other then fractured, porous or karstic.

1.1.26 Values of code list AquiferTypeValue

Value	Name	Definition
confinedSubArtesian	confined subartesian	An aquifer containing water between two relatively impermeable boundaries. The water level in a well tapping a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above it. The water level does not rise above the ground surface
confinedArtesian	confined artesian	An aquifer containing water between two relatively impermeable boundaries. The water level in a well tapping a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above. The water level rises above the ground surface, yielding a flowing well.
unconfined	unconfined	An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well. An unconfined aquifer made up of loose material, such as sand or gravel that has not undergone lithification (settling). In an unconfined aquifer the upper boundary is the top of the Zone of Saturation (water table).

1.1.27 Values of code list ConditionOfGroundwaterValue

Value	Name	Definition
natural	natural	Groundwater quantity or quality is dependent only on

Value	Name	Definition
		natural factors.
lightlyModified	lightly modified	Groundwater quantity or quality is dependent mostly on natural factors, but with some human activity.
modified	modified	Groundwater quantity or quality is modified by human activity.
stronglyModified	strongly modified	Groundwater quantity or quality is modified by human activity and the values of a number of parameters exceed the drinking water standards.
unknown	unknown	The natural state of groundwater changes is unknown.

1.1.28 Values of code list HydroGeochemicalRockValue

Value	Name	Definition
silicatic	silicatic	Silicatic hydrochemical type of groundwater.
carbonatic	carbonatic	Carbonatic hydrochemical type of groundwater.
sulfatic	sulfatic	Sulfatic hydrochemical type of groundwater.
chloridic	chloridic	Chloridic hydrochemical type of groundwater.
organic	organic	Organic hydrochemical type of groundwater.

1.1.29 Values of code list NaturalObjectTypeValue

Value	Name	Definition
spring	spring	Also known as a rising or resurgence - it is a component of the hydrosphere. Specifically, it is any natural situation where water flows to the surface of the earth from underground. Thus, a spring is a site where the aquifer surface meets the ground surface.
seep	seep	A moist or wet place where water, usually groundwater, reaches the earth's surface from an underground aquifer.
swallowHole	swallow hole	Also known as a sink, shake hole, sinkhole, swallow hole, swallet, doline or cenote, it is a natural depression or hole in the Earth's surface caused by karst processes - the chemical dissolution of carbonate rocks or suffosion processes for example in sandstone.
fen	fen	ow land that is covered wholly or partly with water unless artificially drained and that usually has peaty alkaline soil and characteristic flora (as of sedges and reeds). A fen could be an effect of surface maining activity.
other	other	Other places where groundwater table meets the surface.
notSpecified	not specified	Not specified places where groundwater table meets the surface.

1.1.30 Values of code list StatusCodeTypeValue

Value	Name	Definition
abandonedDry	abandoned, dry	Abandoned because of lack of water.
abandonedInsufficient	abandoned, insufficient water	Abandoned because of insufficient amount of water.
abandonedQuality	abandoned, poor water quality	Abandoned because of water quality purposes.
deepened	deepened	Depth of boring increased.

Value	Name	Definition
new	new	Borehole constructed on a site not previously used.
notInUse	not in use	No longer used for any purpose.
reconditioned	reconditioned	Well that has been subject to remedial works to improve its functioning.
standby	standby	Abstraction used only when others are not available.
unfinished	unfinished	Boring or construction not completed.
unknown	unknown	Status not known or defined.
abandoned	abandoned	Previously used, but now no longer in use.

1.1.31 Values of code list WaterPersistenceValueValue

Value	Name	Definition
intermittent	intermittent	Filled and/or flowing for part of the year.
seasonal	seasonal	Filled and/or flowing for particular seasons of the year, i.e.Autumn/Winter.
perennial	perennial	Filled and/or flowing continuously throughout the year as its bed lies below the water table.
notSpecified	not specified	The type of hydrological persistence of water not specified.
ephemeral	ephemeral	Filled and/or flowing during and immediately after precipitation.

1.1.32 Values of code list WaterTypeValue

Value	Name	Definition
ultraFreshWater	ultra fresh water	Water with very low salinity. The salinity is equivalent or nearly equivalent to that of rainwater.
freshWater	fresh water	A- Freshwater is a word that refers to bodies of water such as ponds, lakes, rivers and streams containing low concentrations of dissolved salts and other total dissolved solids. In other words, the term excludes seawater and brackish water. Freshwater can also be the output of desalinated seawater. http://en.wikipedia.org/wiki/Freshwater Fresh water: Water with less than 0.5 parts per thousand dissolved salts.
acratopegae	acratopegae	From Ancient Greek akratos ("pure, unmixed") and PEGE ("source, fountain). Water with low mineral content or less than mineral water. Translated from : Du grec ancien akratos (" pur, sans melange ") et pege (" source, fontaine "). Qui a, en parlant d'une eau, une faible teneur en sels mineraux ou une teneur moindre que celle d'une eau minerale. http://fr.wiktionary.org/wiki/acratop%C3%A8ge
brackishWater	brackish water	Brackish water (less commonly brack water) is water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water, as in estuaries, or it may occur in brackish fossil aquifers. The word comes from the Middle Dutch root "brak," meaning "salten" or "salty" http://en.wikipedia.org/wiki/Brackish
saltWater	salt water	Saline water is a general term for water that contains a significant concentration of dissolved salts (NaCl). The concentration is usually expressed in parts per million (ppm) of salt. The salinity concentration level used by United States Geological Survey classifies saline water in

Value	Name	Definition
		three categories. Slightly saline water contains around 1,000 to 3,000 ppm. Moderately saline water contains roughly 3,000 to 10,000 ppm. Highly saline water has around 10,000 to 35,000 ppm of salt. Seawater has a salinity of roughly 35,000 ppm, equivalent to 35 g/L. Technically, brackish water contains between 0.5 to 30 grams of salt per litre?more often expressed as 0.5 to 30 parts per thousand (ppt). Thus, brackish covers a range of salinity regimes and is not considered a precisely defined condition. http://en.wikipedia.org/wiki/Saline_water
brineWater	brine water	Brine (lat. saltus) is water saturated or nearly saturated with salt (NaCl). http://en.wikipedia.org/wiki/Brine

1.1.33 Values of code list WellObservationTypeValue

Value	Name	Definition
surveillance	surveillance	Monitoring programme to: - Validate risk assessments: supplement and validate the characterisation and risk assessment procedure with respect to risks of failing to achieve good groundwater chemical status; - Classify groundwater bodies: confirm the status of all groundwater bodies, or groups of bodies, determined as not being at risk on the basis of the risk assessments; and - Assess trends: provide information for use in the assessment of long-term trends in natural conditions and in pollutant concentrations resulting from human activity. Parameters indicative of all the biological, hydro-morphological and general as well as specific physico-chemical quality elements must be monitored.
research	research	Monitoring programme to research the GroundWaterBody (or any local groundwater conditions) to obtain quality or quantity measures.
industrial	industrial	Local monitoring networks created to control groundwater status around industrial objects (factories, petrol stations and others).
quantitative	quantitative	Monitoring programme to supplement and validate the WFD Article 5 characterisation and risk assessment procedure with respect to risks of failing to achieve good groundwater quantitative status in all groundwater bodies, or groups of bodies. Its principal purpose is therefore to facilitate quantitative status assessment.
operational	operational	Monitoring programme to - establish the status of all groundwater bodies, or groups of bodies, determined as being 'at risk', - establish the presence of significant and sustained upward trends in the concentration of pollutants.
protectedArea	protected area	Monitoring program established directly for Protected Areas (including Drinking Water Protected Area (DWPA)).
chemical	chemical	Qualitative monitoring to determine groundwater chemical status.
otherObservation	other observation	Other observation (monitoring) process.