ECP-2007-GEO-317001

OneGeology-Europe

Scientific/Semantic Data Specification and Dictionaries

- Generic Specification for Spatial Geological Data in Europe -

Objective of this document

This document represents the OneGeology-Europe Scientific Data Specification produced by Work Package 3.
In addition it provides guidance on the vocabulary, the terms, their definitions and their relationships, which must be used by all OneGeology-Europe participants. An introductory explanation of the relevant parts of the GeoSciML data model along with guidance on the usage of GeoSciML is also included to provide initial context.

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Author(s)
WP3 Leader Kristine Asch
WP 3 Core Team M. Bavec, S. Bergman, F. Perez Cerdan, P. Declercq, S. Hennings, D. Janjou, S. Kacer, M. Klicker, J.L. Laxton, M. Nironen, M. Pantaloni, C. Schubert
Reviewed by A. Smith

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*OJL 79, 24.03.2005, p.1

Executive Summary

OneGeology Europe (1G-E) is delivering a web accessible, semantically and technically interoperable geological dataset, with progress towards harmonisation, for the whole of Europe at 1:1 million scale. This is based on the individual geological datasets held by each geological survey in Europe, and which may differ considerably with respect to their contents, description and geometry. To make these data interoperable is a considerable task and 1G-E Work Package 3 (WP3) is delivering the essential basis for that endeavour: the 1G-E Data Specification.

This document presents in detail the classifications, definitions, terms and Uniform Resource Names (URN) of the 1G-E Geology Data Specification, which are based on existing standards as far as possible. In addition it explains their use and encoding in GeoSciML. This specification will be the basis for each geological survey participating in 1G-E to describe the geology of their country within the project. It is only possible to achieve semantic interoperability and harmonisation of the data by using this common vocabulary.

This specification will also form one of the foundations and inputs for the future INSPIRE Geology Data Specification.

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1. Introduction

1.1 Overview of OneGeology-Europe (1G-E)

OneGeology-Europe (1G-E) is making geological spatial data held by the geological surveys of Europe more easily discoverable and accessible via the internet.

Geological spatial data is, for example, essential for the prediction and mitigation of landslides, subsidence, earthquakes, flooding and pollution. These issues are global in nature and their profile has also been raised by the OneGeology global initiative for the International Year of Planet Earth 2008. 'Geology' is also a key dataset in the EC INSPIRE Directive (Annex II); and fundamental to the Annex III Themes of natural risk zones, energy and mineral resources.

Rich geological datasets exist in the European geological surveys, but for those outside the surveys they are difficult to discover, to obtain and to understand. In addition the datasets from different geological surveys may differ considerably with respect to their contents, description and geometry; and are therefore not interoperable.

Figure 1-1: Participating countries in OneGeology-Europe.

The 1G-E project is delivering a web-accessible, interoperable geological spatial dataset for the whole of onshore Europe at 1:1 million scale based on existing data (specifically composition and structure of the surface geology) held by the various European geological surveys. To enable the interoperability of the datasets, a European specification for basic geological map data, i.e. a common European vocabulary and portrayal, is being developed. This is the vital foundation for the harmonisation of the datasets.

For 1G-E each participating geological survey provides access to its data via the internet, i.e. it implements and hosts an interoperable web service, delivering their national geological data in a semantically harmonised form. It is important to note that the original national databases, internal classifications and the vocabulary will remain unchanged. The 1G-E data model is implemented in GeoSciML which enables the sharing and exchange of the data within and beyond the geological community of Europe and globally. 1G-E therefore accelerates the development and deployment of this new international interchange standard for geological data.

1G-E is addressing the multilingual aspects of access through a multilingual discovery portal, so that awareness and interest is raised in the user and provider communities. Thus the project is moving geological knowledge closer to the end-user where it will have greater societal impact and ensure fuller exploitation of a key data resource gathered at huge public expense. Users of 1G-E will be able to discover, view and download geological data across Europe.

With this sharing of geological knowledge and data across Europe, 1G-E is facilitating re-use and addition of value by a wide spectrum of users in the public and private sectors; and identifying, documenting and disseminating strategies for the reduction of technical and business barriers to re-use. In addition, the project is providing examples of best practice in the delivery of digital geological spatial data to users, e.g. in the insurance, property, engineering, planning, mineral resource and environmental sectors.

Last but not least, 1G-E will be a test case for the geology theme and other themes of the implementation of the INSPIRE Directive. This may not only benefit the geology theme itself, but will also provide a template for other environmental data themes. Thus 1G-E will provide a reference base on which other valuable data products and services can be built. Therefore, 1G-E is ensuring that Europe plays a leading and pivotal role globally in the development of a geoscience spatial data infrastructure (SDI) – a major and significant contribution to INSPIRE.

1.2 The Relationship of the 1G-E Data Specification and INSPIRE

The EU Directive INSPIRE (2007/2/EC) came into force on 15th May 2007 with the aim of creating an Infrastructure for Spatial Information in Europe to provide a legislative framework that will enhance the accessibility of environmentally relevant data for politicians, economists, scientists and citizens. Ideally these data should be consistent and comparable, i.e. they should be interoperable and possibly even harmonised.

INSPIRE addresses 34 thematic geospatial data fields in Annex I, II and III of the Directive, and their metadata; to enable the cross-border interoperability of these data, Data Specifications are being set up for each of these themes - one being ‘Geology’.

The work of the Work Package 3 (WP3) Data Specification team has already been recognised by the European Commission as providing a basis for the necessary, more detailed specification of the INSPIRE geology theme.

Thus, the 1G-E Geology Data Specification exceeds the limits of the 1G-E project. It may influence the description of geology significantly of each European country in future.

1.3 Purpose of the Data Specification

Each geological survey in Europe (and across the world) has, over two centuries, developed their own national way to map, describe and portray geological map units. In the last twenty years different ways of modelling and describing the digital data have also been developed.

The need for harmonised European geological data was previously recognised in 1881 at the second International Geological Congress in Bologna, where the first cross-boundary international mapping project of Europe started: The International Geological Map of Europe and the Mediterranean Regions at the scale 1:1 500 000. This substantial international endeavour was finally completed in 2000 (BGR and UNESCO) and was soon followed by the completion of the first harmonised digital spatial dataset of Europe - the 1:5 million scale International Geological Map of Europe (Asch, 2005) which was also published as a paper map. The data compilation of the geology for these two map projects was carried out and coordinated centrally at the Federal Institute for Geosciences and Natural Resources (BGR), Germany, and its predecessors under the umbrella of the Commission of the Geological Map of the World (CGMW) in cooperation with European geological survey organisations and universities. Unlike these projects, 1G-E is a distributed digital model that leaves the data with the responsible geological survey organisation, which provides access via the internet and the 1G-E Geoportal.

Geology does not change at political boundaries. However, there is a high probability that the same rock formations will be described differently, with regard to their lithology, age, or genesis, from one country to another. Furthermore, they will be portrayed with differing colours and symbols.

The European Commission and many users require consistent geological data, which does not change its attributes or portrayal as it crosses political boundaries. The EC INSPIRE Directive (see section 1.2), as well as the EC Water and Soil Directives, are addressing these issues. An international, general, generic description of the data - a Data Specification - is thus essential.

This document provides the 1G-E Data Specification. It lists, in hierarchical order, required terms and their definitions, for four relevant features: lithology, age, genesis and structures, each referenced to existing definitions and standards.

A major basis for this 1G-E Data Specification on geology is the GeoSciML scheme and the CGI/GeoSciML vocabularies; both developed by the Interoperability Working Group (IWG) of the IUGS Commission for the Management and Application of Geoscience Information (CGI).

The Operational Management Group of 1G-E has decided that this geological Data Specification should contribute to, and take forward, the single global (IUGS endorsed) scheme. This means that additions or amendments required by this European project will be proposed to the IWG. Any issues or conflicts arising will be resolved jointly by the IWG and the WP 3 team to ensure that a single unified global scheme results.

1.4 Development process of the 1G-E Data Specification

This document was iteratively developed by the WP 3 core team - experts from ten geological surveys who met at three workshops and corresponded frequently by email and telephone. In order to ensure consistency with the global GeoSciML scheme other experts from outside the core team were additionally consulted: John Laxton (WP 4), Agnès Tellez-Arenas (WP 6), Lars-Kristian Stølen (CGI Interoperability Working Group) and, in particular, Stephen Richard, chair of the CGI, IWG Concept Definition Task Group, who made a substantial contribution.

The 1G-E vocabulary is created to be consistent with the GeoSciML schema and feature types, and it uses subsets of the CGI/GeoSciML vocabularies (e.g. CGI Simple Lithology).

The CGI Simple Lithology vocabulary uses multiple, overlapping hierarchies and offers numerous detailed ways how to classify and identify a rock unit. For 1G-E, which addresses spatial data at a target scale of 1:1 million, this proved to be too complex and would make harmonisation significantly more difficult. WP3 selected an adequate subset of the CGI vocabulary, and submitted more than120 new terms and concepts and several definitions to the CGI vocabulary in order to meet European requirements (fig. 1-2).

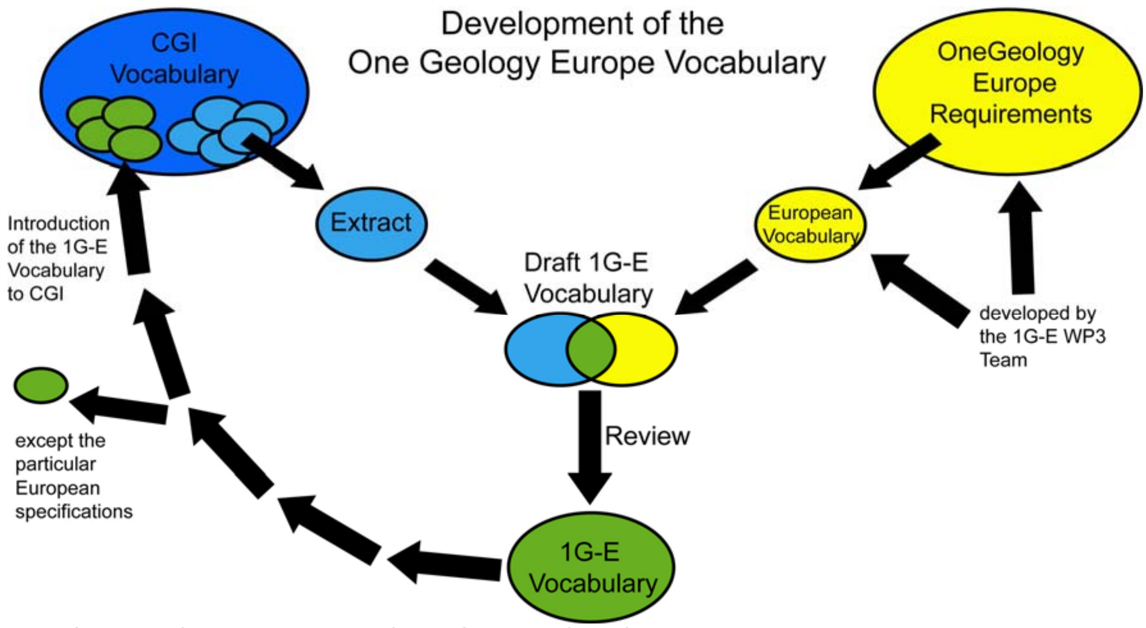

Fig. 1-2: Schema of the development of the 1G-E Data Specification.

The process of delivering an agreed set of terms involved many discussions and iterations between CGI experts and WP 3. The aim was that to build a set of terms for 1G-E that would be part of the global vocabulary. The dialogue was successful – with compromises necessary on both sides. There are only two additional elements in the 1G-E vocabulary that are not globally applicable and will be part of a specific European, rather than a global vocabulary: European terms for orogenic events and additional sub-divisions of the Pre-Cambrian at epoch level. The 1G-E Geology Data Specification thus contains a set of vocabularies that are tailored to describe the European geology appropriately.

A draft version of the vocabulary was developed by nine geological survey partners within the WP3 core team. It then underwent a thorough review process by the 20 project member surveys and eight partners, including two NGOs outside the project (the Commission of the Geological Map of The World and the IUGS Concept Definition Task Group).

The return rate on review comment was substantial: 532 comments were received. This demonstrates the (sometimes) passionate European interest in geological specifications, and accordingly that any pan-European specification will be highly contentious. The vocabulary is a sensitive issue as each European nation has a long held tradition of describing geology in accordance with their own national conventions. The vocabulary produced by WP3 thus represents a compromise between national schemes and is based on a pan-European cross-border approach to geological maps to produce geoscience data at 1:1 M scale consistent with a global vocabulary.

2. Definition of ‘Geology’ for 1G-E

‘Geology’ within 1G-E is defined in the Description of Work (DoW, [EC Contract document], p.25) as "composition (lithology/geochronology) and structure of the surface geology”. Thus it is a mandatory requirement of all geological survey participants to describe and deliver the spatial data of the surface geology of their country, which is defined as follows:

Surface geology = geology that would be visible if the overlaying soil were removed, in other words: the Quaternary/superficial geology plus the exposed bedrock.

As several countries within the 1G-E participants traditionally place emphasis on displaying the bedrock geology of their country, WP 3 offers, in cooperation with WP 5 and 6, to include the bedrock geology as a separate layer. This option can only be used in addition to the surface geology and its use is optional. The Bedrock geology is defined in this context as follows:

Bedrock geology = pre-Quaternary geology.

3. 1G-E and CGI/GeoSciML

3.1 Introduction to the GeoSciML model and its use within 1G-E

This section is designed to provide an introduction to the part of the GeoSciML (GeoScience Markup Language) data model that is used in 1G-E. It is not intended to be a full explanation of the GeoSciML data model, but provides initial context and background so that users may understand how the vocabulary relates to it. Full documentation is available at

http://www.geosciml.org/geosciml/2.0/doc/

and an encoding cookbook, covering the main features of the model, is available at

http://www.geosciml.org/geosciml/2.0/cookbook/GeoSciML_Data_CookBook_V2.pdf.

Specific and detailed GeoSciML technical information will be provided as a 1G-E online resource by Work Packages 4, 5 and 6. GeoSciML follows the encoding rules from ISO 19136 Annex E for GML 3.2.1 and is therefore a profile of GML (Geographic Markup Language). This means that it inherits some properties (attributes), in particular for the specification of geometry, from GML.

GeoSciML is a GML Application Schema that can be used to transfer information about geology. Its emphasis is on the "interpreted geology" that is conventionally portrayed on geological maps. It was created and is governed by the Commission for the Management and Application of Geoscience Information (CGI) to support interoperability of information served from geological surveys and other data providers.

For the unique and unambiguous identification of concepts and terms, URNs are being used within 1G-E, following the conventions used by the CGI and OGC. The URNs relating to specific concepts and terms are given in the 1G-E vocabulary (chapter 4), these URNs must be used to populate properties in 1G-E. More information on the structure of CGI URNs is given at

https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIIdentifierScheme.

Examples of GeoSciML code are provided as figures within the text.

Table 3-1: Overview over the Feature Types used in the 1G-E Data Specification.

GeoSciML FeatureType used in 1G-E	Properties of the FeatureType used in 1G-E	Description in section	URN used to populate the property	mandatory	optional
MappedFeature	MappedFeatureObservationMethod	3.2.1	compilation; Table 3-2	x	
	PositionalAccuracy	3.2.1	-	x	
	Shape	3.2.1	-	x	
	SamplingFrame	3.2.1	Surface map: EarthNaturalSurface; Bedrock map: BedrockSurface	x	
GeologicFeature: GeologicUnit	ID	3.2.2	-	x	
	Name	3.2.2	-	x	
	Description	3.2.2	-		x
	ObservationMethod	3.2.2	Table 3-3	x	
	Purpose	3.2.2	typical_norm	x	
	GeologicUnitType	3.2.2	Table 3-4		
	GeologicUnitMorphology	3.2.2	Dike; Table 3-5	x for dikes	x
	CompositionPart: Lithology	3.1; 4.2	Tables 4-4, 4-5, 4-6 and 4-7	x	
	CompositionPart: GeologicUnitPartRole	3.1; 4.2	only_part or unspecified_part _role; Table 4-3	x	
	CompositionPart: ProportionTerm	3.1; 4.2	all, predominant, subordinate; Table4-2	x	
GeologicFeature: GeologicStructure	ID	3.2.2	-	x	
	Name	3.2.2	-	x	
	Description	3.2.2	-		x
	ObservationMethod	3.2.2	Table3-3	x	
	Purpose	3.2.2	typical_norm	x	
	ContactType	3.1; 4.5	Table 4-12	x for contacts	
	FaultType	3.1; 4.5	Table 4-13	x for faults	
GeologicEvent	PreferredAge	3.1; 4.1	Table 4-1	x	
	GeologicHistory	3.1; 4.1	Table 4-1		x
	EventEnvironment	3.1; 4.3	Table 4-8	x for Quaternary	x
	EventProcess	3.1; 4.3	Table 4-9	x	
	OrogenicEvent	4.7	Table 4-14		x
MetamorphicDescription	MetamorphicFacies	3.1; 4.4	Table 4-10		x
	MetamorphicGrade	3.1; 4.4	Table 4-11		x
	ProtolithLithology	3.1; 4.4	Tables 4-4, 4-5, 4-6 and 4-7; Purpose: typical_norm; consolidationDegree: consolidation_not _specified		x

MappedFeature and GeologicFeature

Central to GeoSciML are the two FeatureTypes: MappedFeature and GeologicFeature. Both are used within 1G-E and require explanation. GeologicFeature is used to describe real-world geological features, whose full geometric extent is unknown. A MappedFeature can be seen as a 'view' of a GeologicFeature; therefore any GeologicFeature can have several such MappedFeature views. On published geological maps different polygons depicting the same rock unit generally show the same symbolisation and have a single description in the map key. In GeoSciML each such polygon is a distinct MappedFeature, each one a different view of the same GeologicUnit. Other MappedFeature 'views' of the GeologicUnit might occur on geological maps of different scales or as volumes in a 3D model, for example. A MappedFeature is therefore mainly a holder of geometry whereas a GeologicFeature is a holder of descriptive properties.

GeologicUnit and GeologicStructure

The feature type GeologicFeature comprises two subtypes in the present implementation of GeoSciML: GeologicUnit and GeologicStructure.

GeologicUnit is used for the descriptions of rock bodies and consists of the following properties:

- CompositionPart, for the description of the lithology
- GeologicEvent, for the description of the age and events, that formed and/or modified the GeologicUnit
- MetamorphicDescription, for the description of metamorphic rocks

With GeologicStructure linear features like faults and contact structures are defined with the following properties:

- FaultType, for the description of faults
- ContactType, for the description of calderas, impact craters and glacial stationary lines
- GeologicEvent, for the description of the age and event, that formed and/or modified the GeologicStructure

CompositionPart

A GeologicUnit can be composed of one or more CompositionParts, i.e. lithologies which together form the GeologicUnit. With the FeatureType CompositionPart, the rock type/s (lithology property), the role of the lithologies (role property) and the proportion of the different lithologies (proportion property) forming the GeologicUnit can be defined.

GeologicEvent

In GeoSciML, ages and events are bound together in the FeatureType GeologicEvent. Any age must be the age of some event happening, for example the age during which deposition of a sedimentary rock took place; the age of intrusion or crystallisation of an igneous rock; the age of a particular period of folding; the protolith age of a metamorphic rock; or the age of the final phase of metamorphism.

The age can be recorded as a numerical value (e.g. 250Ma) or as a geochronological term (e.g. Early Triassic) and both number and term ages can be given as single values or as a range. Note that this age range is to record a time period and is distinct from an error range on a numerical age (which can also be recorded).

GeoSciML allows the recoding of two distinct properties for any GeologicFeature: PreferredAge and GeologicHistory. The PreferredAge property allows a single age or age range, to be given to a GeologicFeature. The GeologicHistory property allows a series of GeologicEvents that led to the formation of the unit to be recorded, e.g. a rock-forming deposition event followed by several metamorphic or deformation events.

MetamorphicDescription

GeoSciML offers the option of describing the metamorphism of a GeologicUnit beyond the lithological term with the property MetamorphicDescription. For 1G-E this property includes the estimated intensity of metamorphism (MetamorphicGrade), the characteristic metamorphic mineral assemblages (MetamorphicFacies) and protolith material (ProtolithLithology), if known.

3.2 Encoding the vocabulary in GeoSciML

In this section the encoding of those properties that are required for every MappedFeature and GeologicFeature in the dataset, and which are more or less fixed, are described. The encoding of the properties that can be defined using the 1G-E vocabulary are explained directly in the vocabulary chapter (see chapter 4).

Note, that unless it is specifically stated that they are optional, all the properties described in the following sections are mandatory to use for 1G-E.

3.2.1 MappedFeature

The FeatureType MappedFeature is used to define the geometry of the geological units or structures of the dataset. In the following the mandatory attributes that need to be defined for each MappedFeature that appears in the dataset, are explained.

MappedFeatureObservationMethod
The ObservationMethod property of MappedFeature enables the reconstruction of the source or sources of the geometry of the MappedFeatures. Note that this is distinct from the ObservationMethod property of GeologicFeature which enables the reconstruction of the source or sources of the described properties of the GeologicFeatures. For 1G-E the MappedFeatureObservationMethod property should always be set to 'compilation' (tab. 3-2, fig. 3-2).

Table 3-2: The 1G-E term to describe the MappedFeatureObservationMethod

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
mfom	Compilation		Mapped feature geometry derived from one or more published or unpublished data sources, involving some interpretation or generalisation by the compiler; not an exact digital reproduction of the sources.	CGI/GeoSciML.	compilation	urn:cgi:classifier:CGI:MappedFeatureObservationMethod:201001:compilation

PositionalAccuracy
The property PositionalAccuracy is designed to provide an indication of spatial resolution. For 1G-E it should be provided as a numerical value in metres to indicate the distance from the given geometric position, e.g. a GeologicFeature. The value is centred on the geometric position; a PositionalAccuracy value of 500 m therefore means +/- 500 m about the geometry. It is recommended to give all MappedFeatures the same, approximate, value; for 1G-E this value should generally be around 250 m (figure 3-2).

Shape
The Shape property holds the geometry of the MappedFeature as a series of coordinate pairs. The geometry can be of any appropriate GML geometric type; for a GeologicUnit this will typically be a Polygon with 'LinearRing' structures defining the OuterBoundary and, if necessary, InnerBoundary (e.g. for holes); for a GeologicStructure this will typically be a 'LineString' (fig. 3-1).

```
<gsml:shape>
  <gml:Polygon srsName="urn:ogc:def:crs:EPSG:4326">
    <gml:outerBoundaryIs>
      <gml:LinearRing>
        <gml:posList> 142.177639798951 -19.2583990608557 142.172068544096 -19.2546485090388 142.155416913158 -19.2516959832536 142.141116191144 -19.2449615283995
42.136385949755 -19.2457329336206 142.136395566884 -19.2479970732439 142.140372291732 -19.2517521359808 142.153849380413 -19.2577358051352 142.168928361458
19.2599404653786 142.172899243883 -19.2621870745973 142.176062814743 -19.262174894991 142.177639798951 -19.2583990608557 </gml:posList>
      </gml:LinearRing>
    </gml:outerBoundaryIs>
  </gml:Polygon>
</gsml:shape>
```

Figure 3-1: Example of the encoding of the Shape porperty of MappedFeature.

SamplingFrame

The SamplingFrame property indicates the spatial reference frame within which the features have been observed. For 1G-E this should be set to ‘EarthNaturalSurface’ for the surface map and ‘BedrockSurface’ for the bedrock map (fig. 3-2).

```
<gsml:MappedFeature>
  <gsml:observationMethod>
    <gsml:CGI_TermValue>
      <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:MappedFeatureObservationMethod:201001:compilation </gsml:value>
    </gsml:CGI_TermValue>
  </gsml:observationMethod>
  <gsml:positionalAccuracy>
    <gsml:CGI_NumericValue>
      <gsml:principalValue uom="urn:ogc:def:uom:UCUM:m">250</gsml:principalValue>
    </gsml:CGI_NumericValue>
  </gsml:positionalAccuracy>
  <gsml:samplingFrame xlink:href="urn:cgi:feature:CGI:BedrockSurface" />
```

Figure 3-2: Example of the encoding of the MappedFeature properties ObservationMethod, PositionalAccuracy and SamplingFrame.

3.2.2 GeologicFeature

For 1G-E the two subtypes GeologicUnit and GeologicStructure of the FeatureType GeologicFeature are used for the description of the geology. In the following, the mandatory attributes that need to be defined for each GeologicFeature that appears in the data set in 1G-E, are explained.

ID
For 1G-E each GeologicUnit and each GeologicStructure should be given a unique identifier (ID). This is for use in application processing rather than for information exchange, so the ID value can be anything as long as it is unique.

Name
Normally a GeologicUnit on a map would have a name, typically recorded in a stratigraphic lexicon. In 1G-E there has been no attempt to harmonise lithostratigraphy by creating a single integrated stratigraphic lexicon for Europe. GeologicUnits will be portrayed in 1G-E web services on the basis of their age or lithology rather than lithostratigraphy. There is therefore no requirement to name GeologicUnits and use of the Name property is optional.

However, you may wish to use the Name property of GeologicUnit to record the name of the unit used in your own stratigraphic lexicon which would therefore provide a link to the 'full' original description of the unit. No retrieval or symbolisation based on this name will be implemented in 1G-E but such a link could be implemented in the future if required.

The same applies for GeologicStructures: some might have a specific name that you wish to define to provide a link to your original description of the structure. The use of the Name property for GeologicStructures is also optional.

If you wish to name a GeologicUnit or GeologicStructure you should give it a URN following the CGI pattern described at
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIIdentifierScheme.

An example of this is (from the BGS Stratigraphic lexicon):
urn:cgi:classifier:BGS:StratigraphicLexicon:MMG;

where: BGS = Registered CGI Party responsible for the resource; StratigraphicLexicon = the name of the vocabulary within which the concept being referenced is held; MMG = the identifier for a specific concept, in this case the 'Mercia Mudstone Group'.

A full list of registered CGI parties, who are able to register resources, is available at
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIPartyRegister.

If your organisation is not on this list you can apply to have it added following the instructions on this web page. You can then register your resources (e.g. a classification scheme) in the CGI Authority Register following the procedures given here:
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIAuthorityRegister

Note that the resource referenced does not need to be available in digital form; the URN is simply providing an identifier, not an address.

It is possible to give multiple names to a GeologicUnit or GeologicStructure. The example shown in figure 3-3 demonstrates that the name can also be presented in natural language in addition to the name giving the URN.

Description

In addition to the Name property it is possible to provide a free-text description of the GeologicUnit/GeologicStructure. The use of this Description property is optional and will not be used for retrieval. However, it can provide useful information about the GeologicUnit or GeologicStructure that is not given elsewhere in the 1G-E specification (fig. 3-3).

Observation Method

The ObservationMethod property of GeologicUnit/GeologicStructure enables the reconstruction of the source or sources of the described properties of the GeologicFeatures. Note that this is distinct from the ObservationMethod property of MappedFeature which enables the reconstruction of the source or sources of the geometry of the GeologicFeatures.

For 1G-E the ObservationMethod property should be set to either 'data_from_single_published_description' (where the property values are derived from a single source document) or 'synthesis_of_multiple_published_descriptions' (where the property values are derived from multiple source documents; see fig. 3-3, tab. 3-3).

Table 3-3: The 1G-E terms to describe the ObservationMethod of GeologicFeatures.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
fom1	Data from single published description		Data are extracted from a publised description of the feature.	CGI/GeoSciML.	data_from_single_published_description	urn:cgi:classifier:CGI:FeatureObservationMethod:201001:data_from_single_published_description
fom2	Synthesis of multiple published descriptions		Data are the result of synthesis from multiple published descriptions.	CGI/GeoSciML.	synthesis_of_multiple_published_descriptions	urn:cgi:classifier:CGI:FeatureObservationMethod:201001:synthesis_of_multiple_published_descriptions

Purpose

The Purpose property is used to state if the GeologicUnit/GeologicStructure description is of a particular occurrence or 'instance', such as given on a field map, or a typical or 'normative' description as used in a stratigraphic lexicon. On published maps the descriptions are generalised and given in the map key, and possibly in a related stratigraphic lexicon. For 1G-E the Purpose property should be set to 'typical_norm', as shown in figure 3-3.

```
<gsml:specification>
  <gsml:GeologicUnit gml:id="MMG_1">
    <gml:description>Dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite widespread; sandstones are also present</gml:description>
    <gml:name codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:BGS:StratigraphicLexicon:MMG</gml:name>
    <gml:name codeSpace="urn:cgi:classifierScheme:BGS:StratigraphicLexicon">MERCIA MUDSTONE GROUP</gml:name>
    <gsml:observationMethod>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:FeatureObservationMethod:201001:synthesis_of_multiple_published_descriptions </gsml:value>
      </gsml:CGI_TermValue>
    </gsml:observationMethod>
    <gsml:purpose>typicalNorm</gsml:purpose>
```

Figure 3-3: Example of the encoding of the GeologicUnit properties ID, Name, Description and Purpose.

GeologicUnitType

Each GeologicUnit must be given a GeologicUnitType value drawn from table 3-4.The GeologicUnitType refers to the definition and/or delimitation of the GeologicUnit, not to its portrayal in 1G-E. Most maps contributing to 1G-E are likely to have a combination of Lithostratigraphic Units and Lithodemic Units. If these cannot be practically separated for encoding, they can all be grouped as Lithologic Units.

Table 3-4: The 1G-E vocabulary to describe the GeologicUnitType.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
g	Geologic Unit		Type of geologic unit is unknow n, unspecified, irrelevant, or some type not included in the vocabulary. Type makes no implication for required properties or cardinalities. This is the root concept for the type hierarchy.	CGI/GeoSciML	geologic_unit	urn:cgi:classifier:CGI:GeologicUnitType:200811:geologic_unit
g1	Lithologic Unit	geologic_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.	CGI/ GeoSciML.	lithologic_unit	urn:cgi:classifier:CGI:GeologicUnitType:200811:lithologic_unit
g1.1	Lithostratigraphic Unit	lithologic_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	Salvador, 1994.	lithostratigraphic_unit	urn:cgi:classifier:CGI:GeologicUnitType:200811:lithostratigraphic_unit
g1.2	Lithodemic Unit	lithologic_unit	Lithostratigraphic unit that lacks stratification.	NACSN, 1983[1].	lithodemic_unit	urn:cgi:classifier:CGI:GeologicUnitType:200811:lithodemic_unit

[1] for explanation please see chapter 8: Abbreviations.

GeologicUnitMorphology

The property geologicUnitMorphology only applies, if it is necessary to describe a GeologicUnit as a dike. In this case, the geologicUnitMorphology should be set to 'dike' (tab. 3-5).

Table 3-5: The 1G-E vocabulary to describe the GeologicUnitMorphology.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
gum	Three dimensional body		Any three dimensional body.	CGI/GeoSciML.	three_dimensional_body	urn:cgi:classifier:CGI:GeologicUnitMorphology:201001:three_dimensional_body
gum1	Geologic body	three_dimensional_body	A three dimensional body defined based on geometric shape, w ith some geologic connotation or denotation.	CGI/GeoSciML.	geologic_body	urn:cgi:classifier:CGI:GeologicUnitMorphology:201001:geologic_body
gum1.1	Dike	geologic_body	A generally sheet-like intrusive rock body that cuts across bedding or foliation in the host rock, or intrudes massive host rock.	Neuendorf et al., 2005.	dike	urn:cgi:classifier:CGI:GeologicUnitMorphology:201001:dike

4. Vocabulary

The vocabulary from 1G-E includes 524 terms and Uniform Resource Names (URN) to describe the age, lithology, genesis and metamorphism of rocks, plus their contacts and fault structures.

However, the 1G-E vocabulary is not a simple list of geological terms. It might be regarded as a set of classification tables and dictionaries, since each vocabulary table has its own hierarchy and all the terms are defined with a description, the source, their broader concept and sometimes a synonym or related concept.

Each vocabulary table has the same format providing similar information for each term listed in the same seven columns. The first column displays the '1G-E ID', an alphanumerical identifier that stores the hierarchy of the terms in that vocabulary. The next column gives the '1G-E Term', the preferred name or label for the described concept. The '1G-E Broader Concept' are parents of terms in a concept hierarchy tree. The 'Definition' column gives an explanation of the intended meaning of a term, including any clarification of what is or is not included within the meaning of this term. The definition establishes the identity of a concept by distinguishing it from other terms. In addition it shows terms that are equivalent to the defined term, i.e. synonyms, as well as terms that are commonly associated with it, but are not exactly equivalent; the latter are labelled with: 'SeeAlso'. For some terms, 'Related Concepts' are given. These are vocabulary concepts associated with the defined term and may be a necessary component in the definition of this term, but are neither equivalent nor hierarchical, e.g. the term 'rock' forms a necessary part of the definition of petrology. The 'Source' column, gives the origin of the definition provided. The last two columns 'CGI_URN' and 'Complete URN' list the Uniform Resource Names for each term; the longer format including a standard prefix link to the particular vocabulary table in the name. The URNs are used to encode the vocabulary in GeoSciML.

Fifteen vocabularies have been defined:

Table 4-1: Overview over the 1G-E vocabularies.

1G-E Vocabulary	Described in Section	Listed in Table
Lithology (including Igneous Material, Sedimentary Material, Composite Genesis Material, Breccia and Tuffite)	4.2	4-5: Igneous Material 4-6: Sedimentary Material 4-7: Composite Genesis Material 4-8: Breccia and Tuffite
Age	4.1	4-2
EventEnvironment	4.3	4-9
EventProcess	4.3	4-10
OrogenicEvent	4.7	4-15
MetamorphicFacies	4.4	4-11
MetamorphicGrade	4.4	4-12
GeologicUnitType	3.2	3-4
GeologicUnitMorphology	3.2	3-5
GeologicUnitPartRole	4.2	4-4
ProportionTerms	4.3	4-3
ContactType	4.5	4-13
FaultType	4.5	4-14
FeatureObservationMethod	3.2	3-3
MappedFeatureObservationMethod	3.1	3-2

The following sections present the vocabulary and explain its use in 1G-E, and inGeoSciML. Note, that unless it is specifically stated that they are optional all the properties described in the following sections are mandatory to use for 1G-E.

4.1 Age

The only global internationally agreed standard to describe the age of rocks is the IUGS-ICS International Stratigraphic Chart (Version 2009, see Annex I). This has been adopted as mandatory by 1G-E, with the following modifications:

1. the chronostratigraphic adjectives “Lower” and “Upper” in the series of the International Stratigraphic Chart are combined with the geochronological epoch adjectives “Early” and “Late”, respectively, e.g. Upper/Late Jurassic (see table 4-2).

2. the International Stratigraphic Chart has been complemented with 27 new Precambrian Epochs (marked with an asterisk in table 4-2). The reason for this is that the ICS Chart does not subdivide the Precambrian enough for 1G-E. The Fennoscandian Shield forms a large part of Europe where most rocks are of Precambrian age.

GeoSciML offers two options for defining the age of a GeologicUnit: PreferredAge and GeologicHistory. For PreferredAge it is only possible to define one age range; GeologicHistory provides the option of recording a series of GeologicEvents that led to the formation of the GeologicUnit, which is likely to be particularly useful for metamorphic rocks. In both options one can describe lower and upper ages of GeologicEvents (EventAge), as well as the process and the environment linked to the GeologicEvent (EventEnvironment and EventProcess, see section 3.4 Genesis).

For 1G-E the PreferredAge is the age of the formation, i.e. the genesis of the GeologicUnit. It is mandatory for each GeologicUnit to provide a term range giving the URNs for the lower (older) age and the upper (younger) age. The aim should be to record ages to the highest resolution possible. If both the lower and upper age falls within the same geochronological unit, then both fields should be populated with the same term. The portrayal in the map service will be based on the lower age (fig. 4-1).

```
<gsml:preferredAge>
  <gsml:GeologicEvent>
    <gsml:eventAge>
      <gsml:CGI_TermRange>
        <gsml:lower>
          <gsml:CGI_TermValue>
            <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:ICS:StratChart:200908:Olenkian</gsml:value>
          </gsml:CGI_TermValue>
        </gsml:lower>
        <gsml:upper>
          <gsml:CGI_TermValue>
            <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:ICS:StratChart:200908:Rhaetian</gsml:value>
          </gsml:CGI_TermValue>
        </gsml:upper>
      </gsml:CGI_TermRange>
    </gsml:eventAge>
    <gsml:eventEnvironment>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:EventEnvironment:201001:arid_or_semi_arid_environment_setting</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:eventEnvironment>
    <gsml:eventProcess>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:EventProcess:201001:deposition</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:eventProcess>
  </gsml:GeologicEvent>
</gsml:preferredAge>
```

Figure 4-1: Example of the encoding of PreferredAge.

The option GeologicHistory is not mandatory for 1G-E. It can be used either to provide a detailed history of events that formed the GeologicUnit or it can be used to provide a numerical age to refine the geochronological unit based age given in PreferredAge, in which case the GeologicHistory may contain only one GeologicEvent. Please note that to record an age of e.g. 250 Million years, the ‘units of measure property (uom)’ should be set to ‘Ma’ and the age recorded as a negative number (‘-250’) (fig. 4-2).

Table 4-2 shows the 1G-E vocabulary for ‘Age’, i.e. the geochronological terms/units that should be used for the age description of the GeologicUnits. Figure 4-3 highlights the corresponding hierarchy.

```xml
<gsml:geologicHistory>
  <gsml:GeologicEvent>
    <gsml:eventAge>
      <gsml:CGI_NumericRange>
        <gsml:lower>
          <gsml:CGI_NumericValue>
            <gsml:principalValue uom="urn:ogc:def:uom:UCUM:Ma">-247</gsml:principalValue>
          </gsml:CGI_NumericValue>
        </gsml:lower>
        <gsml:upper>
          <gsml:CGI_NumericValue>
            <gsml:principalValue uom="urn:ogc:def:uom:UCUM:Ma">-202</gsml:principalValue>
          </gsml:CGI_NumericValue>
        </gsml:upper>
      </gsml:CGI_NumericRange>
    </gsml:eventAge>
    <gsml:eventEnvironment>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:EventEnvironment:201001:arid_or_semi_arid_environment_setting</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:eventEnvironment>
    <gsml:eventProcess>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:EventProcess:201001:deposition</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:eventProcess>
  </gsml:GeologicEvent>
</gsml:geologicHistory>
<gsml:geologicUnitType xlink:href="urn:cgi:classifier:CGI:GeologicUnitType:200811:lithostratigraphic_unit"/>
```

Figure 4-2: Example of the encoding of GeologicHistory to provide a numerical age. The coding of the GeologicUnitType property is also shown.

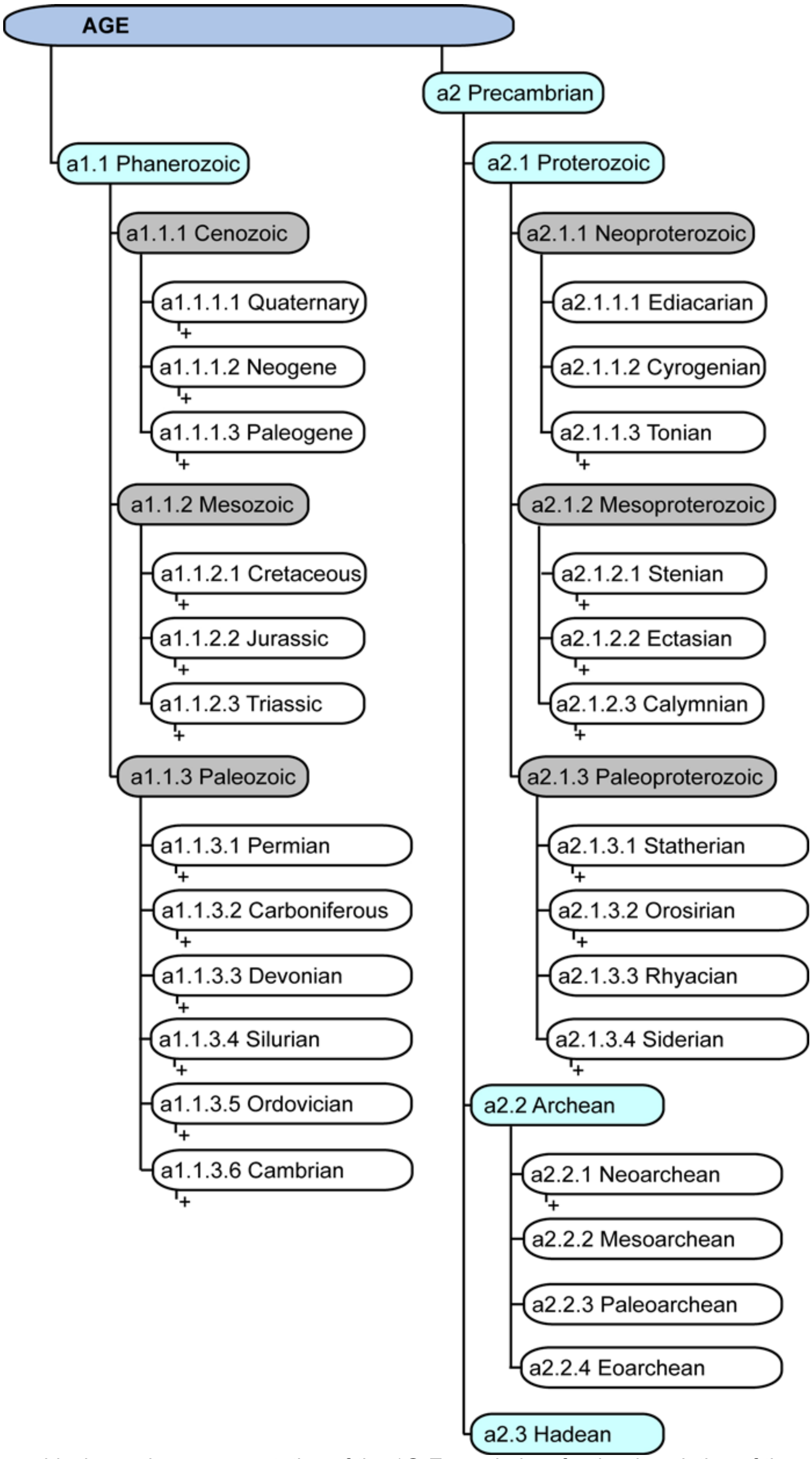

Figure 4-3: Hierarchical overview representation of the 1G-E vocabulary for the description of the age of a GeologicUnit. For clarity concepts are indicated up to Epoch level only.

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1	Phanerozoic		542 ±1 - 0	IUGS ICS Stratigraphic Chart, 2009.	Phanerozoic	urn:cgi:classifier:ICS:StratChart:200908:Phanerozoic
a1.1.1	Cenozoic	Phanerozoic	65.5 ±0.3 - 0	IUGS ICS Stratigraphic Chart, 2009.	Cenozoic	urn:cgi:classifier:ICS:StratChart:200908:Cenozoic
a1.1.1.1	Quaternary	Cenozoic	2.588 - 0	IUGS ICS Stratigraphic Chart, 2009.	Quaternary	urn:cgi:classifier:ICS:StratChart:200908:Quaternary
a1.1.1.1.1	Holocene	Quaternary	0.0117 - 0	IUGS ICS Stratigraphic Chart, 2009.	Holocene	urn:cgi:classifier:ICS:StratChart:200908:Holocene
a1.1.1.1.2	Pleistocene	Quaternary	2.588 - 0.0117	IUGS ICS Stratigraphic Chart, 2009.	Pleistocene	urn:cgi:classifier:ICS:StratChart:200908:Pleistocene
a1.1.1.1.2.1	Late/Upper Pleistocene	Pleistocene	0.126 - 0.0117	IUGS ICS Stratigraphic Chart, 2009.	UpperPleistocene	urn:cgi:classifier:ICS:StratChart:200908:UpperPleistocene
a1.1.1.1.2.2	Ionian	Pleistocene	0.781 - 0.126	IUGS ICS Stratigraphic Chart, 2009.	Ionian	urn:cgi:classifier:ICS:StratChart:200908:Ionian
a1.1.1.1.2.3	Calabrian	Pleistocene	1.806 - 0.781	IUGS ICS Stratigraphic Chart, 2009.	Calabrian	urn:cgi:classifier:ICS:StratChart:200908:Calabrian
a1.1.1.1.2.4	Gelasian	Pleistocene	2.588 - 1.806	IUGS ICS Stratigraphic Chart, 2009.	Gelasian	urn:cgi:classifier:ICS:StratChart:200908:Gelasian
a1.1.1.2	Neogene	Cenozoic	23.03 - 2.588	IUGS ICS Stratigraphic Chart, 2009.	Neogene	urn:cgi:classifier:ICS:StratChart:200908:Neogene
a1.1.1.2.1	Pliocene	Neogene	5.332 - 2.588	IUGS ICS Stratigraphic Chart, 2009.	Pliocene	urn:cgi:classifier:ICS:StratChart:200908:Pliocene
a1.1.1.2.1.1	Piacenzian	Pliocene	3.6 - 2.588	IUGS ICS Stratigraphic Chart, 2009.	Piacenzian	urn:cgi:classifier:ICS:StratChart:200908:Piacenzian
a1.1.1.2.1.2	Zanclean	Pliocene	5.332 - 3.6	IUGS ICS Stratigraphic Chart, 2009.	Zanclean	urn:cgi:classifier:ICS:StratChart:200908:Zanclean
a1.1.1.2.2	Miocene	Neogene	23.03 - 5.332	IUGS ICS Stratigraphic Chart, 2009.	Miocene	urn:cgi:classifier:ICS:StratChart:200908:Miocene
a1.1.1.2.2.1	Messinian	Miocene	7.246 - 5.332	IUGS ICS Stratigraphic Chart, 2009.	Messinian	urn:cgi:classifier:ICS:StratChart:200908:Messinian
a1.1.1.2.2.2	Tortonian	Miocene	11.608 - 7.246	IUGS ICS Stratigraphic Chart, 2009.	Tortonian	urn:cgi:classifier:ICS:StratChart:200908:Tortonian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.1.2.2.3	Serravallian	Miocene	13.82 - 11.608	IUGS ICS Stratigraphic Chart, 2009.	Serravallian	urn:cgi:classifier:ICS:StratChart:200908:Serravallian
a1.1.1.2.2.4	Langhian	Miocene	15.97 - 13.82	IUGS ICS Stratigraphic Chart, 2009.	Langhian	urn:cgi:classifier:ICS:StratChart:200908:Langhian
a1.1.1.2.2.5	Burdigalian	Miocene	20.43 - 15.97	IUGS ICS Stratigraphic Chart, 2009.	Burdigalian	urn:cgi:classifier:ICS:StratChart:200908:Burdigalian
a1.1.1.2.2.6	Aquitanian	Miocene	23.03 - 20.43	IUGS ICS Stratigraphic Chart, 2009.	Aquitanian	urn:cgi:classifier:ICS:StratChart:200908:Aquitanian
a1.1.1.3	Paleogene	Cenozoic	65.5 ±0.3 - 23.03	IUGS ICS Stratigraphic Chart, 2009.	Paleogene	urn:cgi:classifier:ICS:StratChart:200908:Paleogene
a1.1.1.3.1	Oligocene	Cenozoic	33.9 ±0.1 - 23.03	IUGS ICS Stratigraphic Chart, 2009.	Oligocene	urn:cgi:classifier:ICS:StratChart:200908:Oligocene
a1.1.1.3.1.1	Chattian	Oligocene	28.4 ±0.1- 23.03	IUGS ICS Stratigraphic Chart, 2009.	Chattian	urn:cgi:classifier:ICS:StratChart:200908:Chattian
a1.1.1.3.1.2	Rupelian	Oligocene	33.9 ±0.1 - 28.4 ±0.1	IUGS ICS Stratigraphic Chart, 2009.	Rupelian	urn:cgi:classifier:ICS:StratChart:200908:Rupelian
a1.1.1.3.2	Eocene	Cenozoic	55.8 ±0.2 - 33.9 ±0.1	IUGS ICS Stratigraphic Chart, 2009.	Eocene	urn:cgi:classifier:ICS:StratChart:200908:Eocene
a1.1.1.3.2.1	Priabonian	Eocene	37.2 ±0.1 - 33.9 ±0.1	IUGS ICS Stratigraphic Chart, 2009.	Priabonian	urn:cgi:classifier:ICS:StratChart:200908:Priabonian
a1.1.1.3.2.2	Bartonian	Eocene	40.4 ±0.2 - 37.2 ±0.1	IUGS ICS Stratigraphic Chart, 2009.	Bartonian	urn:cgi:classifier:ICS:StratChart:200908:Bartonian
a1.1.1.3.2.3	Lutetian	Eocene	48.6 ±0.2 - 40.4 ±0.2	IUGS ICS Stratigraphic Chart, 2009.	Lutetian	urn:cgi:classifier:ICS:StratChart:200908:Lutetian
a1.1.1.3.2.4	Ypresian	Eocene	55.8 ±0.2 - 48.6 ±0.2	IUGS ICS Stratigraphic Chart, 2009.	Ypresian	urn:cgi:classifier:ICS:StratChart:200908:Ypresian
a1.1.1.3.3	Paleocene	Paleogene	65.5 ±0.3 - 55.8 ±0.2	IUGS ICS Stratigraphic Chart, 2009.	Paleocene	urn:cgi:classifier:ICS:StratChart:200908:Paleocene
a1.1.1.3.3.1	Thanetian	Paleocene	58.7 ±0.2 - 55.8 ±0.2	IUGS ICS Stratigraphic Chart, 2009.	Thanetian	urn:cgi:classifier:ICS:StratChart:200908:Thanetian
a1.1.1.3.3.2	Selandian	Paleocene	61.1 - 58.7 ±0.2	IUGS ICS Stratigraphic Chart, 2009.	Selandian	urn:cgi:classifier:ICS:StratChart:200908:Selandian
a1.1.1.3.3.3	Danian	Paleocene	65.5 ±0.3 - 61.1	IUGS ICS Stratigraphic Chart, 2009.	Danian	urn:cgi:classifier:ICS:StratChart:200908:Danian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.2	Mesozoic	Phanerozoic	251 ±0.4 - 65.5 ±0.3	IUGS ICS Stratigraphic Chart, 2009.	Mesozoic	urn:cgi:classifier:ICS:StratChart:200908:Mesozoic
a1.1.2.1	Cretaceous	Mesozoic	145.5 ±4 - 65.5 ±0.3	IUGS ICS Stratigraphic Chart, 2009.	Cretaceous	urn:cgi:classifier:ICS:StratChart:200908:Cretaceous
a1.1.2.1.1	Late/Upper Cretaceous	Cretaceous	99.6 ±0.9 - 65.5 ±0.3	IUGS ICS Stratigraphic Chart, 2009.	UpperCretaceous	urn:cgi:classifier:ICS:StratChart:200908:UpperCretaceous
a1.1.2.1.1.1	Maastrichtian	UpperCretaceous	70.6 ±0.6 - 65.5 ±0.3	IUGS ICS Stratigraphic Chart, 2009.	Maastrichtian	urn:cgi:classifier:ICS:StratChart:200908:Maastrichtian
a1.1.2.1.1.2	Campanian	UpperCretaceous	83.5 ±0.7 - 70.6 ±0.6	IUGS ICS Stratigraphic Chart, 2009.	Campanian	urn:cgi:classifier:ICS:StratChart:200908:Campanian
a1.1.2.1.1.3	Santonian	UpperCretaceous	85.8 ±0.7 - 83.5 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Santonian	urn:cgi:classifier:ICS:StratChart:200908:Santonian
a1.1.2.1.1.4	Coniacian	UpperCretaceous	88.6 - 85.8 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Coniacian	urn:cgi:classifier:ICS:StratChart:200908:Coniacian
a1.1.2.1.1.5	Turonian	UpperCretaceous	93.6 ±0.8 - 88.6	IUGS ICS Stratigraphic Chart, 2009.	Turonian	urn:cgi:classifier:ICS:StratChart:200908:Turonian
a1.1.2.1.1.6	Cenomanian	UpperCretaceous	99.6 ±0.9 - 93.6 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Cenomanian	urn:cgi:classifier:ICS:StratChart:200908:Cenomanian
a1.1.2.1.2	Early/Lower Cretaceous	Cretaceous	145.5 ±4 - 99.6 ±0.9	IUGS ICS Stratigraphic Chart, 2009.	LowerCretaceous	urn:cgi:classifier:ICS:StratChart:200908:LowerCretaceous
a1.1.2.1.2.1	Albian	LowerCretaceous	112 ±1 - 99.6 ±0.9	IUGS ICS Stratigraphic Chart, 2009.	Albian	urn:cgi:classifier:ICS:StratChart:200908:Albian
a1.1.2.1.2.2	Aptian	LowerCretaceous	125 ±1 - 112 ±1	IUGS ICS Stratigraphic Chart, 2009.	Aptian	urn:cgi:classifier:ICS:StratChart:200908:Aptian
a1.1.2.1.2.3	Barremian	LowerCretaceous	130 ±1.5 - 125 ±1	IUGS ICS Stratigraphic Chart, 2009.	Barremian	urn:cgi:classifier:ICS:StratChart:200908:Barremian
a1.1.2.1.2.4	Hauterivian	LowerCretaceous	133.9 - 130 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Hauterivian	urn:cgi:classifier:ICS:StratChart:200908:Hauterivian
a1.1.2.1.2.5	Valanginian	LowerCretaceous	140.2 ±3 - 133.9	IUGS ICS Stratigraphic Chart, 2009.	Valanginian	urn:cgi:classifier:ICS:StratChart:200908:Valanginian
a1.1.2.1.2.6	Berriasian	LowerCretaceous	145.5 ±4 - 140.2 ±3	IUGS ICS Stratigraphic Chart, 2009.	Berriasian	urn:cgi:classifier:ICS:StratChart:200908:Berriasian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.2.2	Jurassic	Mesozoic	199.6 ±0.6 - 145.5 ±4	IUGS ICS Stratigraphic Chart, 2009.	Jurassic	urn:cgi:classifier:ICS:StratChart:200908:Jurassic
a1.1.2.2.1	Late/Upper Jurassic	Jurassic	161.2 ±4 - 145.5 ±4	IUGS ICS Stratigraphic Chart, 2009.	UpperJurassic	urn:cgi:classifier:ICS:StratChart:200908:UpperJurassic
a1.1.2.2.1.1	Tithonian	UpperJurassic	150.8 ±4 - 145.5 ±4	IUGS ICS Stratigraphic Chart, 2009.	Tithonian	urn:cgi:classifier:ICS:StratChart:200908:Tithonian
a1.1.2.2.1.2	Kimmeridgian	UpperJurassic	155.6 - 150.8 ±4	IUGS ICS Stratigraphic Chart, 2009.	Kimmeridgian	urn:cgi:classifier:ICS:StratChart:200908:Kimmeridgian
a1.1.2.2.1.3	Oxfordian	UpperJurassic	161.2 ±4 - 155.6	IUGS ICS Stratigraphic Chart, 2009.	Oxfordian	urn:cgi:classifier:ICS:StratChart:200908:Oxfordian
a1.1.2.2.2	Middle Jurassic	Jurassic	175.6 ±2 - 161.2 ±4	IUGS ICS Stratigraphic Chart, 2009.	MiddleJurassic	urn:cgi:classifier:ICS:StratChart:200908:MiddleJurassic
a1.1.2.2.2.1	Callovian	MiddleJurassic	164.7 ±4 - 161.2 ±4	IUGS ICS Stratigraphic Chart, 2009.	Callovian	urn:cgi:classifier:ICS:StratChart:200908:Callovian
a1.1.2.2.2.2	Bathonian	MiddleJurassic	167.7 ±3.5 - 164.7 ±4	IUGS ICS Stratigraphic Chart, 2009.	Bathonian	urn:cgi:classifier:ICS:StratChart:200908:Bathonian
a1.1.2.2.2.3	Bajocian	MiddleJurassic	171.6 ±3 - 167.7 ±3.5	IUGS ICS Stratigraphic Chart, 2009.	Bajocian	urn:cgi:classifier:ICS:StratChart:200908:Bajocian
a1.1.2.2.2.4	Aalenian	MiddleJurassic	175.6 ±2 - 171.6 ±3	IUGS ICS Stratigraphic Chart, 2009.	Aalenian	urn:cgi:classifier:ICS:StratChart:200908:Aalenian
a1.1.2.2.3	Early/Lower Jurassic	Jurassic	199.6 ±0.6 - 175.6 ±2	IUGS ICS Stratigraphic Chart, 2009.	LowerJurassic	urn:cgi:classifier:ICS:StratChart:200908:LowerJurassic
a1.1.2.2.3.1	Toarcian	LowerJurassic	183 ±1.5 - 175.6 ±2	IUGS ICS Stratigraphic Chart, 2009.	Toarcian	urn:cgi:classifier:ICS:StratChart:200908:Toarcian
a1.1.2.2.3.2	Pliensbachian	LowerJurassic	189.6 ±1.5 - 183 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Pliensbachian	urn:cgi:classifier:ICS:StratChart:200908:Pliensbachian
a1.1.2.2.3.3	Sinemurian	LowerJurassic	196.5 ±1 - 189.6 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Sinemurian	urn:cgi:classifier:ICS:StratChart:200908:Sinemurian
a1.1.2.2.3.4	Hettangian	LowerJurassic	199.6 ±0.6 - 196.5 ±1	IUGS ICS Stratigraphic Chart, 2009.	Hettangian	urn:cgi:classifier:ICS:StratChart:200908:Hettangian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.2.3	Triassic	Mesozoic	251 ±0.4 - 199.6 ±0.6	IUGS ICS Stratigraphic Chart, 2009.	Triassic	urn:cgi:classifier:ICS:StratChart:200908:Triassic
a1.1.2.3.1	Late/Upper Triassic	Triassic	228.7 - 199.6 ±0.6	IUGS ICS Stratigraphic Chart, 2009.	UpperTriassic	urn:cgi:classifier:ICS:StratChart:200908:UpperTriassic
a1.1.2.3.1.1	Rhaetian	UpperTriassic	203.6 ±1.5 - 199.6 ±0.6	IUGS ICS Stratigraphic Chart, 2009.	Rhaetian	urn:cgi:classifier:ICS:StratChart:200908:Rhaetian
a1.1.2.3.1.2	Norian	UpperTriassic	216.5 ±2 - 203.6 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Norian	urn:cgi:classifier:ICS:StratChart:200908:Norian
a1.1.2.3.1.3	Carnian	UpperTriassic	228.7 - 216.5 ±2	IUGS ICS Stratigraphic Chart, 2009.	Carnian	urn:cgi:classifier:ICS:StratChart:200908:Carnian
a1.1.2.3.2	Middle Triassic	Triassic	245.9 - 228.7	IUGS ICS Stratigraphic Chart, 2009.	MiddleTriassic	urn:cgi:classifier:ICS:StratChart:200908:MiddleTriassic
a1.1.2.3.2.1	Ladinian	MiddleTriassic	237 ±2 - 228.7	IUGS ICS Stratigraphic Chart, 2009.	Ladinian	urn:cgi:classifier:ICS:StratChart:200908:Ladinian
a1.1.2.3.2.2	Anisian	MiddleTriassic	245.9 - 237 ±2	IUGS ICS Stratigraphic Chart, 2009.	Anisian	urn:cgi:classifier:ICS:StratChart:200908:Anisian
a1.1.2.3.3	Early/Low er Triassic	Triassic	251 ±0.4 - 245.9	IUGS ICS Stratigraphic Chart, 2009.	Low erTriassic	urn:cgi:classifier:ICS:StratChart:200908:Low erTriassic
a1.1.2.3.3.1	Olenekian	Low erTriassic	249.5 - 245.9	IUGS ICS Stratigraphic Chart, 2009.	Olenekian	urn:cgi:classifier:ICS:StratChart:200908:Olenekian
a1.1.2.3.3.2	Induan	Low erTriassic	251 ±0.4 - 249.5	IUGS ICS Stratigraphic Chart, 2009.	Induan	urn:cgi:classifier:ICS:StratChart:200908:Induan
a1.1.3	Paleozoic	Phanerozoic	542 ±1 - 251 ±0.4	IUGS ICS Stratigraphic Chart, 2009.	Paleozoic	urn:cgi:classifier:ICS:StratChart:200908:Paleozoic
a1.1.3.1	Permian	Paleozoic	299 ±0.8 - 251 ±0.4	IUGS ICS Stratigraphic Chart, 2009.	Permian	urn:cgi:classifier:ICS:StratChart:200908:Permian
a1.1.3.1.1	Lopingian	Permian	260.4 ±0.7 - 251 ±0.4	IUGS ICS Stratigraphic Chart, 2009.	Lopingian	urn:cgi:classifier:ICS:StratChart:200908:Lopingian
a1.1.3.1.1.1	Changhsingian	Lopingian	253.8 ±0.7 - 251 ±0.4	IUGS ICS Stratigraphic Chart, 2009.	Changhsingian	urn:cgi:classifier:ICS:StratChart:200908:Changhsingian
a1.1.3.1.1.2	Wuchiapingian	Lopingian	260.4 ±0.7 - 253.8 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Wuchiapingian	urn:cgi:classifier:ICS:StratChart:200908:Wuchiapingian
a1.1.3.1.2	Guadalupian	Permian	270.6 ±0.7 - 260.4 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Guadalupian	urn:cgi:classifier:ICS:StratChart:200908:Guadalupian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.3.1.2.1	Capitanian	Guadalupian	265.8 ±0.7 - 260.4 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Capitanian	urn:cgi:classifier:ICS:StratChart:200908:Capitanian
a1.1.3.1.2.2	Wordian	Guadalupian	268 ±0.7 - 265.8 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Wordian	urn:cgi:classifier:ICS:StratChart:200908:Wordian
a1.1.3.1.2.3	Roadian	Guadalupian	270.6 ±0.7 - 268 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Roadian	urn:cgi:classifier:ICS:StratChart:200908:Roadian
a1.1.3.1.3	Cisuralian	Permian	299 ±0.8 - 270.6 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Cisuralian	urn:cgi:classifier:ICS:StratChart:200908:Cisuralian
a1.1.3.1.3.1	Kungurian	Cisuralian	275.6 ±0.7 - 270.6 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Kungurian	urn:cgi:classifier:ICS:StratChart:200908:Kungurian
a1.1.3.1.3.2	Artinskian	Cisuralian	284.4 ±0.7 - 275.6 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Artinskian	urn:cgi:classifier:ICS:StratChart:200908:Artinskian
a1.1.3.1.3.3	Sakmarian	Cisuralian	294.6 ±0.8 - 284.4 ±0.7	IUGS ICS Stratigraphic Chart, 2009.	Sakmarian	urn:cgi:classifier:ICS:StratChart:200908:Sakmarian
a1.1.3.1.3.4	Asselian	Cisuralian	299 ±0.8 - 294.6 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Asselian	urn:cgi:classifier:ICS:StratChart:200908:Asselian
a1.1.3.2	Carboniferous	Paleozoic	359.2 ±2.5 - 299 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Carboniferous	urn:cgi:classifier:ICS:StratChart:200908:Carboniferous
a1.1.3.2.1	Pennsylvanian	Carboniferous	318.1 ±1.3 - 299 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Pennsylvanian	urn:cgi:classifier:ICS:StratChart:200908:Pennsylvanian
a1.1.3.2.1.1	Late/Upper Pennsylvanian	Pennsylvanian	307.2 ±1 - 299 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Upper_Pennsylvanian	urn:cgi:classifier:ICS:StratChart:200908:Upper_Pennsylvanian
a1.1.3.2.1.1.1	Gzhelian	Upper_Pennsylvanian	303.4 ±0.9 - 299 ±0.8	IUGS ICS Stratigraphic Chart, 2009.	Gzhelian	urn:cgi:classifier:ICS:StratChart:200908:Gzhelian
a1.1.3.2.1.1.2	Kasimovian	Upper_Pennsylvanian	307.2 ±1 - 303.4 ±0.9	IUGS ICS Stratigraphic Chart, 2009.	Kasimovian	urn:cgi:classifier:ICS:StratChart:200908:Kasimovian
a1.1.3.2.1.2	Moscovian	Pennsylvanian	311.7 ±1.1 - 307.2 ±1; Synonym: Middle Pennsylvanian.	IUGS ICS Stratigraphic Chart, 2009.	Moscovian	urn:cgi:classifier:ICS:StratChart:200908:Moscovian
a1.1.3.2.1.3	Bashkirian	Pennsylvanian	318.1 ±1.3 - 311.7 ±1.1; Synonym: Early Pennsylvanian.	IUGS ICS Stratigraphic Chart, 2009.	Bashkirian	urn:cgi:classifier:ICS:StratChart:200908:Bashkirian
a1.1.3.2.2	Mississippian	Carboniferous	359.2 ±2.5 - 318.1 ±1.3	IUGS ICS Stratigraphic Chart, 2009.	Mississippian	urn:cgi:classifier:ICS:StratChart:200908:Mississippian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.3.2.2.1	Serpukhovian	Mississippian	328.3 ±1.6 - 318.1 ±1.3; Synonym: Late Mississippian.	IUGS ICS Stratigraphic Chart, 2009.	Serpukhovian	urn:cgi:classifier:ICS:StratChart:200908:Serpukhovian
a1.1.3.2.2.2	Visean	Mississippian	345.3 ±2.1 - 328.3 ±1.6; Synonym: Middle Mississippian.	IUGS ICS Stratigraphic Chart, 2009.	Visean	urn:cgi:classifier:ICS:StratChart:200908:Visean
a1.1.3.2.2.3	Tournaisian	Mississippian	359.2 ±2.5 - 345.3 ±2.1; Synonym: Early Mississippian.	IUGS ICS Stratigraphic Chart, 2009.	Tournaisian	urn:cgi:classifier:ICS:StratChart:200908:Tournaisian
a1.1.3.3	Devonian	Paleozoic	416 ±2.8 - 359.2 ±2.5	IUGS ICS Stratigraphic Chart, 2009.	Devonian	urn:cgi:classifier:ICS:StratChart:200908:Devonian
a1.1.3.3.1	Late/Upper Devonian	Devonian	385.3 ±2.6 - 359.2 ±2.5	IUGS ICS Stratigraphic Chart, 2009.	UpperDevonian	urn:cgi:classifier:ICS:StratChart:200908:UpperDevonian
a1.1.3.3.1.1	Famennian	Upper Devonian	374.5 ±2.6 - 359.2 ±2.5	IUGS ICS Stratigraphic Chart, 2009.	Famennian	urn:cgi:classifier:ICS:StratChart:200908:Famennian
a1.1.3.3.1.2	Frasnian	Upper Devonian	385.3 ±2.6 - 374.5 ±2.6	IUGS ICS Stratigraphic Chart, 2009.	Frasnian	urn:cgi:classifier:ICS:StratChart:200908:Frasnian
a1.1.3.3.2	Middle Devonian	Devonian	397.5 ±2.7 - 385.3 ±2.6	IUGS ICS Stratigraphic Chart, 2009.	MiddleDevonian	urn:cgi:classifier:ICS:StratChart:200908:MiddleDevonian
a1.1.3.3.2.1	Givetian	Middle Devonian	391.8 ±2.7 - 385.3 ±2.6	IUGS ICS Stratigraphic Chart, 2009.	Givetian	urn:cgi:classifier:ICS:StratChart:200908:Givetian
a1.1.3.3.2.2	Eifelian	Middle Devonian	397.5 ±2.7 - 391.8 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	Eifelian	urn:cgi:classifier:ICS:StratChart:200908:Eifelian
a1.1.3.3.3	Early/Lower Devonian	Devonian	416 ±2.8 - 397.5 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	LowerDevonian	urn:cgi:classifier:ICS:StratChart:200908:LowerDevonian
a1.1.3.3.3.1	Emsian	Lower Devonian	407 ±2.8 - 397.5 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	Emsian	urn:cgi:classifier:ICS:StratChart:200908:Emsian
a1.1.3.3.3.2	Pragian	Lower Devonian	411.2 ±2.8 - 407 ±2.8	IUGS ICS Stratigraphic Chart, 2009.	Pragian	urn:cgi:classifier:ICS:StratChart:200908:Pragian
a1.1.3.3.3.3	Lochkovian	Lower Devonian	416 ±2.8 - 411.2 ±2.8	IUGS ICS Stratigraphic Chart, 2009.	Lochkovian	urn:cgi:classifier:ICS:StratChart:200908:Lochkovian
a1.1.3.4	Silurian	Paleozoic	443.7 ±1.5 - 416 ±2.8	IUGS ICS Stratigraphic Chart, 2009.	Silurian	urn:cgi:classifier:ICS:StratChart:200908:Silurian

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.3.4.1	Pridoli	Silurian	418.7 ±2.7 - 416 ±2.8	IUGS ICS Stratigraphic Chart, 2009.	Pridoli	urn:cgi:classifier:ICS:StratChart:200908:Pridoli
a1.1.3.4.2	Ludlow	Silurian	422.9 ±2.5 - 418.7 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	Ludlow	urn:cgi:classifier:ICS:StratChart:200908:Ludlow
a1.1.3.4.2.1	Ludfordian	Ludlow	421.3 ±2.6 - 418.7 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	Ludfordian	urn:cgi:classifier:ICS:StratChart:200908:Ludfordian
a1.1.3.4.2.2	Gorstian	Ludlow	422.9 ±2.5 - 421.3 ±2.6	IUGS ICS Stratigraphic Chart, 2009.	Gorstian	urn:cgi:classifier:ICS:StratChart:200908:Gorstian
a1.1.3.4.3	Wenlock	Silurian	428.2 ±2.3 - 422.9 ±2.5	IUGS ICS Stratigraphic Chart, 2009.	Wenlock	urn:cgi:classifier:ICS:StratChart:200908:Wenlock
a1.1.3.4.3.1	Homerian	Wenlock	426.2 ±2.4 - 418.7 ±2.7	IUGS ICS Stratigraphic Chart, 2009.	Homerian	urn:cgi:classifier:ICS:StratChart:200908:Homerian
a1.1.3.4.3.2	Sheinw oodian	Wenlock	428.2 ±2.3 - 426.2 ±2.4	IUGS ICS Stratigraphic Chart, 2009.	Sheinw oodian	urn:cgi:classifier:ICS:StratChart:200908:Sheinw oodian
a1.1.3.4.4	Llandovery	Silurian	443.7 ±1.5 - 428.2 ±2.3	IUGS ICS Stratigraphic Chart, 2009.	Llandovery	urn:cgi:classifier:ICS:StratChart:200908:Llandovery
a1.1.3.4.4.1	Telychian	Llandovery	436 ±1.9 - 428.2 ±2.3	IUGS ICS Stratigraphic Chart, 2009.	Telychian	urn:cgi:classifier:ICS:StratChart:200908:Telychian
a1.1.3.4.4.2	Aeronian	Llandovery	439 ±1.8 - 436 ±1.9	IUGS ICS Stratigraphic Chart, 2009.	Aeronian	urn:cgi:classifier:ICS:StratChart:200908:Aeronian
a1.1.3.4.4.3	Rhuddanian	Llandovery	443.7 ±1.5 - 439 ±1.8	IUGS ICS Stratigraphic Chart, 2009.	Rhuddanian	urn:cgi:classifier:ICS:StratChart:200908:Rhuddanian
a1.1.3.5	Ordovician	Paleozoic	488.3 ±1.7 - 443.7 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Ordovician	urn:cgi:classifier:ICS:StratChart:200908:Ordovician
a1.1.3.5.1	Late/Upper Ordovician	Ordovician	460.9 ±1.6 - 443.7 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	UpperOrdovician	urn:cgi:classifier:ICS:StratChart:200908:UpperOrdovician
a1.1.3.5.1.1	Hirnantian	UpperOrdovician	445.6 ±1.5 - 443.7 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Hirnantian	urn:cgi:classifier:ICS:StratChart:200908:Hirnantian
a1.1.3.5.1.2	Katian	UpperOrdovician	455.8 ±1.6 - 445.6 ±1.5	IUGS ICS Stratigraphic Chart, 2009.	Katian	urn:cgi:classifier:ICS:StratChart:200908:Katian
a1.1.3.5.1.3	Sandbian	UpperOrdovician	460.9 ±1.6 - 455.8 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	Sandbian	urn:cgi:classifier:ICS:StratChart:200908:Sandbian
a1.1.3.5.2	Middle Ordovician	Ordovician	471.8 ±1.6 - 460.9 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	MiddleOrdovician	urn:cgi:classifier:ICS:StratChart:200908:MiddleOrdovician

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.3.5.2.1	Darriw ilian	MiddleOrdovician	468.1 ±1.6 - 460.9 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	Darriw ilian	urn:cgi:classifier:ICS:StratChart:200908:Darriw ilian
a1.1.3.5.2.2	Dapingian	MiddleOrdovician	471.8 ±1.6 - 468.1 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	Dapingian	urn:cgi:classifier:ICS:StratChart:200908:Dapingian
a1.1.3.5.3	Early/Low er Ordovician	Ordovician	488.3 ±1.7 - 471.8 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	Low erOrdovician	urn:cgi:classifier:ICS:StratChart:200908:Low erOrdovician
a1.1.3.5.3.1	Floian	Low erOrdovician	478.6 ±1.7 - 471.8 ±1.6	IUGS ICS Stratigraphic Chart, 2009.	Floian	urn:cgi:classifier:ICS:StratChart:200908:Floian
a1.1.3.5.3.2	Tremadocian	Low erOrdovician	488.3 ±1.7 - 478.6 ±1.7	IUGS ICS Stratigraphic Chart, 2009.	Tremadocian	urn:cgi:classifier:ICS:StratChart:200908:Tremadocian
a1.1.3.6	Cambrian	Paleozoic	542 ±1 - 488.3 ±1.7	IUGS ICS Stratigraphic Chart, 2009.	Cambrian	urn:cgi:classifier:ICS:StratChart:200908:Cambrian
a1.1.3.6.1	Furongian	Cambrian	499 - 488.3 ±1.7	IUGS ICS Stratigraphic Chart, 2009.	Furongian	urn:cgi:classifier:ICS:StratChart:200908:Furongian
a1.1.3.6.1.1	Cambrian-Stage 10	Furongian	492 - 488.3 ±1.7	IUGS ICS Stratigraphic Chart, 2009.	Stage10	urn:cgi:classifier:ICS:StratChart:200908:Stage10
a1.1.3.6.1.2	Cambrian-Stage 9	Furongian	496 - 492	IUGS ICS Stratigraphic Chart, 2009.	Stage9	urn:cgi:classifier:ICS:StratChart:200908:Stage9
a1.1.3.6.1.3	Paibian	Furongian	499 - 496	IUGS ICS Stratigraphic Chart, 2009.	Paibian	urn:cgi:classifier:ICS:StratChart:200908:Paibian
a1.1.3.6.2	Cambrian-Series 3	Cambrian	510 - 499	IUGS ICS Stratigraphic Chart, 2009.	Series3	urn:cgi:classifier:ICS:StratChart:200908:Series3
a1.1.3.6.2.1	Guzhangian	Series3	503 - 499	IUGS ICS Stratigraphic Chart, 2009.	Guzhangian	urn:cgi:classifier:ICS:StratChart:200908:Guzhangian
a1.1.3.6.2.2	Drumian	Series3	506.5 - 503	IUGS ICS Stratigraphic Chart, 2009.	Drumian	urn:cgi:classifier:ICS:StratChart:200908:Drumian
a1.1.3.6.2.3	Cambrian-Stage 5	Series3	510 - 506.5	IUGS ICS Stratigraphic Chart, 2009.	Stage5	urn:cgi:classifier:ICS:StratChart:200908:Stage5
a1.1.3.6.3	Cambrian-Series 2	Cambrian	521 - 510	IUGS ICS Stratigraphic Chart, 2009.	Series2	urn:cgi:classifier:ICS:StratChart:200908:Series2
a1.1.3.6.3.1	Cambrian-Stage 4	Series2	515 - 510	IUGS ICS Stratigraphic Chart, 2009.	Stage4	urn:cgi:classifier:ICS:StratChart:200908:Stage4
a1.1.3.6.3.2	Cambrian-Stage 3	Series2	521 - 515	IUGS ICS Stratigraphic Chart, 2009.	Stage3	urn:cgi:classifier:ICS:StratChart:200908:Stage3

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a1.1.3.6.4	Terreneuvian	Cambrian	542 ±1 - 521	IUGS ICS Stratigraphic Chart, 2009.	Terreneuvian	urn:cgi:classifier:ICS:StratChart:200908:Terreneuvian
a1.1.3.6.4.1	Cambrian-Stage 2	Terreneuvian	528 - 521	IUGS ICS Stratigraphic Chart, 2009.	Stage2	urn:cgi:classifier:ICS:StratChart:200908:Stage2
a1.1.3.6.4.2	Fortunian	Terreneuvian	542 ±1 - 528	IUGS ICS Stratigraphic Chart, 2009.	Fortunian	urn:cgi:classifier:ICS:StratChart:200908:Fortunian
a2	Precambrian		4600 - 542	IUGS ICS Stratigraphic Chart, 2009.	Precambrian	urn:cgi:classifier:ICS:StratChart:200908:Precambrian
a2.1	Proterozoic	Precambrian	2500 - 542	IUGS ICS Stratigraphic Chart, 2009.	Proterozoic	urn:cgi:classifier:ICS:StratChart:200908:Proterozoic
a2.1.1	Neoproterozoic	Proterozoic	1000 - 542	IUGS ICS Stratigraphic Chart, 2009.	Neoproterozoic	urn:cgi:classifier:ICS:StratChart:200908:Neoproterozoic
a2.1.1.1	Ediacaran	Neoprotero zoic	635 - 542	IUGS ICS Stratigraphic Chart, 2009.	Ediacaran	urn:cgi:classifier:ICS:StratChart:200908:Ediacaran
a2.1.1.2	Cryogenian	Neoprotero zoic	850 - 635	IUGS ICS Stratigraphic Chart, 2009.	Cryogenian	urn:cgi:classifier:ICS:StratChart:200908:Cryogenian
a2.1.1.3	Tonian	Neoprotero zoic	1000 - 850	IUGS ICS Stratigraphic Chart, 2009.	Tonian	urn:cgi:classifier:ICS:StratChart:200908:Tonian
a2.1.1.3.1	Tonian 2 *	Tonian	910 - 850	Koistinen et al., 2001.	Tonian2	urn:cgi:classifier:CGI:StratChart:2009:Tonian2
a2.1.1.3.2	Tonian 1 *	Tonian	1000 - 910	Koistinen et al., 2001.	Tonian1	urn:cgi:classifier:CGI:StratChart:2009:Tonian1
a2.1.2	Mesoproterozoic	Proterozoic	1600 - 1000	IUGS ICS Stratigraphic Chart, 2009.	Mesoproterozoic	urn:cgi:classifier:ICS:StratChart:200908:Mesoproterozoic
a2.1.2.1	Stenian	Mesoproterozoic	1200 - 1000	IUGS ICS Stratigraphic Chart, 2009.	Stenian	urn:cgi:classifier:ICS:StratChart:200908:Stenian
a2.1.2.1.1	Stenian 2	Stenian	1130 - 1000	Koistinen et al., 2001.	Stenian2	urn:cgi:classifier:CGI:StratChart:2009:Stenian2
a2.1.2.1.2	Stenian 1	Stenian	1200 - 1130	Koistinen et al., 2001.	Stenian1	urn:cgi:classifier:CGI:StratChart:2009:Stenian1
a2.1.2.2	Ectasian	Mesoproterozoic	1400 - 1200	IUGS ICS Stratigraphic Chart, 2009.	Ectasian	urn:cgi:classifier:ICS:StratChart:200908:Ectasian
a2.1.2.2.1	Ectasian 4 *	Ectasian	1250 - 1200	Koistinen et al., 2001.	Ectasian4	urn:cgi:classifier:CGI:StratChart:2009:Ectasian4

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a2.1.2.2.2	Ectasian 3 *	Ectasian	1270 - 1250	Koistinen et al., 2001.	Ectasian3	urn:cgi:classifier:CGI:StratChart:2009:Ectasian3
a2.1.2.2.3	Ectasian 2 *	Ectasian	1360 - 1270	Koistinen et al., 2001.	Ectasian2	urn:cgi:classifier:CGI:StratChart:2009:Ectasian2
a2.1.2.2.4	Ectasian 1 *	Ectasian	1400 - 1360	Koistinen et al., 2001.	Ectasian1	urn:cgi:classifier:CGI:StratChart:2009:Ectasian1
a2.1.2.3	Calymmian	Mesoproterozoic	1600 - 1400	IUGS ICS Stratigraphic Chart, 2009.	Calymmian	urn:cgi:classifier:ICS:StratChart:200908:Calymmian
a2.1.2.3.1	Calymmian 4 *	Calymmian	1440 - 1400	Koistinen et al., 2001.	Calymmian4	urn:cgi:classifier:CGI:StratChart:2009:Calymmian4
a2.1.2.3.2	Calymmian 3 *	Calymmian	1470 - 1440	Koistinen et al., 2001.	Calymmian3	urn:cgi:classifier:CGI:StratChart:2009:Calymmian3
a2.1.2.3.3	Calymmian 2 *	Calymmian	1520 - 1470	Koistinen et al., 2001.	Calymmian2	urn:cgi:classifier:CGI:StratChart:2009:Calymmian2
a2.1.2.3.4	Calymmian 1 *	Calymmian	1600 - 1520	Koistinen et al., 2001.	Calymmian1	urn:cgi:classifier:CGI:StratChart:2009:Calymmian1
a2.1.3	Paleoproterozoic	Proterozoic	2500 - 1600	IUGS ICS Stratigraphic Chart, 2009.	Paleoproterozoic	urn:cgi:classifier:ICS:StratChart:200908:Paleoproterozoic
a2.1.3.1	Statherian	Paleoproterozoic	1800 - 1600	IUGS ICS Stratigraphic Chart, 2009.	Statherian	urn:cgi:classifier:ICS:StratChart:200908:Statherian
a2.1.3.1.1	Statherian 4 *	Statherian	1260 - 1600	Koistinen et al., 2001.	Statherian4	urn:cgi:classifier:CGI:StratChart:2009:Statherian4
a2.1.3.1.2	Statherian 3 *	Statherian	1740 - 1660	Koistinen et al., 2001.	Statherian3	urn:cgi:classifier:CGI:StratChart:2009:Statherian3
a2.1.3.1.3	Statherian 2 *	Statherian	1770 - 1740	Koistinen et al., 2001.	Statherian2	urn:cgi:classifier:CGI:StratChart:2009:Statherian2
a2.1.3.1.4	Statherian 1 *	Statherian	1800 - 1770	Koistinen et al., 2001.	Statherian1	urn:cgi:classifier:CGI:StratChart:2009:Statherian1
a2.1.3.2	Orosirian	Paleoproterozoic	2050 - 1800	IUGS ICS Stratigraphic Chart, 2009.	Orosirian	urn:cgi:classifier:ICS:StratChart:200908:Orosirian
a2.1.3.2.1	Orosirian 7 *	Orosirian	1820 - 1800	Koistinen et al., 2001.	Orosirian7	urn:cgi:classifier:CGI:StratChart:2009:Orosirian7
a2.1.3.2.2	Orosirian 6 *	Orosirian	1840 - 1820	Koistinen et al., 2001.	Orosirian6	urn:cgi:classifier:CGI:StratChart:2009:Orosirian6

Table 4-2: The 1G-E vocabulary for the description of the age of a GeologicUnit (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition (Ma)	Source	CGI_URN	Complete URN
a2.1.3.2.3	Orosirian 5 *	Orosirian	1870 - 1840	Koistinen et al., 2001.	Orosirian5	urn:cgi:classifier:CGI:StratChart:2009:Orosirian5
a2.1.3.2.4	Orosirian 4 *	Orosirian	1880 - 1870	Koistinen et al., 2001.	Orosirian4	urn:cgi:classifier:CGI:StratChart:2009:Orosirian4
a2.1.3.2.5	Orosirian 3 *	Orosirian	1920 - 1880	Koistinen et al., 2001.	Orosirian3	urn:cgi:classifier:CGI:StratChart:2009:Orosirian3
a2.1.3.2.6	Orosirian 2 *	Orosirian	1960 - 1920	Koistinen et al., 2001.	Orosirian2	urn:cgi:classifier:CGI:StratChart:2009:Orosirian2
a2.1.3.2.7	Orosirian 1 *	Orosirian	2050 - 1960	Koistinen et al., 2001.	Orosirian1	urn:cgi:classifier:CGI:StratChart:2009:Orosirian1
a2.1.3.3	Rhyacian	Paleoproterozoic	2300 - 2050	IUGS ICS Stratigraphic Chart, 2009.	Rhyacian	urn:cgi:classifier:ICS:StratChart:200908:Rhyacian
a2.1.3.4	Siderian	Paleoprotero zoic	2500 - 2300	IUGS ICS Stratigraphic Chart, 2009.	Siderian	urn:cgi:classifier:ICS:StratChart:200908:Siderian
a2.1.3.4.1	Siderian 2 *	Siderian	2400 - 2300	Koistinen et al., 2001.	Siderian2	urn:cgi:classifier:CGI:StratChart:2009:Siderian2
a2.1.3.4.2	Siderian 1 *	Siderian	2500 - 2400	Koistinen et al., 2001.	Siderian1	urn:cgi:classifier:CGI:StratChart:2009:Siderian1
a2.2	Archean	Precambrian	4000 - 2500	IUGS ICS Stratigraphic Chart, 2009.	Archean	urn:cgi:classifier:ICS:StratChart:200908:Archean
a2.2.1	Neoarchean	Archean	2800 - 2500	IUGS ICS Stratigraphic Chart, 2009.	Neoarchean	urn:cgi:classifier:ICS:StratChart:200908:Neoarchean
a2.2.1.1	Neoarchean 2 *	Neoarchean	2650 - 2500	Koistinen et al., 2001.	Neoarchean2	urn:cgi:classifier:CGI:StratChart:2009:Neoarchean2
a2.2.1.2	Neoarchean 1 *	Neoarchean	2800 - 2650	Koistinen et al., 2001.	Neoarchean1	urn:cgi:classifier:CGI:StratChart:2009:Neoarchean1
a2.2.2	Mesoarchean	Archean	3200 - 2800	IUGS ICS Stratigraphic Chart, 2009.	Mesoarchean	urn:cgi:classifier:ICS:StratChart:200908:Mesoarchean
a2.2.3	Paleoarchean	Archean	3600 - 3200	IUGS ICS Stratigraphic Chart, 2009.	Paleoarchean	urn:cgi:classifier:ICS:StratChart:200908:Paleoarchean
a2.2.4	Eoarchean	Archean	4000 - 3600	IUGS ICS Stratigraphic Chart, 2009.	Eoarchean	urn:cgi:classifier:ICS:StratChart:200908:Eoarchean
a2.3	Hadean (informal)	Precambrian	4600 - 4000	IUGS ICS Stratigraphic Chart, 2009.	Hadean	urn:cgi:classifier:ICS:StratChart:200908:Hadean

4.2 Lithology

Following the CGI/GeoSciML schema, lithology is divided into Igneous Material, Sedimentary Material, and Composite Genesis Material. For 1G-E two additional categories, Breccia and Tuffite, were added. The definitions of the terms are kept as close as possible to the existing IUGS definitions (LeMaitre et al., 2002 for igneous rocks and Fettes & Desmons, 2007 for metamorphic rocks) and the CGI SimpleLithology vocabulary, with slight modification to the definitions for GeoSciML when considered appropriate. The hierarchy of the terms was also defined on the basis of the CGI SimpleLithology vocabulary.

In GeoSciML the lithology of GeologicUnits is described using the option CompositionParts. Each CompositionPart has three properties – the lithology; the role of the CompositionPart in the GeologicUnit as a whole; and the proportion of the CompositionPart in the GeologicUnit as a whole.

The tables 4-5, 4-6, 4-7 and 4-8 give the definitions and corresponding URNs which have to be used to populate the lithology property. To determine the correct lithology concept, one should focus on the concept definition rather than the concept term.

Some terms, which are commonly used as lithologies, such as 'ophiolite', are in fact a combination of lithology, genesis and other concepts. Section 4.6 describes how to encode such complex rocks.

With the role property of CompositionPart (GeologicUnitPartRole), it is possible to state, whether the GeologicUnit consists of only one type of lithology or if it comprises additional units, e.g. a 'lithosome' or 'cyclic bedding'. For 1GE, due to both the scale of the maps and the harmonisation, the role property should in most cases be restricted to one of two values: 'only_part' (the CompositionPart is the only one in the GeologicUnit) or 'unspecified_part_role' (the CompositionPart is one of several in the GeologicUnit) (tab. 4-4). Additional values like 'inclusion', 'lithosome' or 'blocks' should only be used for the description of the complex rocks (see section 4.6).

In GeoSciML one can describe a GeologicUnit with more than one lithological term. To emphasise the predominant lithology the proportion property of CompositionPart (ProportionTerm) is used. When only one lithology is selected that covers the whole GeologicUnit, the ProportionTerm should be set to 'all'.
For heterogeneous GeologicUnits the lithology that comprises the single largest proportion of the GeologicUnit should be given a ProportionTerm of 'predominant'. The predominant lithology will be the one used for portrayal of the GeologicUnit. It is possible to add four additional lithological terms to the CompositionPart; all these should be given the ProportionTerm of 'subordinate'. Table 4-3 shows the complete hierarchy of ProportionTerms of GeoSciML. For 1G-E only the three terms 'all', 'predominant' and 'subordinate' are used.

Note that additional information on the lithology of a GeologicUnit beyond CompositionPart can be provided with the properties GeologicEvents (age, process, and environment; see sections 4.1 and 4.4) and MetamorphicDescription (facies, grade, and protolith; see section 4.5).

Table 4-3: The GeoSciML vocabulary for the description of the ProportionTerm of GeologicUnit; for 1G-E only the three terms 'all', 'predominant' and 'subordinate' are used.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
pt1	major		Component constitutes greater than 50 % of the volume of the described	CGI/GeoSciML.	major	urn:cgi:classifier:CGI:ProportionTerm:201001:major
pt1.1	dominant	major	Component constitutes greater than 75 % of the volume of the EarthMaterial.	CGI/GeoSciML.	dominant	urn:cgi:classifier:CGI:ProportionTerm:201001:dominant
pt1.1.1	all	dominant	Component constitutes effectively 100 % of the volume of the EarthMaterial.	CGI/GeoSciML.	all	urn:cgi:classifier:CGI:ProportionTerm:201001:all
pt2	present		Component is present, but proportion is unknown.	CGI/GeoSciML.	present	urn:cgi:classifier:CGI:ProportionTerm:201001:present
pt2.1	predominant	present	Constituent forms more of the described entity than any other constituent.	CGI/GeoSciML.	predominant	urn:cgi:classifier:CGI:ProportionTerm:201001:predominant
pt3	subordinate		Component constitutes less than 50 % of the volume of the described entity. Synonym: inferior,	CGI/GeoSciML.	subordinate	urn:cgi:classifier:CGI:ProportionTerm:201001:subordinate

Table 4-4: The 1G-E vocabulary for the description of the role property of GeologicUnit

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
gupr1	Part of		The geologic unit part role is not know n in any greater detail. Inclusion of only_part as a separate concept implies that this concept is the equivalent of 'proper part' in mereology. Synonym: unknow n.	CGI/ GeoSciML.	part_of	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:part_of
gupr1.1	Inclusion	part_of	Geologic unit constituent is present as masses w ith generally sharp boundaries enclosed w ithin a matrix of some other material.	CGI/ GeoSciML.	inclusion	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:inclusion
gupr1.1.1	Blocks	inclusion	Geologic unit constituent is present as masses w ith generally sharp boundaries and block-like geometry w ithin a matrix of some other material emplaced by processes at the earth's surface, e.g. volcanic eruption or mass w asting. Implication is that blocks w ere derived from the same source geologic unit and emplaced in the described unit.	CGI/ GeoSciML.	blocks	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:blocks
gupr1.2	Lithosome	part_of	A kind of rock body that has multiple occurrences in a single geologic unit. A mass of rock of uniform character, characterised 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, e.g. 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.*	CGI/ GeoSciML.	lithosome	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:lithosome
gupr1.2.1	Cyclic bedding package	lithosome	Lithosome characterised by an internal sequence of units, w hich is repeated in a stacked sequence e.g. fining-upw ard sequence, thickening upw ard sequence, bouma sequence.	CGI/ GeoSciML.	cyclic_bedding_package	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:cyclic_bedding_package
gupr1.2.2	Geologic unit matrix	lithosome	Lithosome in a geologic unit that is generally interstitial to other constituents, e.g. in a mass w asting deposit, melange, tuff breccia.	CGI/ GeoSciML.	geologic_unit_matrix	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:geologic_unit_matrix
gupr1.2.3	Layer lithosome	lithosome	Lithosome in igneous or metamorphic geologic unit that occurs as layers alternating w ith other constituents.	CGI/ GeoSciML.	layer_lithosome	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:layer_lithosome
gupr1.3	Unspecifie d part role	part_of	Geologic unit part w ith unspecified role; used in normative descriptions w hen any role is allow ed.	CGI/ GeoSciML.	unspecified_part_role	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:unspecified_part_role
gupr2	Only part		The entire described unit consists of a single part or constituent. Synonym: dominant constituent, w hole.	CGI/ GeoSciML.	only_part	urn:cgi:classifier:CGI:GeologicUnitPart Role:200811:only_part

* This vocabulary generalises the concept defined in Neuendorf et al. (2005) to include bodies of igneous or metamorphic rock as well as sedimentary rock. SLTT (2004) used the term 'lithotope' with similar meaning for sedimentary rocks.

4.2.1 Igneous material

Igneous material comprises Fragmental igneous material and Igneous rocks (fig. 4-4). Following LeMaitre et al. (2002), Fragmental igneous material is divided into Unconsolidated pyroclastic material (e.g. Tephra) and Pyroclastic rocks, according to variation in clast size. As Breccia and Tuffite are special types, these lithologies are treated separately (see sections 4.2.4 and 4.2.5).

For Igneous rocks there are numerous classification systems, and most of them are based on geochemistry. The most commonly used, however, is the IUGS ("Streckeisen")-classification, based on the modal amounts of the common minerals which are divided into five groups: Q-Quartz, A-Alkali feldspar, P-Plagioclase, F-Feldspathoids and M-Mafic minerals. The Q-A-F-P Double Triangles Diagram for Plutonites (Streckeisen, 1976, Annex II), and Volcanites (Streckeisen, 1978, Annex II) used by LeMaitre et al. (2002) are a comprehensive and appropriate nomenclature and classification of igneous rocks for the use by 1G-E. However, the descriptive, non-genetic terms “Phaneritic crystalline igneous rock” and “Fine-grained crystalline igneous rock” are used instead of plutonic and volcanic rocks, respectively. The separating grain-size is taken to be 1 mm. Another difference to the IUGS classification is a new meaning for certain terms that were considered useful in the classification of the igneous rocks: e.g. Dioritic rock is a subtype of Dioritoid rather than a synonym.

Table 4-5 shows the agreed terms, their definitions and URNs for Igneous material.

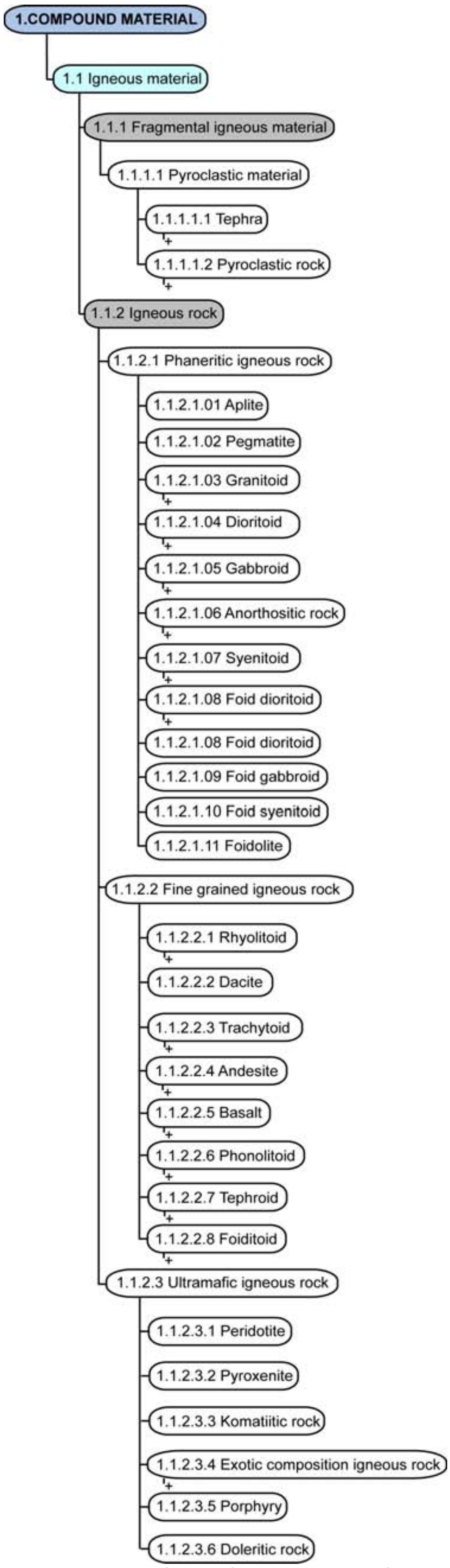

Figure 4-4: Hierarchical overview representation of the 1G-E vocabulary for Igneous material. For clarity only the main groups are indicated.

Table 4-5: The 1G-E vocabulary for Igneous material.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.	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.	SLTT, 2004[1].	compound_material	urn:cgi:classifier:CGI:SimpleLithology:201001:compound_material
1.1	Igneous material	compound _material	Earth material formed as a result of igneous processes, e.g. intrusion and cooling of magma in the crust, volcanic eruption.	CGI SimpleLithology, 2010.	igneous_material	urn:cgi:classifier:CGI:SimpleLithology:201001:igneous_material
1.1.1	Fragmental igneous material	igneous _material	Igneous material of unspecified consolidation state in w hich greater than 75 % of the rock consists of fragments produced as a result of igneous rock-forming process.	CGI SimpleLithology, 2010.	fragmental_igneous_material	urn:cgi:classifier:CGI:SimpleLithology:201001:fragmental_igneous_material
1.1.1.1	Pyroclastic material	fragmental _igneous _material	Fragmental igneous material that consists of more than 75 % of particles formed by disruption as a direct result of volcanic action.	LeMaitre et al., 2002.	pyroclastic_material	urn:cgi:classifier:CGI:SimpleLithology:201001:pyroclastic_material
1.1.1.1.1	Tephra	pyroclastic _material	Unconsolidated pyroclastic material in w hich greater than 75 % of the fragments are deposited as a direct result of volcanic processes and the deposit has not been rew orked by epiclastic processes. Includes ash, lapilli tephra, bomb tephra, block tephra and unconsolidated agglomerate.	Hallsw orth & Knox, 1999; LeMaitre et al., 2002.	tephra	urn:cgi:classifier:CGI:SimpleLithology:201001:tephra
1.1.1.1.1.1	Ash and lapilli	tephra	Tephra in w hich less than 25 % of fragments are greater than 64 mm in longest dimension.	Schmid, 1981; LeMaitre et al., 2002.	ash_and_lapilli	urn:cgi:classifier:CGI:SimpleLithology:201001:ash_and_lapilli
1.1.1.1.1.2	Ash breccia, bomb, or block tephra	tephra	Tephra in w hich more than 25 % of particles are greater than 64 mm in largest dimension. Includes ash breccia, bomb tephra and block tephra of Gillespie and Styles (1999).	Schmid 1981; LeMaitre et al., 2002.	ash_breccia_bomb_or_block_tephra	urn:cgi:classifier:CGI:SimpleLithology:201001:ash_breccia_bomb_or_block_tephra
1.1.1.1.2	Pyroclastic rock	pyroclastic _material	Fragmental igneous rock that consists of greater than 75 % fragments produced as a direct result of eruption or extrusion of magma from w ithin the earth onto its surface. Includes autobreccia associated w ith lava flow s. Excludes deposits rew orked by epiclastic processes.	LeMaitre et al., 2002.	pyroclastic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:pyroclastic_rock

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.1.1.2.1	Ash tuff, lapillistone, and lapilli tuff	pyroclastic _rock	Pyroclastic rock in w hich less than 25 % of rock by volume are more than 64 mm in longest diameter. Includes tuff, lapilli tuff, and lapillistone.	Schmid, 1981; LeMaitre et al., 2002.	ash_tuff_lapillistone_and_lapilli_tuff	urn:cgi:classifier:CGI:SimpleLithology:201001:ash_tuff_lapillistone_and_lapilli_tuff
1.1.1.1.2.2	Tuff-breccia, agglomerate, or pyroclastic breccia	pyroclastic _rock	Pyroclastic rock in w hich greater than 25 % of particles are greater than 64 mm in largest dimension. Includes agglomerate, pyroclastic breccia of Gillespie and Styles (1999).	Schmid, 1981; LeMaitre et al., 2002.	tuff_breccia_agglomerate_or_pyroclastic_breccia	urn:cgi:classifier:CGI:SimpleLithology:201001:tuff_breccia_agglomerate_or_pyroclastic_breccia
1.1.2	Igneous rock	igneous _material	Rock formed as a result of igneous processes, e.g. intrusion and cooling of magma in the crust, volcanic eruption.	Neuendorf et al., 2005.	igneous_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:igneous_rock
1.1.2.1	Phaneritic igneous rock	igneous_rock	Igneous rock in w hich the framew ork of the rock consists of individual crystals that can be discerned w ith the unaided eye. Bounding grain size is on the order of 32 to 100 µm. Excludes igneous rocks w ith 'exotic' composition. Synonym: coarse grained crystalline igneous rock, plutonic rock.	Neuendorf et al., 2005.	phaneritic_igneous_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:phaneritic_igneous_rock
1.1.2.1.01	Aplite	phaneritic _igneous_rock	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.	Neuendorf et al., 2005.	aplite	urn:cgi:classifier:CGI:SimpleLithology:201001:aplite
1.1.2.1.02	Pegmatite	phaneritic _igneous_rock	Exceptionally coarse grained crystalline rock w ith interlocking crystals; most grains are 1 cm or more in 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 w ith plutons or batholiths.	Neuendorf et al., 2005.	pegmatite	urn:cgi:classifier:CGI:SimpleLithology:201001:pegmatite
1.1.2.1.03.1	Granite	granitoid	Phaneritic crystalline rock consisting of quartz, alkali feldspar and plagioclase (typically sodic) in variable amounts, usually w ith biotite and/or hornblende. Includes rocks defined modally in QAPF Field 3. SeeAlso: charnockite.	LeMaitre et al., 2002.	granite	urn:cgi:classifier:CGI:SimpleLithology:201001:granite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.1.03.1.1	Monzogranite	granite	Granite that has a plagiolcase to total feldspar ratio betw een 0.35 and 0.65. QAPF field 3b.	LeMaitre et al., 2002.	monzogranite	urn:cgi:classifier:CGI:SimpleLithology:201001:monzogranite
1.1.2.1.03.1.2	Syenogranite	granite	Granite that has a plagiolcase to total feldspar ratio betw een 0.10 and 0.35. QAPF field 3a.	LeMaitre et al., 2002.	syenogranite	urn:cgi:classifier:CGI:SimpleLithology:201001:syenogranite
1.1.2.1.03.2	Tonalite	granitoid	Granitoid consisting of quartz and intermediate plagioclase, usually w ith biotite and amphibole. Includes rocks defined modally in QAPF field 5; ratio of plagioclase to total feldspar is greater than 0.9. SeeAlso: plagiogranite, trondhjemite.	LeMaitre et al., 2002.	tonalite	urn:cgi:classifier:CGI:SimpleLithology:201001:tonalite
1.1.2.1.03.3	Granodiorite	granitoid	Phaneritic crystalline rock consisting essentially of quartz, sodic plagioclase and lesser amounts of alkali feldspar w ith minor hornblende and biotite. Includes rocks defined modally in QAPF field 4.	LeMaitre et al., 2002.	granodiorite	urn:cgi:classifier:CGI:SimpleLithology:201001:granodiorite
1.1.2.1.04	Dioritoid	phaneritic_igneous_rock	Phaneritic crystalline igneous rock w ith M less than 90; consisting of intermediate plagioclase, commonly w ith hornblende and often w ith biotite or augite. Plagioclase to total feldspar ratio is greater that 0.65; and anorthite content of plagioclase is less than 50 %. Less than 10 % feldspathoid mineral and less than 20 % quartz in the QAPF fraction. Includes rocks defined modally in QAPF fields 9 and 10 (and their subdivisions). Related Concept: doleritic_rock.	LeMaitre et al., 2002.	dioritoid	urn:cgi:classifier:CGI:SimpleLithology:201001:dioritoid
1.1.2.1.04.1	Dioritic rock	dioritoid	Phaneritic crystalline rock w ith M less than 90, consisting of intermediate plagioclase, commonly w ith hornblende and often w ith biotite or augite. A dioritoid w ith 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*.	LeMaitre et al., 2002.	dioritic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:dioritic_rock
1.1.2.1.04.1.1	Quartz diorite	dioritic_rock	Dioritic rock that contains betw een 5 to 20 % quartz in the QAPF fraction. QAPF field 10*.	LeMaitre et al. 2002	quartz_diorite	urn:cgi:classifier:CGI:SimpleLithology:201001:quartz_diorite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.1.04.1.2	Diorite	dioritic_rock	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 to An50), no feldspathoid, and between 0 and 5 % quartz. Includes rocks defined modally in QAPF field 10 as diorite.	LeMaitre et al., 2002.	diorite	urn:cgi:classifier:CGI:SimpleLithology:201001:diorite
1.1.2.1.04.2	Monzodioritic rock	dioritoid	Phaneritic crystalline igneous rock consisting of sodic plagioclase (An0 to An50), alkali feldspar, hornblende and biotite, with or without pyroxene, and 0 to 10 % feldspathoid or 0 to 20 % 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.	CGI SimpleLithology, 2008; LeMaitre et al., 2002.	monzodioritic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:monzodioritic_rock
1.1.2.1.04.2.1	Monzodiorite	monzodioritic_rock	Phaneritic crystalline igneous rock consisting of sodic plagioclase (An0 to An50), alkali feldspar, hornblende and biotite, with or without pyroxene, and 0 to 5 % quartz. Includes rocks defined modally in QAPF field 9.	LeMaitre et al., 2002.	monzodiorite	urn:cgi:classifier:CGI:SimpleLithology:201001:monzodiorite
1.1.2.1.05	Gabbroid	phaneritic_igneous_rock	Phaneritic crystalline igneous rock that contains less than 90 % mafic minerals, and up to 20 % quartz or up to 10 % 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 %. Includes rocks defined modally in QAPF fields 9 and 10 and their subdivisions. Related Concept: dolertitic_rock.	LeMaitre et al., 2002.	gabbroid	urn:cgi:classifier:CGI:SimpleLithology:201001:gabbroid
1.1.2.1.05.1	Gabbroic rock	basic_igneous_rock, gabbroid	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. SeeAlso: gabbro (sensu stricto), gabbronorite, norite, troctolite.	LeMaitre et al., 2002.	gabbroic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:gabbroic_rock

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.1.05.1.1	Gabbro	gabbroic_rock	Gabbroic rock that contains between 0 and 5 % quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF Field 10 as gabbro.	LeMaitre et al., 2002.	gabbro	urn:cgi:classifier:CGI:SimpleLithology:201001:gabbro
1.1.2.1.05.2	Monzogabbroic rock	gabbroid	Gabbroid with a plagioclase to total feldspar ratio between 0.65 and 0.9. QAPF field 9, 9' and 9*.	LeMaitre et al., 2002; CGI SimpleLithology, 2010.	monzogabbroic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:monzogabbroic_rock
1.1.2.1.05.2.1	Monzogabbro	monzogabbroic_rock	Monzogabbroic rock that contains between 0 an 5 % quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF field 9.	LeMaitre et al. 2002, CGI SimpleLithology, 2010.	monzogabbro	urn:cgi:classifier:CGI:SimpleLithology:201001:monzogabbro
1.1.2.1.06	Anorthositic rock	phaneritic _igneous_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 % quartz and less than 10 % feldspathoid in the QAPF fraction. QAPF field 10, 10*, and 10'.	LeMaitre et al., 2002; CGI SimpleLithology, 2010.	anorthositic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:anorthositic_rock
1.1.2.1.07	Syenitoid	phaneritic _igneous_rock	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 plagioclase to total feldspar is less than 0.65, quartz forms less than 20 % of QAPF fraction, and feldspathoid minerals form less than 10 % of QAPF fraction. Includes rocks classified in QAPF fields 6, 7 and 8 and their subdivisions.	LeMaitre et al., 2002.	syenitoid	urn:cgi:classifier:CGI:SimpleLithology:201001:syenitoid
1.1.2.1.07.1	Syenitic rock	syenitoid	Syenitoid with a plagioclase to total feldspar ratio between 0.1 and 0.35. Includes rocks in QAPF fields 7, 7*, and 7'.	LeMaitre et al., 2002.	syenitic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:syenitic_rock
1.1.2.1.07.1.1	Quartz syenite	syenitic_rock	Syenitic rock that contains between 5 and 20 % quartz in the QAPF fraction. Defined modally in QAPF Field 7*.	LeMaitre et al., 2002.	quartz_syenite	urn:cgi:classifier:CGI:SimpleLithology:201001:quartz_syenite
1.1.2.1.07.1.2	Syenite	syenitic_rock	Syenitic rock that contains between 0 and 5 % quartz and no feldspathoid mineral in the QAPF fraction. Defined modally in QAPF Field 7.	LeMaitre et al., 2002.	syenite	urn:cgi:classifier:CGI:SimpleLithology:201001:syenite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.1.07.1.3	Foid bearing syenite	syenitic_rock	Syenitic rock that contains betw een 0 and 10 % feldspathoid mineral and no quartz in the QAPF fraction. Defined modally in QAPF Field 7'.	LeMaitre et al., 2002.	foid_bearing_syenite	urn:cgi:classifier:CGI:SimpleLithology:201001:foid_bearing_syenite
1.1.2.1.07.2	Monzonitic rock	syenitoid	Syenitoid w ith a plagioclase to total feldspar ratio betw een 0.35 and 0.65. Includes rocks in QAPF fields 8, 8*, and 8'.	LeMaitre et al., 2002.	monzonitic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:monzonitic_rock
1.1.2.1.07.2.1	Quartz monzonite	monzonitic _rock	Monzonitic rock that contains 5-20 % quartz in the QAPF fraction. Includes rocks defined modally in QAPF Field 8*.	LeMaitre et al., 2002.	quartz_monzonite	urn:cgi:classifier:CGI:SimpleLithology:201001:quartz_monzonite
1.1.2.1.07.2.2	Monzonite	monzonitic _rock	Monzonitic rock that contains 0-5 % quartz and no feldspathoid mineral in the QAPF fraction. Includes rocks defined modally in QAPF Field 8.	LeMaitre et al., 2002.	monzonite	urn:cgi:classifier:CGI:SimpleLithology:201001:monzonite
1.1.2.1.08	Foid dioritoid	phaneritic _igneous_rock	Phaneritic crystalline igneous rock in w hich M is less than 90; the plagioclase to total feldspar ratio is greater than 0.5; feldspathoid minerals form 10-60 % of the QAPF fraction; plagioclase has anorthite content less than 50 %. These rocks typically contain large amounts of mafic minerals. Includes rocks defined modally in QAPF fields 13 and 14.	LeMaitre et al., 2002.	oid_dioritoid	urn:cgi:classifier:CGI:SimpleLithology:201001:foid_dioritoid
1.1.2.1.09	Foid gabbroid	phaneritic _igneous_rock	Phaneritic crystalline igneous rock in w hich M is less than 90; the plagioclase to total feldspar ratio is greater than 0.5; feldspathoids form 10-60 % of the QAPF fraction, and plagioclase has anorthite content greater than 50 %. These rocks typically contain large amounts of mafic minerals. Includes rocks defined modally in QAPF fields 13 and 14.	LeMaitre et al., 2002.	foid_gabbroid	urn:cgi:classifier:CGI:SimpleLithology:201001:foid_gabbroid
1.1.2.1.10	Foid syenitoid	phaneritic _igneous_rock	Phaneritic crystalline igneous rock w ith M less than 90, contains betw een 10 and 60 % feldspathoid mineral in the QAPF fraction, and has a plagioclase to total feldspar ratio less than 0.5. Includes QAPF fields 11 and 12.	LeMaitre et al., 2002.	foid_syenitoid	urn:cgi:classifier:CGI:SimpleLithology:201001:foid_syenitoid

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.1.11	Foidolite	phaneritic _igneous_rock	Phaneritic crystalline rock containing more than 60 % feldspathoid minerals in the QAPF fraction. Includes rocks defined modally in QAPF field 15. SeeAlso: ijolite, melteigite, nephelinolite, urtite.	LeMaitre et al., 2002.	foidolite	urn:cgi:classifier:CGI:SimpleLithology: 201001:foidolite
1.1.2.2	Fine grained igneous rock	igneous_rock	Igneous rock in w hich the framew ork of the rock consists of crystals that are too small to determine mineralogy w ith the unaided eye; framew ork may include up to 50 % glass. A significant %age of the rock by volume may be phenocrysts. Includes rocks that are generally called volcanic rocks. Synonym: volcanic rock.	Gillespie and Styles, 1999; LeMaitre et al., 2002.	fine_grained_igneous _rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:fine_grained_igneous_rock
1.1.2.2.1	Rhyolitoid	fine_grained _igneous_rock	Fine grained igneous rock consisting of quartz and alkali feldspar, w ith 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: less than 90 % mafic minerals, betw een 20 and 60 % quartz in the QAPF fraction, and ratio of plagioclse to total feldspar is less than 0.65. Synonym: rhyolitic rock.	LeMaitre et al., 2002.	rhyolitoid	urn:cgi:classifier:CGI:SimpleLithology: 201001:rhyolitoid
1.1.2.2.1.1	Rhyolite	rhyolitoid	Rhyolitoid in w hich the ratio of plagioclase to total feldspar is betw een 0.1 and 0.65. SeeAlso: liparite, rhyodacite.	LeMaitre et al., 2002.	rhyolite	urn:cgi:classifier:CGI:SimpleLithology: 201001:rhyolite
1.1.2.2.1.2	Alkali feldspar rhyolite	rhyolitoid	Rhyolitoid in w hich the ratio of plagioclase to total feldspar is less than 0.1. QAPF field 2. SeeAlso: alkali feldspar liparite, peralkaline rhyolite.	LeMaitre et al., 2002.	alkali_feldspar_rhyolit e	urn:cgi:classifier:CGI:SimpleLithology: 201001:alkali_feldspar_rhyolite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.2.2	Dacite	fine_grained_igneous_rock	Fine grained or porphyritic crystalline rock that contains less than 90 % mafic minerals, between 20 and 60 % 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. SeeAlso: rhyodacite.	LeMaitre et al., 2002.	dacite	urn:cgi:classifier:CGI:SimpleLithology:201001:dacite
1.1.2.2.3	Trachytoid	fine_grained_igneous_rock	Fine grained igneous rock than contains less than 90 % mafic minerals, less than 10 % feldspathoid mineral and less than 20 % 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. SeeAlso: basaltic-trachyandesite, benmoreite, hawaiite, mugearite, potassic-trachybasalt, shoshonite, trachyandesite, trachybasalt, trachydacite, trachyte (TAS).	LeMaitre et al., 2002.	trachytoid	urn:cgi:classifier:CGI:SimpleLithology:201001:trachytoid
1.1.2.2.3.1	Trachytic rock	trachytoid	Trachytoid that has a plagioclase to total feldspar ratio between 0.1 and 0.35. QAPF fields 7, 7', and 7*.	LeMaitre et al., 2002.	trachytic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:trachytic_rock
1.1.2.2.3.1.1	Trachyte	trachytic_rock	Trachytoid that has a plagioclase to total feldspar ratio between 0.1 and 0.35, between 0 and 5 % quartz in the QAPF fraction, and no feldspathoid minerals. QAPF field 7.	LeMaitre et al., 2002.	trachyte	urn:cgi:classifier:CGI:SimpleLithology:201001:trachyte
1.1.2.2.3.2	Latitic rock	trachytoid	Trachytoid that has a plagioclase to total feldspar ratio between 0.35 and 0.65. QAPF fields 8, 8' and 8*.	LeMaitre et al., 2002.	latitic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:latitic_rock
1.1.2.2.3.2.1	Latite	latitic_rock	Latitic rock that contains between 0 and 5 % quartz and no feldspathoid in the QAPF fraction. QAPF field 8.	LeMaitre et al., 2002.	latite	urn:cgi:classifier:CGI:SimpleLithology:201001:latite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.2.4	Andesite	fine_grained _igneous_rock	Fine-grained igneous rock w ith less than 20 % quartz and less than 10 % feldspathoid minerals in the QAPF fraction, in w hich 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, w hich share the same QAPF fields, are distinguished chemically based on silica content, w ith basalt defined to contain less than 52 w eight % silica. If chemical data are not available, the color index is used to distinguish the categories, w ith basalt defined to contain greater than 35 % mafic minerals by volume or greater than 40 % mafic minerals by w eight. Typically consists of plagioclase (frequently zoned from labradorite to oligoclase), pyroxene, hornblende and/or biotite. Fine grained equivalent of dioritic rock. SeeAlso: basaltic andesite, leuco-basalt, mela-andesite.	LeMaitre et al., 2002.	andesite	urn:cgi:classifier:CGI:SimpleLithology:201001:andesite
1.1.2.2.4.1	Boninite	andesite	Andesitic rock that contains more than 8 % 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 grow th.	LeMaitre et al., 2002	boninite	urn:cgi:classifier:CGI:SimpleLithology:201001:boninite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.2.5	Basalt	fine_grained _igneous_rock	Fine-grained or porphyritic igneous rock with less than 20 % quartz, and less than 10 % 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 % silica. If chemical data are not available, the color index is used to distinguish the categories, with basalt defined to contain greater than 35 % mafic minerals by volume or greater than 40 % mafic minerals by weight. SeeAlso: leuco-basalt, mela-andesite, picrite, picrobasalt.	after LeMaitre et al., 2002.	basalt	urn:cgi:classifier:CGI:SimpleLithology:201001:basalt
1.1.2.2.5.1	Alkali olivine basalt	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.	Carmichael et al., 1974.	alkali-olivine_basalt	urn:cgi:classifier:CGI:SimpleLithology:201001:alkali-olivine_basalt
1.1.2.2.5.2	Tholeiitic basalt	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 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.	Carmichael et al., 1974.	tholeiitic_basalt	urn:cgi:classifier:CGI:SimpleLithology:201001:tholeiitic_basalt

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.2.6	Phonolitoid	fine_grained _igneous_rock	Fine grained igneous rock than contains less than 90 % mafic minerals, betw een 10 and 60 % 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. Synonym: phonolitic rock.	LeMaitre et al., 2002.	phonolitoid	urn:cgi:classifier:CGI:SimpleLithology:201001:phonolitoid
1.1.2.2.6.1	Phonolite	phonolitoid	Phonolitoid in w hich the plagioclase to total feldspar ratio is less than 0.1. Rock consists of alkali feldspar, feldspathoid minerals, and mafic minerals. SeeAlso: peralkaline phonolite.	LeMaitre et al., 2002.	phonolite	urn:cgi:classifier:CGI:SimpleLithology:201001:phonolite
1.1.2.2.7	Tephritoid	fine_grained _igneous_rock	Fine grained igneous rock than contains less than 90 % mafic minerals, betw een 10 and 60 % 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. Synonym: tephritic rock.	LeMaitre et al., 2002.	tephritoid	urn:cgi:classifier:CGI:SimpleLithology:201001:tephritoid
1.1.2.2.7.1	Tephrite	tephritoid	Tephritoid that has a plagioclase to total feldspar ratio greater than 0.9, and contains less than 10 % normative (CIPW[1]) olivine. Synonym: tephritoid.	LeMaitre et al., 2002.	tephrite	urn:cgi:classifier:CGI:SimpleLithology:201001:tephrite
1.1.2.2.7.2	Basanite	tephritoid	Tephritoid that has a plagioclase to total feldspar ratio greater than 0.9, and contains more than 10 % normative (CIPW[1]) olivine. Synonym: tephritoid.	LeMaitre et al., 2002.	basanite	urn:cgi:classifier:CGI:SimpleLithology:201001:basanite
1.1.2.2.8	Foiditoid	fine_grained _igneous_rock	Fine grained crystalline rock containing less than 90 % mafic minerals and more than 60 % feldspathoid minerals in the QAPF fraction. Includes rocks defined modally in QAPF field 15 or chemically in TAS field F. Synonym: foidite (sensu lato), foiditic rock.	LeMaitre et al., 2002.	foiditoid	urn:cgi:classifier:CGI:SimpleLithology:201001:foiditoid
1.1.2.2.8.1	Foidite	foiditoid	Foiditoid that contains greater than 90 % feldspathoid minerals in the QAPF fraction.	LeMaitre et al., 2002.	foidite	urn:cgi:classifier:CGI:SimpleLithology:201001:foidite
1.1.2.3	Ultramafic igneous rock	igneous_rock	Igneous rock that consists of greater than 90 % mafic minerals. SeeAlso: alkremite.	LeMaitre et al., 2002; Gillespie & Styles, 1999.	ultramafic_igneous_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:ultramafic_igneous_rock

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.3.1	Peridotite	ultramafic _igneous_rock	Ultramafic rock consisting of more than 40 % (by volume) olivine w ith 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, w ehrlite, olivinite, pyroxene peridotite, pyroxene hornblende peridotite or hornblende peridotite. SeeAlso: dunite, harzburgite, lherzolite, olivinite, w herlite.	LeMaitre et al., 2002.	peridotite	urn:cgi:classifier:CGI:SimpleLithology:201001:peridotite
1.1.2.3.2	Pyroxenite	ultramafic _igneous_rock	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 w ebsterite. SeeAlso: clinopyroxenite, orthopyroxenite, w ebsterite.	LeMaitre et al., 2002.	pyroxenite	urn:cgi:classifier:CGI:SimpleLithology:201001:pyroxenite
1.1.2.3.3	Komatiitic rock	ultramafic _igneous rock	Ultramafic, magnesium-rich volcanic rock, typically w ith spinifex texture of intergrow n skeletal and bladed olivine and pyroxene crystals set in abundant glass. Includes komatiite and meimechite. SeeAlso: komatiite, meimechite.	LeMaitre et al., 2002.	komatiitic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:komatiitic_rock
1.1.2.4	Exotic composition igneous rock	igneous_rock	Rock w ith 'exotic' mineralogical, textural or field setting characteristics; typically dark colored, w ith abundant phenocrysts. Criteria include: presence of greater than 10 % melilite or leucite, or presence of kalsilite, or greater than 50 % carbonate minerals. Includes Carbonatite, Melilitic rock, Kalsilitic rocks, Kimberlite, Lamproite, Leucitic rock and Lamprophyres.	Gillespie & Styles, 1999; LeMaitre et al., 2002.	exotic_composition_igneous_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:exotic_composition_igneous_rock
1.1.2.4.1	Carbonatite	exotic _composition _igneous_rock	Igneous rock composed of more than 50 % modal carbonate minerals.	LeMaitre et al., 2002.	carbonatite	urn:cgi:classifier:CGI:SimpleLithology:201001:carbonatite

Table 4-5: The 1G-E vocabulary for Igneous material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.1.2.4.2	Kalsilitic and melilitic rocks	exotic _composition _igneous_rock	Igneous rock containing greater than 10 % melilite or kalsilite. Typically undersaturated, ultrapotassic (kalsilitic rocks) or calcium-rich (melilitic rocks) mafic or ultramafic rocks. SeeAlso: coppaelite, kalsilitite, katungite, mafurite, melilitite, melilitolite, ugandite, venanzite.	LeMaitre et al., 2002.	kalsilitic_and_melilitic_ rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:kalsilitic_and_melilitic_rock
1.1.2.4.3	Exotic alkaline rock	exotic _composition _igneous_rock	Kimberlite, lamproite, or lamprophyre. Generally are potassic, mafic or ultramafic rocks. Olivine (commonly serpentinized in kimberlite), and phlogopite are significant constituents. SeeAlso: cancalite, cedricite, fitzroyite, fortunite, jumillite, kimberlite, lamproite, lamprophyre, madupite, mamilite, orendite, verite, w olgidite, w yomingite.	LeMaitre et al., 2002.	exotic_alkaline_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:exotic_alkaline_rock
1.1.2.5	Porphyry	igneous_rock	Igneous rock that contains conspicuous phenocrysts in a finer grained groundmass; groundmass itself may be phaneritic or fine-grained.	LeMaitre et al., 2002.	porphyry	urn:cgi:classifier:CGI:SimpleLithology: 201001:porphyry
1.1.2.6	Doleritic rock	igneous_rock	Dark colored gabbroic (basaltic) or dioritic (andesitic) rock intermediate in grain size betw een basalt and gabbro and composed of plagioclase, pyroxene and opaque minerals; often w ith ophitic texture. Typically occurs as hypabyssal intrusions. Includes dolerite, microdiorite, diabase and microgabbro. SeeAlso: diabase, microdiorite, microgabbro, trap. Related Concept: andesite, dioritic_rock, gabbroid.	Neuendorf et al., 2005; LeMaitre et al., 2002; Gillespie & Styles, 1999.	doleritic_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:doleritic_rock

4.2.2 Sedimentary material

Sedimentary material is divided into Sediments, Sedimentary rocks and Chemical sedimentary material. This classification follows the Science Language Technical Team (SLTT) of the North American Geologic-map Data Model Steering Committee (NADMSC) of 2004.

Sediment comprises all unconsolidated material and is further subdivided into Clastic, Carbonate and Biogenic sediments. Sedimentary rocks, which formed by accumulation and cementation of solid fragmental material, are further subdivided into Clastic, Organic-rich, Carbonate, Non-clastic siliceous and Iron-rich categories, as well as Generic mudstones. Chemical sedimentary material comprises the evaporites.

Table 4-6 shows the agreed terms, their definitions and URNs for Sedimentary Material; figure 4-5 shows the corresponding concept hierarchy.

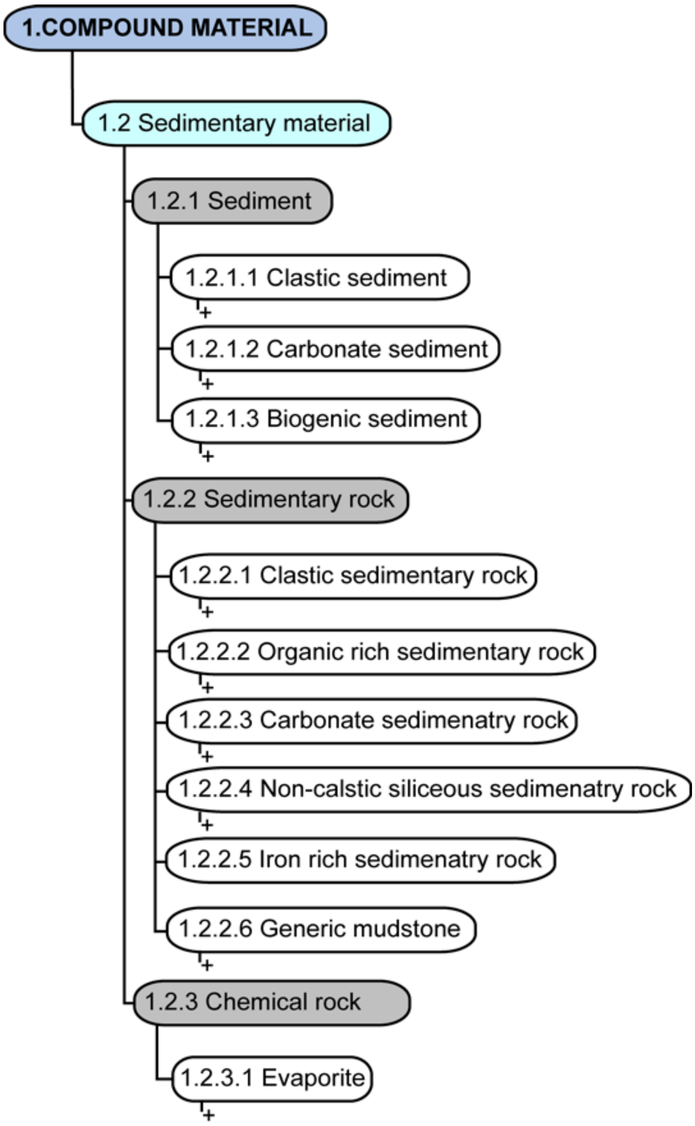

Figure 4-5: Hierarchical overview representation of the 1G-E vocabulary for Sedimentary material. For clarity only the main groups are indicated.

Table 4-6: The 1G-E vocabulary for Sedimentary material.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2	Sedimentary material	compound _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).	SLTT, 2004[1].	sedimentary_material	urn:cgi:classifier:CGI:SimpleLithology:201001:sedimentary_material
1.2.1	Sediment	sedimentary _material	Unconsolidated material consisting of an aggregation of particles transported or deposited by air, water or ice, or that accumulated by other natural agents, such as chemical precipitation, and that forms in layers on the Earth's surface. Includes epiclastic deposits.	SLTT, 2004[1].	sediment	urn:cgi:classifier:CGI:SimpleLithology:201001:sediment
1.2.1.1	Clastic sediment	sediment	Sediment in which at least 50 % 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.	SLTT, 2004[1]; Neuendorf et al., 2005.	clastic_sediment	urn:cgi:classifier:CGI:SimpleLithology:201001:clastic_sediment
1.2.1.1.1	Diamicton	clastic _sediment	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.	Fairbridge & Bourgeois, 1978.	diamicton	urn:cgi:classifier:CGI:SimpleLithology:201001:diamicton

[1] for explanation please see chapter 8: Abbreviations.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.1.1.2	Gravel	clastic _sediment	Clastic sediment containing greater than 30 % gravel-size particles (greater than 2.0 mm diameter). Gravel in which more than half of the particles are of epiclastic origin.	SLTT, 2004[1,2].	gravel	urn:cgi:classifier:CGI:SimpleLithology: 201001:gravel
1.2.1.1.3	Sand	clastic _sediment	Clastic sediment in which less than 30 % 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.	SLTT, 2004[1,2].	sand	urn:cgi:classifier:CGI:SimpleLithology: 201001:sand
1.2.1.1.4	Mud	clastic _sediment	Clastic sediment consisting of less than 30 % 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.	SLTT, 2004[1,2].	mud	urn:cgi:classifier:CGI:SimpleLithology: 201001:mud
1.2.1.1.4.1	Clay	mud	Mud that consists of greater than 50 % particles with grain size less than 4 µm.	SLTT, 2004[1,3]; Neuendorf et al. 2005.	clay	urn:cgi:classifier:CGI:SimpleLithology: 201001:clay
1.2.1.1.4.2	Silt	mud	Mud that consists of greater than 50 % silt-size grains. Synonym: loess.	SLTT, 2004[1]; Neuendorf et al. 2005.	silt	urn:cgi:classifier:CGI:SimpleLithology: 201001:silt
1.2.1.2	Carbonate sediment	sediment	Sediment in which at least 50 % 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.	SLTT, 2004[1].	carbonate_sediment	urn:cgi:classifier:CGI:SimpleLithology: 201001:carbonate_sediment
1.2.1.2.1	Impure carbonate sediment	carbonate _sediment	Carbonate sediment in which between 50 and 90 % of the constituents are composed of one (or more) of the carbonate minerals in particles of intrabasinal origin. Synonym: marl.	CGI SimpleLithology, 2010.	impure_carbonate_se diment	urn:cgi:classifier:CGI:SimpleLithology: 201001:impure_carbonate_sediment
1.2.1.3	Biogenic sediment	sediment	Sediment composed of greater than 50 % material of biogenic origin. Because the biogenic material may be skeletal remains that are not organic, all biogenic sediment is not necessarily organic-rich. Related Concept: carbonate_sediment, non_clastic_siliceous_sediment.	SLTT, 2004[1].	biogenic_sediment	urn:cgi:classifier:CGI:SimpleLithology: 201001:biogenic_sediment

[1] for explanation please see chapter 8: Abbreviations; [2] particle sizes defined from Krumbein & Sloss, 1963; Krumbein & Pettijohn, 1938; [3] particle size from Wentworth grade scale.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.1.3.1	Organic rich sediment	biogenic _sediment	Sediment with color, composition, texture and apparent density indicating greater than 50 % organic content by weight on a moisture-free basis.	SLTT, 2004[1].	organic_rich_sediment	urn:cgi:classifier:CGI:SimpleLithology:201001:organic_rich_sediment
1.2.1.3.1.1	Peat	organic_rich _sediment	Unconsolidated organic-rich sediment composed of at least 50 % 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 %. Liptinite to Inertinite ratio is less than 1.	Hallsworth & Knox 1999; ECE-UN, 1998[1].	peat	urn:cgi:classifier:CGI:SimpleLithology:201001:peat
1.2.1.3.1.2	Sapropel	organic_rich _sediment	Jelly like organic rich sediment composed of plant remains, usually algal. Liptinite to Inertinite ratio is greater than 1. Related Concept: ooze.	Neuendorf et al., 2005; ECE-UN, 1998[1].	sapropel	urn:cgi:classifier:CGI:SimpleLithology:201001:sapropel
1.2.1.3.2	Ooze	biogenic _sediment	Biogenic sediment consisting of less than 1 % 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 % carbonate minerals. Synonym: biogenic mud.	Bates & Jackson, 1987; Hallsworth & Knox, 1999.	ooze	urn:cgi:classifier:CGI:SimpleLithology:201001:ooze
1.2.1.3.2.1	Carbonate ooze	ooze	Ooze that consists of more than 50 % carbonate skeletal remains.	CGI SimpleLithology, 2010.	carbonate_ooze	urn:cgi:classifier:CGI:SimpleLithology:201001:carbonate_ooze
1.2.1.3.2.2	Siliceous ooze	ooze	Ooze that consists of more than 50 % siliceous skeletal remains.	CGI SimpleLithology, 2010.	siliceous_ooze	urn:cgi:classifier:CGI:SimpleLithology:201001:siliceous_ooze
1.2.2	Sedimentary rock	sedimentary _material	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.	SLTT, 2004[1].	sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:sedimentary_rock
1.2.2.1	Clastic sedimentary rock	sedimentary _rock	Sedimentary rock in which at least 50 % 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.	SLTT, 2004[1]; Neuendorf et al., 2005.	clastic_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:clastic_sedimentary_rock

[1] for explanation please see chapter 8: Abbreviations.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.2.1.1	Diamictite	clastic _sedimentary _rock	Unsorted or poorly sorted, clastic sedimentary rock w ith a w ide range of particle sizes including a muddy matrix. Biogenic materials that have such texture are excluded.	Fairbridge & Bourgeois, 1978.	diamictite	urn:cgi:classifier:CGI:SimpleLithology: 201001:diamictite
1.2.2.1.2	Conglomerate	clastic _sedimentary _rock	Clastic sedimentary rock composed of at least 30 % rounded to subangular fragments larger than 2 mm in diameter; typically contains finer grained material in interstices betw een larger fragments. If more than 15 % of the fine grained matrix is of indeterminant clastic or diagenetic origin and the fabric is matrix supported, may also be categorized as w ackestone. If rock has unsorted or poorly sorted texture w ith a w ide range of particle sizes, may also be categorised as diamictite. Synonym: clastic conglomerate.	Neuendorf et al., 2005; SLTT, 2004[1].	clastic_conglomerate	urn:cgi:classifier:CGI:SimpleLithology: 201001:clastic_conglomerate
1.2.2.1.3	Sandstone	clastic _sedimentary _rock	Clastic sedimentary rock in w hich less than 30 % of particles are greater than 2 mm in diameter (gravel) and the sand to mud ratio is at least 1. Synonym: clastic sandstone.	SLTT, 2004[1]; Neuendorf et al. 2005[3].	clastic_sandstone	urn:cgi:classifier:CGI:SimpleLithology: 201001:clastic_sandstone
1.2.2.1.3.1	Arenite	clastic _sandstone	Clastic sandstone that contains less than 10 % matrix. Matrix is mud-size silicate minerals (clay, feldspar, quartz, rock fragments, and alteration products) of detrital or diagenetic nature. SeeAlso: pure sandstone.	Pettijohn et al., 1972.	arenite	urn:cgi:classifier:CGI:SimpleLithology: 201001:arenite
1.2.2.1.3.2	Wacke	clastic _sandstone	Clastic sandstone w ith more than 10 % matrix of indeterminate detrital or diagenetic nature. Matrix is mud size silicate minerals (clay, feldspar, quartz, rock fragments, and alteration products). SeeAlso: grayw acke, impure sandstone.	Pettijohn et al., 1972.	w acke	urn:cgi:classifier:CGI:SimpleLithology: 201001:w acke
1.2.2.1.4	Mudstone	clastic _sedimentary _rock	Clastic sedimentary rock consisting of less than 30 % gravel-size (2 mm) particles and w ith a mud to sand ratio greater than 1. Synonym: clastic mudstone. SeeAlso: argillite.	Pettijohn et al., 1987[4].	clastic_mudstone	urn:cgi:classifier:CGI:SimpleLithology: 201001:clastic_mudstone
1.2.2.1.4.1	Claystone	clastic _mudstone	Mudstone that contains no detectable silt, inferred to consist virtually entirely of clay-size particles. Related Concept: clastic_mudstone.	CGI SimpleLithology, 2010.	claystone	urn:cgi:classifier:CGI:SimpleLithology: 201001:claystone

[1] for explanation please see chapter 8: Abbreviations; [3] particle size from Wentworth grade scale; [4] referenced in Hallsworth & Knox 1999; extrapolated from Folk, 1954, Figure 1a.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.2.1.4.2	Siltstone	clastic _mudstone	Mudstone that contains detectable silt. Synonym: silt bearing mudstone. SeeAlso: siltstone. Related Concept: clastic_mudstone.	CGI SimpleLithology, 2010.	siltstone	urn:cgi:classifier:CGI:SimpleLithology: 201001:siltstone
1.2.2.1.4.3	Shale	clastic _mudstone	Laminated mudstone that w ill part or break along thin, closely spaced layers parallel to stratification. Related Concept: clastic_mudstone.	SLTT, 2004[1].	shale	urn:cgi:classifier:CGI:SimpleLithology: 201001:shale
1.2.2.2	Organic rich sedimentary rock	sedimentary _rock	Sedimentary rock w ith color, composition, texture and apparent density indicating greater than 50 % organic content by w eight on a moisture-free basis.	SLTT, 2004[1].	organic_rich_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:organic_rich_sedimentary_rock
1.2.2.2.1	Coal	organic_rich _sedimentary _rock	A consolidated organic sedimentary material having less than 75 % moisture. This category includes low , medium, and high rank coals, 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.	ECE-UN, 1998[1].	coal	urn:cgi:classifier:CGI:SimpleLithology: 201001:coal
1.2.2.2.1.1	Lignite	coal	Coal that has a gross calorific value less than 24 MJ/kg[5], and vitrinite mean random reflectance less than 0.6 %[6]. Gross calorific value is recalculated to a moist, ash free basis using bed moisture[7]. Includes all low -rank coals, including sub-bitiminous coal. A consolidated, dull, soft brow n 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 brow n streak for sub-bitiminous coal and black streak for bituminous coal. Synonym: low rank coal. SeeAlso: brow n coal, metalignite, ortholignite, sub-bituminous coal.	ECE-UN, 1998[1].	lignite	urn:cgi:classifier:CGI:SimpleLithology: 201001:lignite

[1] for explanation please see chapter 8: Abbreviations; [5] determined in conformance with ISO 1928; [6] determined in conformance with ISO 7404-5; [7] determined according to ISO 1015 or ISO 5068.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.2.2.1.2	Bituminous coal	coal	Coal that has vitrinite mean random reflectance greater than 0.6 % and less than 2 %[6], or has a gross calorific value greater than 24 MJ/kg[5]. Hard, black, organic rich sedimentary rock; contains less than 91 % fixed carbon on a dry, mineral-matter-free basis, and greater than 13-14 % volatiles (dry, ash free). Formed from the compaction or induration of variously altered plant remains similar to those of peaty deposits. Synonym: medium rank coal. SeeAlso: esskohle, fettkohle, flammkohle, gasflammkohle, gaskohle, glanzkohle.	ECE-UN, 1998[1]; Lindner, 1993.	bituminous_coal	urn:cgi:classifier:CGI:SimpleLithology:201001:bituminous_coal
1.2.2.2.1.3	Anthracite	coal	Coal that has vitrinite mean random reflectance greater than 2 %[6]. Less than 12-14 % volatiles (dry, ash free), greater than 91 % fixed carbon (dry, ash free basis). The highest rank coal; very hard, glossy, black, with semimetallic luster, semi conchoidal fracture. Synonym: high rank coal.	ECE-UN, 1998[1]; Lindner, 1993.	anthracite_coal	urn:cgi:classifier:CGI:SimpleLithology:201001:anthracite_coal
1.2.2.3	Carbonate sedimentary rock	sedimentary _rock	Sedimentary rock in which at least 50 % of the primary and/or recrystallized constituents are composed of one (or more) of the carbonate minerals calcite, aragonite, magnesite or dolomite.	SLTT, 2004[1].	carbonate_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:carbonate_sedimentary_rock
1.2.2.3.1	Pure carbonate sedimentary rock	carbonate _sedimentary _rock,	Sedimentary rock in which greater than 90 % of the primary and/or recrystallized constituents are carbonate minerals.	CGI SimpleLithology, 2010.	pure_carbonate_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:pure_carbonate_sedimentary_rock
1.2.2.3.1.1	Dolomitic or magnesian sedimentary rock	pure _carbonate _sedimentary _rock	Carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1. Includes dolostone, lime dolostone and magnesite-stone.	after SLTTs, 2004; Hallsworth & Knox,1999.	dolomitic_or_magnesian_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:dolomitic_or_magnesian_sedimentary_rock

[1] for explanation please see chapter 8: Abbreviations; [5] determined in conformance with ISO 1928; [6] determined in conformance with ISO 7404-5.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.2.3.1.1.1	Dolomite	dolomitic_or _magnesian _sedimentary _rock	Pure carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1. Synonym: dolostone.	CGI SimpleLithology, 2010.	dolostone	urn:cgi:classifier:CGI:SimpleLithology: 201001:dolostone
1.2.2.3.1.2	Limestone	pure _carbonate _sedimentary _rock	Pure carbonate sedimentary rock with a calcite (plus aragonite) to dolomite ratio greater than 1 to 1. Includes limestone and dolomitic limestone. SeeAlso: dolomitic limestone.	CGI SimpleLithology, 2010.	limestone	urn:cgi:classifier:CGI:SimpleLithology: 201001:limestone
1.2.2.3.1.2.1	Chalk	limestone	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.	Harris, 2009.	chalk	urn:cgi:classifier:CGI:SimpleLithology: 201001:chalk
1.2.2.3.1.2.2	Travertine	limestone	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. SeeAlso: calcareous sinter, onyx marble, tufa.	Neuendorf et al., 2005; Chafetz & Folk, 1984.	travertine	urn:cgi:classifier:CGI:SimpleLithology: 201001:travertine
1.2.2.3.2	Impure carbonate sedimentary rock	carbonate _sedimentary _rock	Sedimentary rock in which between 50 and 90 % of the primary and/or recrystallized constituents are composed of carbonate minerals. Synonym: marlstone. SeeAlso: marlstone.	CGI SimpleLithology, 2010.	impure_carbonate_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:impure_carbonate_sedimentary_rock
1.2.2.3.2.1	Impure limestone	impure _carbonate _sedimentary _rock	Impure carbonate sedimentary rock with a calcite (plus aragonite) to dolomite ratio greater than 1. Synonym: calcareous marlstone. SeeAlso: marlstone.	CGI SimpleLithology, 2010.	impure_limestone	urn:cgi:classifier:CGI:SimpleLithology: 201001:impure_limestone

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.2.3.2.2	Impure dolomite	impure _carbonate _sedimentary _rock	Impure carbonate sedimentary rock with a ratio of magnesium carbonate to calcite (plus aragonite) greater than 1. Synonym: impure dolostone, dolomitic marlstone. SeeAlso: marlstone.	CGI SimpleLithology, 2010.	impure_dolostone	urn:cgi:classifier:CGI:SimpleLithology:201001:impure_dolostone
1.2.2.4	Non-clastic siliceous sedimentary rock	sedimentary _rock	Sedimentary rock that consists of at least 50 % 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. SeeAlso: chert, flint.	SLTT, 2004[1].	non_clastic_siliceous _sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:non_clastic_siliceous_sedimentary_rock
1.2.2.4.1	Biogenic silica sedimentary rock	non_clastic _siliceous _sedimentary _rock	Sedimentary rock that consists of at least 50 % silicate mineral material, deposited directly by biological processes at the depositional surface, or in particles formed by biological processes within the basin of deposition. SeeAlso: radiolarite, spicularite, spiculite.	based on SLTT, 2004[1]; Hallsworth & Knox, 1999.	biogenic_silica_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:biogenic_silica_sedimentary_rock
1.2.2.5	Iron rich sedimentary rock	sedimentary _rock	Sedimentary rock that consists of at least 50 % 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 % iron by weight.	Hallsworth & Knox, 1999; SLTT, 2004[1].	iron_rich_sedimentary_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:iron_rich_sedimentary_rock
1.2.2.6	Generic mudstone	sedimentary _rock	Sedimentary rock consisting of less than 30 % gravel-size (2 mm) particles and with a mud to sand ratio greater than 1. Clasts may be of any composition or origin. SeeAlso: argillite.	Pettijohn et al. 1987[1,4].	generic_mudstone	urn:cgi:classifier:CGI:SimpleLithology:201001:generic_mudstone
1.2.2.6.1	Organic bearing mudstone	genereric _mudstone	Mudstone that contains a significant amount of organic carbon, typically kerogen. Commonly finely laminated, brown or black in color. Synonym: oil shale. SeeAlso: tar sand.	Neuendorf et al., 2005.	organic_bearing_mudstone	urn:cgi:classifier:CGI:SimpleLithology:201001:organic_bearing_mudstone

[1] for explanation please see chapter 8: Abbreviations; [4] referenced in Hallsworth & Knox 1999; extrapolated from Folk, 1954, Figure 1a.

Table 4-6: The 1G-E vocabulary for Sedimentary material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.2.3	Chemical sedimentary material	sedimentary _material	Sedimentary material that consists of at least 50 % material produced by inorganic chemical processes within the basin of deposition. Includes inorganic siliceous, carbonate, evaporite, iron-rich, and phosphatic sediment classes.	SLTT, 2004[1].	chemical_sedimentary_material	urn:cgi:classifier:CGI:SimpleLithology:201001:chemical_sedimentary_material
1.2.3.1	Evaporite	chemical _sedimentary _material	Nonclastic sedimentary rock composed of at least 50 % non-carbonate salts, including chloride, sulfate or borate minerals; formed through precipitation of mineral salts from a saline solution (non-carbonate salt rock).	Jackson 1997; SLTT, 2004[1].	evaporite	urn:cgi:classifier:CGI:SimpleLithology:201001:evaporite
1.2.3.1.1	Rock salt	evaporite	Evaporite composed of at least 50 % halite.	CGI SimpleLithology, 2010.	rock_salt	urn:cgi:classifier:CGI:SimpleLithology:201001:rock_salt
1.2.3.1.2	Gypsum or anhydrite	evaporite	Evaporite composed of at least 50 % gypsum or anhydrite.	CGI SimpleLithology, 2010.	rock_gypsum_or_anhydrite	urn:cgi:classifier:CGI:SimpleLithology:201001:rock_gypsum_or_anhydrite

[1] for explanation please see chapter 8: Abbreviations.

4.2.3 Composite genesis material

Following SLTT 2004, Composite genesis material is defined as material of unspecified consolidation state formed by geological modification of pre-existing materials outside the realm of igneous and sedimentary processes. This includes rocks formed by impact metamorphism, standard dynamothermal metamorphism, brittle deformation, weathering, metasomatism and hydrothermal alteration (diagenesis is a sedimentary process in this context). Therefore Composite genesis material is a heterogeneous category, comprising rocks of different genesis, i.e. Metamorphic and Metasomatic rocks, Material formed in surficial environment (e.g. bauxite), Fault-related material like mylonitic rocks, and Impact generated material (fig. 4-6).

Table 4-7 shows the agreed terms, their definitions and URNs for Composite genesis material.

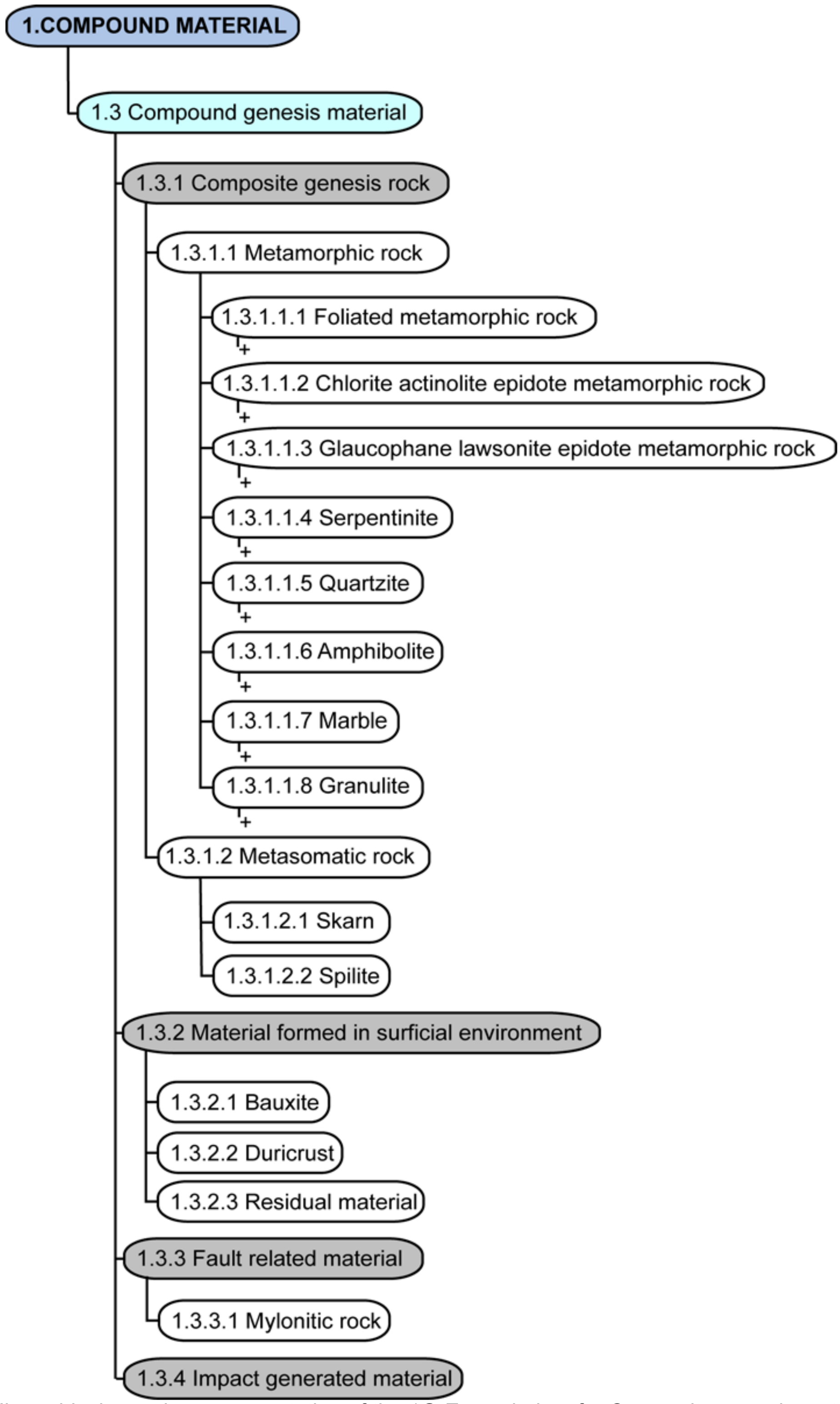

Figure 4-6: Hierarchical overview representation of the 1G-E vocabulary for Composite genesis material. For clarity only the main groups are indicated.

Table 4-7: The 1G-E vocabulary for Composite genesis material.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3	Composite genesis material	compound _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, w eathering, metasomatism and hydrothermal alteration (diagenesis is a sedimentary process in this context).	SLTT, 2004[1].	composite_genesis_ material	urn:cgi:classifier:CGI:SimpleLithology: 201001:composite_genesis_material
1.3.1	Composite genesis rock	composite _genesis _material	Rock formed by geological modification of pre-existing rocks outside the realm of igneous and sedimentary processes. Includes rocks formed by impact metamorphism, standard dynamothermal metamorphism, brittle deformation, w eathering, metasomatism and hydrothermal alteration (diagenesis is a sedimentary process in this context).	SLTT, 2004[1].	composite_genesis_r ock	urn:cgi:classifier:CGI:SimpleLithology: 201001:composite_genesis_rock
1.3.1.1	Metamorphic rock	composite _genesis_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. SeeAlso: buchite, fulgurite.	Jackson, 1997.	metamorphic_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:metamorphic_rock
1.3.1.1.01	Foliated metamorphic rock	metamorphic _rock	Metamorphic rock in w hich 10 % or more of the contained mineral grains are elements in a planar or linear fabric. Cataclastic or glassy character precludes classification w ith this concept. SeeAlso: tectonite, w hiteschist.	SLTT, 2004[1].	foliated_metamorphic _rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:foliated_metamorphic_rock
1.3.1.1.01.1	Gneiss	foliated _metamorphic _rock	Foliated metamorphic rock w ith bands or lenticles rich in granular minerals alternating w ith bands or lenticles rich in minerals w ith a flaky or elongate prismatic habit. Mylonitic foliation or w ell developed, continuous schistosity (greater than 50 % of the rock consists of grains participate in a planar or linear fabric) precludes classification w ith this concept.	Neuendorf et al., 2005.	gneiss	urn:cgi:classifier:CGI:SimpleLithology: 201001:gneiss

[1] for explanation please see chapter 8: Abbreviations.

Table 4-7: The 1G-E vocabulary for Composite genesis material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3.1.1.01.1.1	Orthogneiss	gneiss	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.	CGI SimpleLithology, 2010.	orthogneiss	urn:cgi:classifier:CGI:SimpleLithology:201001:orthogneiss
1.3.1.1.01.1.2	Paragneiss	gneiss	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.	CGI SimpleLithology, 2010.	paragneiss	urn:cgi:classifier:CGI:SimpleLithology:201001:paragneiss
1.3.1.1.01.2	Phyllite	foliated_metamorphic_rock	Rock with a well developed, continuous schistosity, an average grain size between 0.1 and 0.5 mm, and a silvery sheen on cleavage surfaces. Individual phyllosilicate grains are barely visible with the unaided eye.	IUGS SCMR, 2007[1].	phyllite	urn:cgi:classifier:CGI:SimpleLithology:201001:phyllite
1.3.1.1.01.3	Slate	foliated_metamorphic_rock	Compact, fine grained rock with an average grain size less than 0.032 mm and a well developed schistosity (slaty cleavage), and hence can be split into slabs or thin plates.	SLTT, 2004;[1] Neuendorf et al., 2005.	slate	urn:cgi:classifier:CGI:SimpleLithology:201001:slate
1.3.1.1.01.4	Schist	foliated_metamorphic_rock	Foliated phaneritic metamorphic rock with well developed, continuous schistosity, meaning that greater than 50 % 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.	SLTT, 2004[1]; Neuendorf et al., 2005.	schist	urn:cgi:classifier:CGI:SimpleLithology:201001:schist
1.3.1.1.01.4.1	Mica schist	schist	A schist that consists of more than 50 % mica minerals, typically muscovite or biotite. Special type included to distinguish this common variety of schist.	CGI SimpleLithology, 2010.	mica_schist	urn:cgi:classifier:CGI:SimpleLithology:201001:mica_schist
1.3.1.1.02	Chlorite actinolite epidote metamorphic rock	metamorphic_rock	Metamorphic rock characterized by 50 % or more of combined chlorite, actinolite and epidote. Category for rocks generally named greenschist or greenstone. SeeAlso: greenschist, greenstone.	CGI SimpleLithology, 2010.	chlorite_actinolite_epidote_metamorphic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:chlorite_actinolite_epidote_metamorphic_rock

[1] for explanation please see chapter 8: Abbreviations.

Table 4-7: The 1G-E vocabulary for Composite genesis material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3.1.1.03	Glaucophane lawsonite epidote metamorphic rock	metamorphic_rock	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. Synonym: Blauschiefer, Blueschist. SeeAlso: blueschist, glaucophanite.	CGI SimpleLithology, 2010.	glaucophane_lawsonite_epidote_metamorphic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:glaucophane_lawsonite_epidote_metamorphic_rock
1.3.1.1.04	Serpentinite	metamorphic_rock	Rock consisting of more than 75 % serpentine-group minerals, e.g. antigorite, chrysotile or lizardite; accessory chlorite, talc and magnetite may be present; derived from hydration of ferromagnesian silicate minerals such as olivine and pyroxene.	Neuendorf et al., 2005.	serpentinite	urn:cgi:classifier:CGI:SimpleLithology:201001:serpentinite
1.3.1.1.05	Quartzite	metamorphic_rock	Metamorphic rock consisting of greater than or equal to 75 % quartz; typically granoblastic texture. SeeAlso: itacolumite.	after Neuendorf et al., 2005.	quartzite	urn:cgi:classifier:CGI:SimpleLithology:201001:quartzite
1.3.1.1.06	Amphibolite	metamorphic_rock	Metamorphic rock mainly consisting of green, brown or black amphibole and plagioclase (including albite), which combined form 75 % or more of the rock, and both of which are present as major constituents. The amphibole constitutes 50 % or more of the total mafic constituents and is present in an amount of 30 % or more; other common minerals include quartz, clinopyroxene, garnet, epidote-group minerals, biotite, titanite and scapolite.	Coutinho et al., 2007; IUGS SCMR, 2007[1].	amphibolite	urn:cgi:classifier:CGI:SimpleLithology:201001:amphibolite
1.3.1.1.07	Marble	metamorphic_rock	Metamorphic rock consisting of greater than 75 % fine- to coarse-grained recrystallized calcite and/or dolomite; usually with a granoblastic, saccharoidal texture.	IUGS SCMR, 2007; SLTT, 2004[1].	marble	urn:cgi:classifier:CGI:SimpleLithology:201001:marble

[1] for explanation please see chapter 8: Abbreviations.

Table 4-7: The 1G-E vocabulary for Composite genesis material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3.1.1.08	Granulite	metamorphic_rock	Metamorphic rock of high metamorphic grade in which Fe-Mg silicate minerals are dominantly hydroxyl-free; feldspar must be present, and muscovite is absent; rock contains less than 90 % mafic minerals, less than 75 % calcite and/or dolomite, less than 75 % quartz, less than 50 % iron-bearing minerals (hematite, magnetite, limonite-group, siderite, iron-sulfides), and less than 50 % calc-silicate minerals. SeeAlso: nebulite. Related Concept: gneiss, granofels.	Fettes & Desmons, 2007; See also: Wimmenauer, 1985; Winkler, 1979; Bowes, 1989.	granulite	urn:cgi:classifier:CGI:SimpleLithology:201001:granulite
1.3.1.1.09	Eclogite	metamorphic_rock	Metamorphic rock composed of 75 % 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 % (by volume); the presence of plagioclase precludes classification as an eclogite.	IUGS SCMR, 2007[1].	eclogite	urn:cgi:classifier:CGI:SimpleLithology:201001:eclogite
1.3.1.1.10	Migmatite	metamorphic_rock	Silicate metamorphic rock that is pervasively heterogeneous on a dm to m 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. SeeAlso: agmatite, diatectite, dictyonite, ditexite, metatexite, nebulite, phlebite, stromatite, venite.	Fettes & Desmons, 2007; IUGS SCMR, 2007[1].	migmatite	urn:cgi:classifier:CGI:SimpleLithology:201001:migmatite
1.3.1.1.11	Granofels	metamorphic_rock	Metamorphic rock with granoblastic fabric and very little or no foliation (less than 10 % of the mineral grains in the rock are elements in a planar or linear fabric). Grainsize not specified.	SLTT, 2004[1].	granofels	urn:cgi:classifier:CGI:SimpleLithology:201001:granofels
1.3.1.1.11.1	Hornfels	granofels	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. SeeAlso: skarn.	IUGS SCMR, 20071.	hornfels	urn:cgi:classifier:CGI:SimpleLithology:201001:hornfels

[1] for explanation please see chapter 8: Abbreviations.

Table 4-7: The 1G-E vocabulary for Composite genesis material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3.1.2	Metasomatic rock	composite _genesis_rock	Rock that has fabric and composition indicating open-system mineralogical and chemical changes in response to interaction w ith a fluid phase, typically w ater rich. SeeAlso: aceite, argillisite, beresite, endoskarn, fenite, greisen, gumbeite, propylite, rodingite, spilite.	CGI SimpleLithology, 2010.	metasomatic_rock	urn:cgi:classifier:CGI:SimpleLithology:201001:metasomatic_rock
1.3.1.2.1	Skarn	metasomatic _rock	Metasomatic rock consisting mainly of Ca-, Mg-, Fe-, or Mn-silicate minerals, w hich are free from or poor in w ater. Typically formed at the contact betw een a silicate rock or magma and a carbonate rock. Synonym: exoskarn, tactite.	Fettes & Desmons, 2007.	skarn	urn:cgi:classifier:CGI:SimpleLithology:201001:skarn
1.3.1.2.2	Spilite	metasomatic _rock	Altered basic to intermediate composition fine-grained igneous rock in w hich 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. SeeAlso: meta-andesite, metabasalt.	Fettes and Desmon, 2007; Best, 1982; Neuendorf et al., 2005.	spilite	urn:cgi:classifier:CGI:SimpleLithology:201001:spilite
1.3.2	Material formed in surficial environment	composite _genesis _material	Material that is the product of w eathering processes operating on pre-existing rocks or deposits, analogous to hydrothermal or metasomatic rocks, but formed at ambient Earth surface temperature and pressure.	CGI SimpleLithology, 2010.	material_formed_in_surficial_environment	urn:cgi:classifier:CGI:SimpleLithology:201001:material_formed_in_surficial_environment
1.3.2.1	Bauxite	material _formed_in _surficial _environment	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 % quartz. Commonly has a pisolitic or nodular texture, and may be cemented.	Eggleton, 2001.	bauxite	urn:cgi:classifier:CGI:SimpleLithology:201001:bauxite
1.3.2.2	Duricrust	material _formed_in _surficial _environment	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.	CGI SimpleLithology, 2010.	duricrust	urn:cgi:classifier:CGI:SimpleLithology:201001:duricrust

Table 4-7: The 1G-E vocabulary for Composite genesis material (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.3.2.3	Residual material	material _formed_in _surficial _environment	Material of composite origin resulting from weathering processes at the Earth's surface, with genesis dominated by removal of chemical constituents by aqueous leaching. Minor clastic, chemical, or organic input may also contribute. Consolidation state is not inherent in definition, but typically the material is unconsolidated or weakly consolidated.	CGI SimpleLithology, 2010.	residual_material	urn:cgi:classifier:CGI:SimpleLithology: 201001:residual_material
1.3.3	Fault-related material	composite _genesis _material	Material formed as a result of brittle faulting, composed of greater than 10 % matrix; matrix is fine-grained material caused by tectonic grainsize reduction. Includes cohesive (cataclasite series) and non-cohesive (breccia-gouge series) material.	CGI SimpleLithology, 2010; SLTT, 2004[1].	fault_related_material	urn:cgi:classifier:CGI:SimpleLithology: 201001:fault_related_material
1.3.3.1	Mylonitic rock	fault_related _material	Metamorphic rock characterised by a foliation resulting from tectonic grain size reduction, in which more than 10 % of the rock volume has undergone grain size reduction. Includes protomylonite, mylonite, ultramylonite, and blastomylonite. SeeAlso: blastomylonite, mesomylonite, mylonite, protomylonite, ultramylonite.	Marshak & Mitra, 1988.	mylonitic_rock	urn:cgi:classifier:CGI:SimpleLithology: 201001:mylonitic_rock
1.3.4	Impact generated material	composite _genesis _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. SeeAlso: impact breccia, impact metamorphic rock, suevite, tagamite, tektite.	Stöffler & Grieve, 2007; Jackson, 1997.	impact_generated_material	urn:cgi:classifier:CGI:SimpleLithology: 201001:impact_generated_material

[1] for explanation please see chapter 8: Abbreviations.

4.2.4 Breccia and Tuffite

The term Breccia is defined as coarse-grained material composed of angular broken rock fragments, which typically have sharp unworn edges and corners. The fragments may be held together by a mineral cement or enclosed in a fine-grained matrix; they may be consolidated or nonconsolidated and of any composition or origin (Neuendorf et al., 2005).

Based on LeMaitre et al. (2002) and Murawski and Meyer (1998) the term Tuffite represents a commonly laminated or size-graded rock, which consists of more than 50 % particles of indeterminate pyroclastic or epiclastic origin, and less than 75 % particles of clearly pyroclastic origin.

Since both rocks can be generated by many different processes, the terms Breccia and Tuffite cannot strictly be classified in one of the other lithological categories.

Table 4-8 shows the agreed terms, their definitions and URNs for Breccia and Tuffite.

Table 4-8: The 1G-E vocabulary for Breccia and Tuffite.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
1.4	Breccia	compound _material	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 enclosed in a fine-grained matrix; they may be 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.	Neuendorf et al., 2005.	breccia	urn:cgi:classifier:CGI:SimpleLithology:201001:breccia
1.5	Tuffite	compound _material	Rock consists of more than 50 % particles of indeterminate pyroclastic or epiclastic origin and less than 75 % particles of clearly pyroclastic origin. Commonly the rock is laminated or exhibits size grading. SeeAlso: volcaniclastic sedimentary rock. Related Concept: clastic_sedimentary_rock.	LeMaitre et al. 2002; Murawski and Meyer 1998.	tuffite	urn:cgi:classifier:CGI:SimpleLithology:201001:tuffite

4.3 Genesis

The genetic origin of a rock is described within 1G-E by the properties EventEnvironment and/or EventProcess of GeologicEvent. The use of the property EventProcess is mandatory, that of EventEnvironment is optional, except for the description of Quaternary rocks where it is mandatory.

The vocabulary of the genesis was added during the course of the work, although it is not listed in the project’s original work description (DoW), because it is deemed essential for the description of the Quaternary, which covers large areas of Europe.

4.3.1 EventEnviroment

The property EventEnvironment can be used to describe the environment in which the GeologicUnit was formed, e.g. in a ‘Basin plain setting’ or in a ‘volcanic arc setting’. To populate this property one term from table 4-9 should be chosen. Figure 4-7 shows the corresponding concept hierarchy.

4.3.2 EventProcess

With the property EventProcess it is possible to characterise a GeologicUnit more precisely by defining the process of its formation. Typical processes include ‘deposition’ for sediments or ‘intrusion’ for plutonic rocks. The EventProcess should always match the age given in the corresponding EventAge of the property GeologicEvents. For rocks that were formed by different processes over a period of time, such as metamorphic rocks, the option GeologicHistory (see section 3.1) ought to be chosen. That property provides the possibility of recording several events by age, process and environment.

The EventProcess property should be populated with the URN of one of the concepts given in table 4-10. The concept hierarchy is shown in figure 4-8.

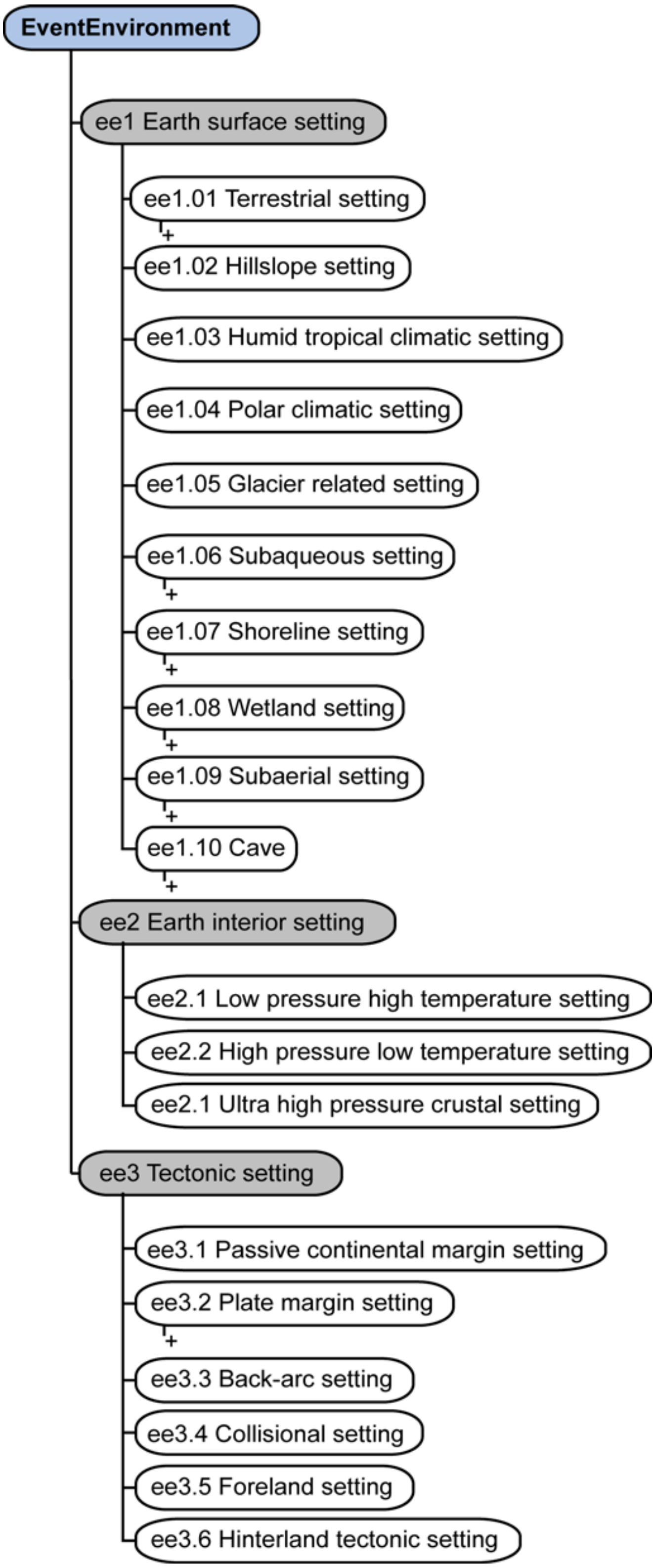

Figure 4-7: Hierarchical overview representation of the 1G-E vocabulary for EventEnvironment.

Table 4-9: The 1G-E vocabulary for EventEnvironment.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1	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 w ith one or more process or geomorphically defined settings.	CGI/GeoSciML.	earth_surface_settin g	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:earth_surface_setti ng
ee1.01	Terrestrial setting	earth_surface _setting	Setting characterised by absence of direct marine influence. Most of the subaerial settings are also terrestrial, but lacustrine settings, w hile terrestrial, are not subaerial, so the subaerial settings are not included as subcategories.	CGI/GeoSciML.	terrestrial_setting	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:terrestrial_setting
ee1.01.1	Lacustrine setting	terrestrial _setting	Setting associated w ith a lake. Alw ays overlaps w ith terrestrial, may overlap w ith subarial, subaqueous, or shoreline.	CGI/GeoSciML.	lacustrine_setting	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:lacustrine_setting
ee1.01.2	River plain system setting	terrestrial _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.	CGI/GeoSciML.	river_plain_system_s etting	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:river_plain_system_ setting
ee1.02	Hillslope setting	earth_surface _setting	Earth surface setting characterized by surface slope angles high enough that gravity alone becomes a significant factor in geomorphic development, as w ell as base-of-slope areas influenced by hillslope processes. Hillslope activities include creep, sliding, slumping, falling, and other dow nslope movements caused by slope collapse induced by gravitational influence on earth materials. May be subaerial or subaqueous.	SLTT, 2004[1]; Haw ley & Parsons, 1980.	hillslope_setting	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:hillslope_setting
ee1.03	Humid tropical climatic setting	earth_surface _setting	Setting w ith hot, humid climate influenced by equatorial air masses, no w inter season.	Cleland et al., 1997.	humid_tropical_climati c_setting	urn:cgi:classifier:CGI:E ventEnvironment:2010 01:humid_tropical_clim atic_setting

[1] for explanation please see chapter 8: Abbreviations.

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1.04	Polar climatic setting	earth_surface_setting	Setting with climate dominated by temperatures below the freezing temperature of water. Includes polar deserts because precipitation is generally scant at high latitude. Climate controlled by arctic air masses, cold dry enviornment with short summer.	Cleland et al., 1997.	polar_climatic_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:polar_climatic_setting
ee1.05	Glacier related setting	earth_surface_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.	CGI/GeoSciML.	glacier_related_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:glacier_related_setting
ee1.06	Subaqueous setting	earth_surface_setting	Setting situated in or under permanent, standing water. Used for marine and lacustrine settings, but not for fluvial settings.	based on SLTT, 2004[1].	subaqueous_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:subaqueous_setting
ee1.06.1	Marine setting	subaqueous_setting	Setting characterised by location under the surface of the sea.	SLTT, 2004[1].	marine_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:marine_setting
ee1.06.1.1	Biological reef setting	marine_setting	A ridgelike or moundlike structure, layered or massive, built by sedentary calcareous organisms, especially corals, and consisting mostly of their remains; it is wave-resistant and stands topographically above the surrounding contemporaneously deposited sediment.	Neuendorf et al., 2005.	biological_reef_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:biological_reef_setting
ee1.06.1.2	Basin plain setting	marine_setting	Near flat areas of ocean floor, slope less than 1:1000; generally receives only distal turbidite and pelagic sediments.	Bates & Jackson, 1987; Heezen & Laughton, 1963; Reading, 1978.	basin_plain_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:basin_plain_setting

[1] for explanation please see chapter 8: Abbreviations.

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1.06.1.3	Continental shelf setting	marine_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. Continental shelves have a classic shoreline-shelf-slope profile termed 'clinoform'.	SLTT, 2004[1]; Jackson, 1997.	continental_shelf_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:continental_shelf_setting
ee1.06.1.4	Epicontinental marine setting	marine_setting	Marine setting situated within the interior of the continent, rather than at the edge of a continent.	SLTT, 2004[1].	epicontinental_marine_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:epicontinental_marine_setting
ee1.06.1.5	Bathyal	marine_setting	The ocean environment at water depths between 200 and 3500 m.	Neuendorf et al., 2005.	bathyal	urn:cgi:classifier:CGI:EventEnvironment:201001:bathyal
ee1.06.1.6	Ocean highland setting	marine_setting	Broad category for subaqueous marine settings characterised by significant relief above adjacent sea floor.	CGI/GeoSciML.		urn:cgi:classifier:CGI:EventEnvironment:201001:ocean_highland_setting
ee1.06.1.6.1	Mid ocean ridge setting	ocean_highland_setting	Ocean highland associated with a divergent continental margin (spreading center). Setting is characterised by active volcanism, locally steep relief, hydrothermal activity, and pelagic sedimentation.	CGI/GeoSciML.	mid_ocean_ridge_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:mid_ocean_ridge_setting
ee1.06.1.6.2	Oceanic plateau setting	ocean_highland_setting	Region of elevated ocean crust that commonly rises to within 2 to 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.	Reading, 1978.	oceanic_plateau_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:oceanic_plateau_setting

[1] for explanation please see chapter 8: Abbreviations.

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1.07	Shoreline settings	earth_surface_setting	Geologic settings characterised by location adjacent to the ocean or a lake. A zone of indefinite width (may be many km), 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.	based on Neuendorf et al., 2005.	shoreline_settings	urn:cgi:classifier:CGI:EventEnvironment:201001:shoreline_settings
ee1.07.1	Deltaic system setting	shoreline_settings	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.	SLTT, 2004[1]; Jackson, 1997.	deltaic_system_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:deltaic_system_setting
ee1.07.2	Coastal plain setting	shoreline_settings	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.	based on Neuendorf et al., 2005.	coastal_plain_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:coastal_plain_setting
ee1.08	Wetland setting	earth_surface_setting	Setting characterised 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.	CGI/GeoSciML	wetland_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:wetland_setting
ee1.08.1	Bog	wetland_setting	Waterlogged, spongy ground, consisting primarily of mosses, containing acidic, decaying vegetation that may develop into peat.	Jackson, 1997; SLTT, 2004[1];	bog	urn:cgi:classifier:CGI:EventEnvironment:201001:bog

[1] for explanation please see chapter 8: Abbreviations.

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1.08.1.1	Basin Bog	bog	An ombrotrophic or ombrogene peat/bog whose nutrient supply is exclusively from rain water (including snow and atmospheric fallout) therefore making nutrients extremly oligotrophic.	1G-E WP3; Neuendorf et al., 2005.	basin_bog	urn:cgi:classifier:CGI:EventEnvironment:201001:basin_bog
ee1.08.1.2	Blanket Bog	bog	Topogene bog/peat whose moisture content is largely dependent on surface water. It is relatively rich in plant nutrients, nitrogen, and mineral matter, mildly acidic to nearly neutral, and contains little or no cellulose; forms in topographic depressions with essential stagnat or non-moving minerotrophic water supply.	1G-E WP3; Neuendorf et al., 2005.	blanket_bog	urn:cgi:classifier:CGI:EventEnvironment:201001:blanket_bog
ee1.09	Subaerial setting	earth_surface_setting	Setting at the interface between the solid earth and the atmosphere, includes some shallow subaqueous settings in river channels and playas. Characterised by conditions and processes, such as erosion, that exist or operate in the open air on or immediately adjacent to the land surface.	Neuendorf et al., 2005.	subaerial_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:subaerial_setting
ee1.09.1	Aeolian process setting	subaerial_setting	Sedimentary setting in which wind is the dominant process producing, transporting, and depositing sediment. Typically has low-relief plain or piedmont slope physiography. Synonym: eolian setting, Sand dune system setting.	CGI/GeoSciML.	aeolian_process_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:aeolian_process_setting
ee1.09.2	Piedmont slope system setting	subaerial_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.	Hawley & Parsons, 1980.	piedmont_slope_system_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:piedmont_slope_system_setting

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee1.10	Cave	earth_surface_setting	A natural underground open space; it generally has a connection to the surface, is large enough for a person to enter, and extends into darkness. The most common type of cave is formed in limestone by dissolution. Synonym: cavern.	Neuendorf et al., 2005.	cave	urn:cgi:classifier:CGI:EventEnvironment:201001:cave
ee2	Earth interior setting		Geologic environments w ithin the solid Earth.	CGI/GeoSciML.	earth_interior_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:earth_interior_setting
ee2.1	Low pressure high temperature setting	earth_interior_setting	Setting characterised by temperatures significantly higher that those associated w ith normal continental geothermal gradient.	CGI/GeoSciML.	low_pressure_high_temperature_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:low_pressure_high_temperature_setting
ee2.2	High pressure low temperature Earth interior setting	earth_interior_setting	High pressure environment characterised by geothermal gradient significantly low er than standard continental geotherm; enviornment in w hich blueschist facies metamorphic rocks form. Typically associated w ith subduction zones.	CGI/GeoSciML.	high_pressure_low_temperature_earth_interior_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:high_pressure_low_temperature_earth_interior_setting
ee2.3	Ultra high pressure crustal setting	earth_interior_setting	Setting characterised by pressures characteristic of upper mantle, but indicated by mineral assemblage in crustal composition rocks.	CGI/GeoSciML.	ultra_high_pressure_crustal_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:ultra_high_pressure_crustal_setting
ee3	Tectonic setting		Setting defined by relationships to tectonic plates on or in the Earth.	CGI/GeoSciML.	tectonic_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:tectonic_setting
ee3.1	Passive continental margin setting	tectonic_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 w hen ocean basin w as initially formed.	CGI/GeoSciML.	passive_continetal_margin_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:passive_continetal_margin_setting
ee3.2	Plate margin setting	tectonic_setting	An active margin occurs w here the continental margin is a plate boundary.	1GE WP3; Neuendorf et al., 2005.	plate_margin_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:plate_margin_setting

Table 4-9: The 1G-E vocabulary for EventEnvironment (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
ee3.2.1	Forearc setting	plate_margin _setting	Tectonic setting betw een a subduction-related trench and a volcanic arc	1GE WP3; Neuendorf et al., 2005.	forearc_margin_setti ng	urn:cgi:classifier:CGI:EventEnvironment:201001:forearc_margin_setting
ee3.2.2	Volcanic arc setting	plate_margin _setting	A generally curvillinear belt of volcanoes above a subduction zone.	1GE WP3; Neuendorf et al., 2005.	volcanic_arc_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:volcanic_arc_setting
ee3.3	Back-arc setting	tectonic _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 w hich oceanic crust is consumed in a subduction zone. Back arc setting includes terrane that is affected by plate margin and arc-related processes.	CGI/GeoSciML.	back_arc_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:back_arc_setting
ee3.4	Collisional setting	tectonic _setting	Tectonic setting in w hich tw o 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.	CGI/GeoSciML.	collisional_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:collisional_setting
ee3.5	Foreland setting	tectonic _setting	The exterior area of an orogenic belt w here deformation occurs w ithout significant metamorphism. Generally the foreland is closer to the continental interior than other portions of the orogenic belt are.	1GE WP3; Neuendorf et al., 2005.	foreland_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:foreland_setting
ee3.6	Hinterland tectonic setting	tectonic _setting	Tectonic setting in the internal part of an orogenic belt, characterised by plastic deformation of rocks accompanied by significant metamorphism, typically involving crystalline basement rocks. Typically denotes the most structurally thickened part of an orogenic belt, betw een a magmatic arc or collision zone and a more 'external' foreland setting.	CGI/GeoSciML.	hinterland_setting	urn:cgi:classifier:CGI:EventEnvironment:201001:hinterland_setting

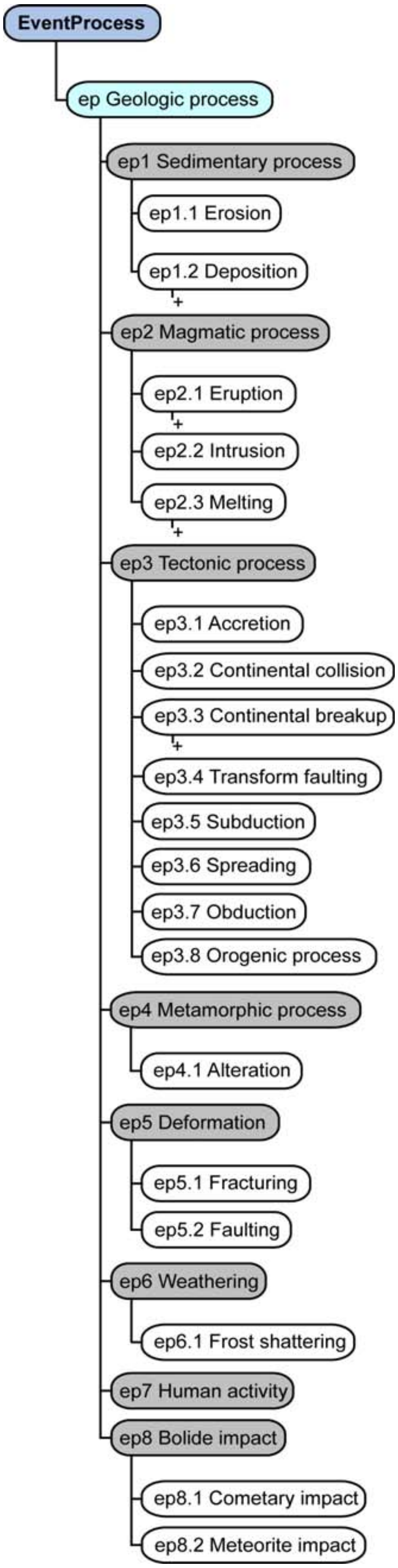

Figure 4-8: Hierarchical overview presentation of the 1G-E vocabulary for EventProcess.

Table 4-10: The 1G-E vocabulary for EventProcess.

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep	Geologic process		Process that effects the geologic record.	CGI/GeoSciML.	geologic_process	urn:cgi:classifier:CGI:EventProcess:201001:geologic_process
ep1	Sedimentary process	geologic _process	A phenomenon that changes the distribution or physical properties of sediment at or near the earth's surface.	CGI/GeoSciML.	sedimentary_process	urn:cgi:classifier:CGI:EventProcess:201001:sedimentary_process
ep1.1	Erosion	sedimentary _process	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).	CGI/GeoSciML.	erosion	urn:cgi:classifier:CGI:EventProcess:201001:erosion
ep1.2	Deposition	geologic _process	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.	Neuendorf et al., 2005.	deposition	urn:cgi:classifier:CGI:EventProcess:201001:deposition
ep1.2.1	Mechanical deposition	deposition	Process by which material that is being transported as particles by moving air, water, ice, or other fluid comes to rest and accumulates.	SLTT, 2004[1].	mechanical_deposition	urn:cgi:classifier:CGI:EventProcess:201001:mechanical_deposition
ep1.2.1.1	Turbidity current deposition	mechanical _deposition	Deposition from a turbulent, low concentration sediment-water mixture.	Postma, 1986.	turbidity_current_deposition	urn:cgi:classifier:CGI:EventProcess:201001:turbidity_current_deposition
ep1.2.1.2	Debris flow deposition	mechanical _deposition	Laminar high-concentration, generally cohesionless deposition process. Flow types included liquefied flow, fluidised flow, grain flow, traction carpet or modified grain flow.	Postma, 1986.	debris_flow_deposition	urn:cgi:classifier:CGI:EventProcess:201001:debris_flow_deposition

[1] for explanation please see chapter 8: Abbreviations.

Table 4-10: The 1G-E vocabulary for EventProcess (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep1.2.1.3	Mass w asting depostion	mechanical _deposition	A general term for the dislodgement and dow nslope 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 w asting is not carried w ithin, 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 w asting includes slow displacements, such as creep and solifluction, and rapid movements such as rockfalls, rockslides, and cohesive debris flow s. Includes both subaerial mass-w asting processes and subaqueous mass-w asting processes.	Jackson, 1997; SLTT, 2004[1]; Postma, 1986.	mass_w asting_deposition	urn:cgi:classifier:CGI:EventProcess:201001:mass_w asting_deposition
ep1.2.2	Chemical precipitation	deposition	The deposition of mineral matter by precipitation from solution or as a result of chemical reactions. May be sedimentary or hydrothermal.	Neuendorf et al., 2005.	chemical_precipitation	urn:cgi:classifier:CGI:EventProcess:201001:chemical_precipitation
ep1.2.3	Organic accumulation	deposition	Sediment accumulation of biologically produced organic material, as in bog or coal sw amps.	CGI/GeoSciML.	organic_accumulation	urn:cgi:classifier:CGI:EventProcess:201001:organic_accumulation
ep1.2.4	Biological precipitation	deposition	The deposition of minerals from solution by the agency of organisms.	CGI/GeoSciML.	biological_precipitation	urn:cgi:classifier:CGI:EventProcess:201001:biological_precipitation
ep2	Magmatic process	geologic _process	A process involving melted rock (magma).	CGI/GeoSciML.	magmatic_process	urn:cgi:classifier:CGI:EventProcess:201001:magmatic_process
ep2.1	Eruption	magmatic _process	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.	Neuendorf et al., 2005.	eruption	urn:cgi:classifier:CGI:EventProcess:201001:eruption
ep2.1.1	Pyroclastic eruption	eruption	Eruption produced by the generation and rapid expansion of a gas phase that disrupts magma, surrounding w all rock or sediment.	Orton, 1996.	pyroclastic_eruption	urn:cgi:classifier:CGI:EventProcess:201001:pyroclastic_eruption

[1] for explanation please see chapter 8: Abbreviations.

Table 4-10: The 1G-E vocabulary for EventProcess (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep2.1.1.1	Vulcanian eruption	pyroclastic _eruption	Eruption characterised by the explosive ejection of fragments of new lava, commonly incandescent w hen 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.	Neuendorf et al., 2005.	vulcanian_eruption	urn:cgi:classifier:CGI:EventProcess:201001:vulcanian_eruption
ep2.1.2	Strombolian eruption	eruption	Eruption characterised by jetting of clots or 'fountains' of fluid, basaltic lava from a central crater.	Neuendorf et al., 2005.	strombolian_eruption	urn:cgi:classifier:CGI:EventProcess:201001:strombolian_eruption
ep2.2	Intrusion	magmatic _process	The process of emplacement of magma in pre-existing rock.	Neuendorf et al., 2005.	intrusion	urn:cgi:classifier:CGI:EventProcess:201001:intrusion
ep2.3	Melting	magmatic _process	Change of state from solid to liquid.	CGI/GeoSciML.	melting	urn:cgi:classifier:CGI:EventProcess:201001:melting
ep2.3.1	Partial melting	melting	Process of melting involving only some of the mineral phases in a rock, to produce a mixture of melt and residual particles.	Neuendorf et al., 2005.	partial_melting	urn:cgi:classifier:CGI:EventProcess:201001:partial_melting
ep3	Tectonic process	geologic _process	Processes related to the interaction betw een or deformation of rigid plates forming the crust of the Earth.	CGI/GeoSciML.	tectonic_process	urn:cgi:classifier:CGI:EventProcess:201001:tectonic_process
ep3.1	Accretion	tectonic _process	The addition of material to a continent. Typically involves convergent or transform motion.	Neuendorf et al., 2005.	accretion	urn:cgi:classifier:CGI:EventProcess:201001:accretion
ep3.2	Continental collision	tectonic _process	The amalgamation of tw o continental plates or blocks along a convergent margin.	CGI/GeoSciML.	continental_collision	urn:cgi:classifier:CGI:EventProcess:201001:continental_collision
ep3.3	Continental breakup	tectonic _process	Fragmentation of a continental plate into tw o or more smaller plates; may involve rifting or strike slip faulting.	CGI/GeoSciML.	continental_breakup	urn:cgi:classifier:CGI:EventProcess:201001:continental_breakup
ep3.3.1	Rifting	continental _breakup	Extension of the crust to form one or more long, narrow graben of regional extent.	Neuendorf et al., 2005.	rifting	urn:cgi:classifier:CGI:EventProcess:201001:rifting

[1] for explanation please see chapter 8: Abbreviations.

Table 4-10: The 1G-E vocabulary for EventProcess (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep3.4	Transform faulting	tectonic _process	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 as slip accrues on it.	Neuendorf et al., 2005.	transform_faulting	urn:cgi:classifier:CGI:EventProcess:201001:transform_faulting
ep3.5	Subduction	tectonic _process	The process of one lithospheric plate descending beneath another.	Neuendorf et al., 2005.	subduction	urn:cgi:classifier:CGI:EventProcess:201001:subduction
ep3.6	Spreading	tectonic _process	A process whereby new oceanic crust is formed by upwelling of magma at the center of mid-ocean ridges and [illegible]	Neuendorf et al., 2005.	spreading	urn:cgi:classifier:CGI:EventProcess:201001:spreading
ep3.7	Obduction	tectonic _process	The overthrusting of continental crust by oceanic crust or mantle rocks at a convergent plate boundary.	1G-E WP3.	obduction	urn:cgi:classifier:CGI:EventProcess:201001:obduction
ep3.8	Orogenic process	tectonic _process	Mountain building process. Synonym: Orogenesis.	Neuendorf et al., 2005.	orogenic_process	urn:cgi:classifier:CGI:EventProcess:201001:orogenic_process
ep4	Metamorphic process	geologic _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.	CGI/GeoSciML.	metamorphic_process	urn:cgi:classifier:CGI:EventProcess:201001:metamorphic_process
ep3.1	Accretion	tectonic _process	The addition of material to a continent. Typically involves convergent or transform motion.	Neuendorf et al., 2005.	accretion	urn:cgi:classifier:CGI:EventProcess:201001:accretion
ep3.2	Continental collision	tectonic _process	The amalgamation of two continental plates or blocks along a convergent margin.	CGI/GeoSciML.	continental_collision	urn:cgi:classifier:CGI:EventProcess:201001:continental_collision
ep3.3	Continental breakup	tectonic _process	Fragmentation of a continental plate into two or more smaller plates; may involve rifting or strike slip faulting.	CGI/GeoSciML.	continental_breakup	urn:cgi:classifier:CGI:EventProcess:201001:continental_breakup

Table 4-10: The 1G-E vocabulary for EventProcess (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep3.3.1	Rifting	continental _breakup	Extension of the crust to form one or more long, narrow graben of regional extent.	Neuendorf et al., 2005.	rifting	urn:cgi:classifier:CGI:EventProcess:201001:rifting
ep3.4	Transform faulting	tectonic _process	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 as slip accrues on it.	Neuendorf et al., 2005.	transform_faulting	urn:cgi:classifier:CGI:EventProcess:201001:transform_faulting
ep3.5	Subduction	tectonic _process	The process of one lithospheric plate descending beneath another.	Neuendorf et al., 2005.	subduction	urn:cgi:classifier:CGI:EventProcess:201001:subduction
ep3.6	Spreading	tectonic _process	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.	Neuendorf et al., 2005.	spreading	urn:cgi:classifier:CGI:EventProcess:201001:spreading
ep3.7	Obduction	tectonic _process	The overthrusting of continental crust by oceanic crust or mantle rocks at a convergent plate boundary.	1G-E WP3.	obduction	urn:cgi:classifier:CGI:EventProcess:201001:obduction
ep3.8	Orogenic process	tectonic _process	Mountain building process. Synonym: Orogenesis.	Neuendorf et al., 2005.	orogenic_process	urn:cgi:classifier:CGI:EventProcess:201001:orogenic_process
ep4	Metamorphic process	geologic _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.	CGI/GeoSciML.	metamorphic_process	urn:cgi:classifier:CGI:EventProcess:201001:metamorphic_process

Table 4-10: The 1G-E vocabulary for EventProcess (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ep4.1	Alteration	metamorphic _process	General term for any change in the mineralogical or chemical composition of a rock. Typically related to interaction with hydrous fluids.	Fettes & Desmons, 2007.	alteration	urn:cgi:classifier:CGI:EventProcess:201001:alteration
ep5	Deformation	geologic _process	Movement of rock bodies by displacement on fault or shear zones, or change in shape of a body of Earth material.	CGI/GeoSciML.	deformation	urn:cgi:classifier:CGI:EventProcess:201001:deformation
ep5.1	Fracturing	deformation	The formation of a surface of failure resulting from stress.	CGI/GeoSciML.	fracturing	urn:cgi:classifier:CGI:EventProcess:201001:fracturing
ep5.2	Faulting	deformation	The process of fracturing, frictional slip, and displacement accumulation that produces a fault.	Neuendorf et al., 2005.	faulting	urn:cgi:classifier:CGI:EventProcess:201001:faulting
ep6	Weathering	geologic _process	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.	CGI/GeoSciML.	weathering	urn:cgi:classifier:CGI:EventProcess:201001:weathering
ep6.1	Frost shattering	physical_weathering	Propagation of fractures due to expansion of freezing water in intergranular spaces and fractures in a rock	Neuendorf et al., 2005.	frost_shattering	urn:cgi:classifier:CGI:EventProcess:201001:frost_shattering
ep7	Human activity	geologic _process	Processes of human modification of the earth to produce geologic features.	CGI/GeoSciML.	human_activity	urn:cgi:classifier:CGI:EventProcess:201001:human_activity
ep8	Bolide impact	geologic _process	The impact of an extraterrestrial body on the surface of the earth.	CGI/GeoSciML.	bolide_impact	urn:cgi:classifier:CGI:EventProcess:201001:bolide_impact
ep8.1	Cometary impact	bolide_impact	The impact of a comet on the surface of the earth.	CGI/GeoSciML.	cometary_impact	urn:cgi:classifier:CGI:EventProcess:201001:cometary_impact
ep8.2	Meteorite impact	bolide_impact	The impact of a meteorite on the surface of the earth.	CGI/GeoSciML.	meteorite_impact	urn:cgi:classifier:CGI:EventProcess:201001:meteorite_impact

4.4 Metamorphic Terms

Due to the complexity of metamorphic rocks, the description of the lithology alone is not always sufficient to characterise the rock uniquely; additional options might be required.

GeoSciML offers packages of descriptive properties to allow a very detailed description of particular aspects of a GeologicUnit, such as bedding, weathering, physical properties and metamorphism. As 1G-E is addressing overview maps at a scale around 1: 1 million most of these are not a part of the 1G-E vocabulary and model. An exception is the GeoSciML MetamorphicDescription package, which has five properties for describing the metamorphism of a GeologicUnit, three of which are available for use in 1G-E: the metamorphic facies, the metamorphic grade and the protolih lithology. The pressure/temperature conditions regarding the metamorphic rocks can be described with the property EventEnvironment (see chapter 4.3.1, 'Earth interior setting'). Use of the MetamorphicDescription package is optional for 1G-E.

4.4.1 Metamorphic Facies

Table 4-11 shows the1G-E vocabulary of MetamorphicFacies for the description of metamorphic rocks. The facies definitions are mainly after Fettes & Desmons (2007) and Smulikowski et al. (2003); to determine the correct URN for the metamorphic rocks one should focus on these definitions. Figure 4-9 gives an example of the encoding of MetamorphicDescription.

4.4.2 Metamorphic Grade

With the property MetamorphicGrade the degree of metamorphism can be recorded. The definitions and URNs of the different metamorphic grades defined for 1G-E are shown in table 4-12. Figure 4-9 gives an example of the encoding of MetamorphicDescription.

4.4.3 Protolith Lithology

In GeoSciML the encoding of ProtolithLithology requires the recording of three properties: the Lithology, the Purpose and the ConsolidationDegree.

The lithology of the protholith of the metamorphic rock should be described in the same way as the lithology of an unmetamorphosed rock. Therefore, the property ProtolithLithology needs to be populated with the same terms and URNs used for the Lithology property of CompositionParts (see section 4.2, tables 4-5, 4-6, 4-7, 4-8).

The purpose property should always be set to 'TypicalNorm'; that of ConsolidationDegree to 'consolidation_not_specified', as shown in figure 4-9.

```xml
<gsml:metamorphicCharacter>
  <gsml:MetamorphicDescription>
    <gsml:metamorphicFacies>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:MetamorphicFacies:201001:granulite_facies</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:metamorphicFacies>
    <gsml:metamorphicGrade>
      <gsml:CGI_TermValue>
        <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:MetamorphicGrade:201001:high_metamorphic_grade</gsml:value>
      </gsml:CGI_TermValue>
    </gsml:metamorphicGrade>
    <gsml:protolithLithology>
      <gsml:RockMaterial>
        <gsml:purpose>typicalNorm</gsml:purpose>
        <gsml:consolidationDegree>
          <gsml:CGI_TermValue>
            <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:ConsolidationDegree:200811:consolidation_not_specified</gsml:value>
          </gsml:CGI_TermValue>
        </gsml:consolidationDegree>
        <gsml:lithology xlink:href="urn:cgi:classifier:CGI:SimpleLithology:201001:basalt"/>
      </gsml:RockMaterial>
    </gsml:protolithLithology>
  </gsml:MetamorphicDescription>
</gsml:metamorphicCharacter>
```

Figure 4-9: Example of the encoding of MetamorphicDescription.

Table 4-11: The 1G-E vocabulary for MetamorphicFacies.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
mf0	Metamorphic facies not specified		For use in normative description to indicate that any metamorphic facies value is valid.	CGI/GeoSciML.	metamorphic_facies_not_specified	urn:cgi:classifier:CGI:MetamorphicFacies:201001:metamorphic_facies_not_specified
mf0.1	Zeolite metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by zeolite minerals such as laumontite and heulandites (in place of other Ca-Al silicates such as prehnite, pumpellyite and epidote).	Smulikowski et al. 2003; Fettes and Desmons 2007	zeolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:zeolite_metamorphic_facies
mf0.2	Subgreenschist metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by prehnite-pumpellyite, pumpellyite-actinolite, prehnite-actinolite (prehnite and pumpellyite are the diagnostic Ca-Al silicates rather than minerals of the epidote or zeolite groups).	Smulikowski et al. 2003; Fettes and Desmons 2007	subgreenschist_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:subgreenschist_metamorphic_facies
mf0.3	Greenschist metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by actinolite-albite-epidote-chlorite (an epidote group mineral is the diagnostic Ca-Al silicate rather than prehnite or pumpellyite).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	greenschist_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:greenschist_metamorphic_facies
mf0.4	Epidote amphibolite metamorphic facies	metamorphic_facies_not_specified	Hornblende-albite-epidote(-chlorite); assemblage for rocks of basaltic composition.	Fettes & Desmons, 2007.	epidote_amphibolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:epidote_amphibolite_metamorphic_facies
mf0.5	Amphibolite metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by hornblende-plagioclase (plagioclase more calcic than An17).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	amphibolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:amphibolite_metamorphic_facies
mf0.6	Pyroxene hornfels metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by clinopyroxene-orthopyroxene-plagioclase (olivine stable with plagioclase).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	pyroxene_hornfels_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:pyroxene_hornfels_metamorphic_facies

Table 4-11: The 1G-E vocabulary for MetamorphicFacies (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Complete URN
mf0	Metamorphic facies not specified		For use in normative description to indicate that any metamorphic facies value is valid.	CGI/GeoSciML.	metamorphic_facies_not_specified	urn:cgi:classifier:CGI:MetamorphicFacies:201001:metamorphic_facies_not_specified
mf0.1	Zeolite metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by zeolite minerals such as laumontite and heulandites (in place of other Ca-Al silicates such as prehnite, pumpellyite and epidote).	Smulikowski et al. 2003; Fettes and Desmons 2007	zeolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:zeolite_metamorphic_facies
mf0.2	Subgreenschist metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by prehnite-pumpellyite, pumpellyite-actinolite, prehnite-actinolite (prehnite and pumpellyite are the diagnostic Ca-Al silicates rather than minerals of the epidote or zeolite groups).	Smulikowski et al. 2003; Fettes and Desmons 2007	subgreenschist_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:subgreenschist_metamorphic_facies
mf0.3	Greenschist metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by actinolite-albite-epidote-chlorite (an epidote group mineral is the diagnostic Ca-Al silicate rather than prehnite or pumpellyite).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	greenschist_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:greenschist_metamorphic_facies
mf0.4	Epidote amphibolite metamorphic facies	metamorphic_facies_not_specified	Hornblende-albite-epidote(-chlorite); assemblage for rocks of basaltic composition.	Fettes & Desmons, 2007.	epidote_amphibolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:epidote_amphibolite_metamorphic_facies
mf0.5	Amphibolite metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by hornblende-plagioclase (plagioclase more calcic than An17).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	amphibolite_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:amphibolite_metamorphic_facies
mf0.6	Pyroxene hornfels metamorphic facies	metamorphic_facies_not_specified	Metamorphic facies characterised in rocks of basaltic composition by clinopyroxene-orthopyroxene-plagioclase (olivine stable with plagioclase).	Smulikowski et al., 2003; Fettes & Desmons, 2007.	pyroxene_hornfels_metamorphic_facies	urn:cgi:classifier:CGI:MetamorphicFacies:201001:pyroxene_hornfels_metamorphic_facies

Table 4-12: The 1G-E vocabulary for MetamorphicGrade.

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
mg0	Metamorphosed grade not specified		Rock is metamorphosed, may have any value for metamorphic grade.	CGI/GeoSciML.	metamorphosed_grade_not_specified	urn:cgi:classifier:CGI:MetamorphicGrade:201001:metamorphosed_grade_not_specified
mg0.1	Very low metamorphic grade	metamorphosed_grade_not_specified	Rock very slightly metamorphosed, protolith structure ubiquitous; mineral assemblage of zeolite facies, subgreenschist facies, or low temperature part of blueschist facies. Mineral assemblages according to Fry (1984; table 10-1): ultramafic-serpentine (quartz, magnesite); mafic-clay, chlorite, relict igneous minerals; calc-aluminous basic-zeolite, pumpellite, epidote, albite; pelite, semi-pelite -- clays, chlorite, sericite, quartz.	CGI/GeoSciML.	very_low_metamorphic_grade	urn:cgi:classifier:CGI:MetamorphicGrade:201001:very_low_metamorphic_grade
mg0.2	Low metamorphic grade	metamorphosed_grade_not_specified	Metamorphic effects clearly visible, protolith structures typically still observable, includes rocks metamorphosed in greenschist, high-temperature blueschist, very low temperature eclogite facies. Mineral assemblages according to Fry (1984; table 10-1): ultramafic-serpentine (talc, magnesite); mafic-chlorite, actinolite (garnet); calc-aluminous basic-albite, epidote; pelite, semi-pelite -- white mica, chlorite, quartz, biotite (garnet, Al-minerals).	Smulikowski et al., 2003; Fry, 1984.	low_metamorphic_grade	urn:cgi:classifier:CGI:MetamorphicGrade:201001:low_metamorphic_grade
mg0.3	Medium metamorphic grade	metamorphosed_grade_not_specified	Protolith structure typically obliterated. Includes rocks metamorphosed in high-temperature epidote-amphibolite, low-temperature amphibolite, and low temperature eclogite facies. Mineral assemblages according to Fry (1984; table 10-1): ultramafic-olivine, talc (magnesite, anthophyllite); mafic-hornblende, (diopside, garnet); calc-aluminous basic-plagioclase; pelite, semi-pelite -- white mica, biotite, quartz (garnet, Al-minerals).	Smulikowski et al., 2003; Fry, 1984.	medium_metamorphic_grade	urn:cgi:classifier:CGI:MetamorphicGrade:201001:medium_metamorphic_grade

Table 4-12: The 1G-E vocabulary for MetamorphicGrade (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
mg0.4	High metamorphic grade	metamorphosed_grade_not_specified	Protolith structures almost always obliterated, evidence of partial melting common. Includes rocks metamorphosed in high-temperature amphibolite, pyroxene hornfels, and medium to high-temperature eclogite facies. Mineral assemblages according to Fry (1984) Table 10-1: ultramafic-olivine, anthophyllite, cummingtonite, enstatite; mafic-hornblende, (diopside, garnet); calc-aluminous basic-plagioclase; pelite, semi-pelite -- K-feldspar, biotite, quartz, Al-minerals (garnet), migmatite.	Smulikowski et al., 2003; Fry, 1984.	high_metamorphic_grade	urn:cgi:classifier:CGI:MetamorphicGrade:201001:high_metamorphic_grade
mg0.5	Very high metamorphic grade	metamorphosed_grade_not_specified	Protolith structures almost always obliterated. Includes rocks metamorphosed in granulite (or sanidinite), and high-temperature eclogite facies. Mineral assemblages according to Fry (1984; table 10-1): ultramafic-olivine, enstatite; mafic-hypersthene, diopside (hornblende); calc-aluminous basic-plagioclase; pelite, semi-pelite -- hypersthene + Al-minerals (K-feldspar, quartz), or sapphirine.	Smulikowski et al., 2003; Fry, 1984.	very_high_metamorphic_grade	urn:cgi:classifier:CGI:MetamorphicGrade:201001:very_high_metamorphic_grade

4.5 Contacts and Structures

In 1G-E the only types of structure that are being used are Faults and Contacts. Both the property ContactType and FaultType belong to the GeoSciML FeatureType GeologicStructures. The mandatory definitions (e.g. ID, Name, ObservationMethod etc.) for the encoding of GeologicStructures are given in section 3.2.2. In the following the encoding of the properties ContactType and FaultType is illustrated.

4.5.1 ContactType

For 1G-E the property ContactType is only being used to describe Calderas, Impact craters and Glacial stationary lines. The map features for Impact craters and calderas should not be defined as polygons, but as linear features deliminating the geological structures. The material within these structures should be described as a normal geological unit (using the FeatureTypes GeologicUnit and CompositionPart).

Table 4-13 shows the vocabulary used to populate the ContactType property; figure 4-10 shows an encoding example and figure 4-11 illustrates the corresponding hierarchy.

```xml
<gsml:Contact gml:id="CON_1">
  <gsml:observationMethod>
    <gsml:CGI_TermValue>
      <gsml:value codeSpace="http://www.cgi-iugs.org/uri">urn:cgi:classifier:CGI:FeatureObservationMethod:201001:synthesis_of_multiple_published_descriptions </gsml:value>
    </gsml:CGI_TermValue>
  </gsml:observationMethod>
  <gsml:purpose>typicalNorm</gsml:purpose>
  <gsml:contactType xlink:href="urn:cgi:classifier:CGI:ContactType:201001:volcanic_subsidence_zone_boundary"/>
</gsml:Contact>
```

Figure 4-10: Example of the encoding of ContactType.

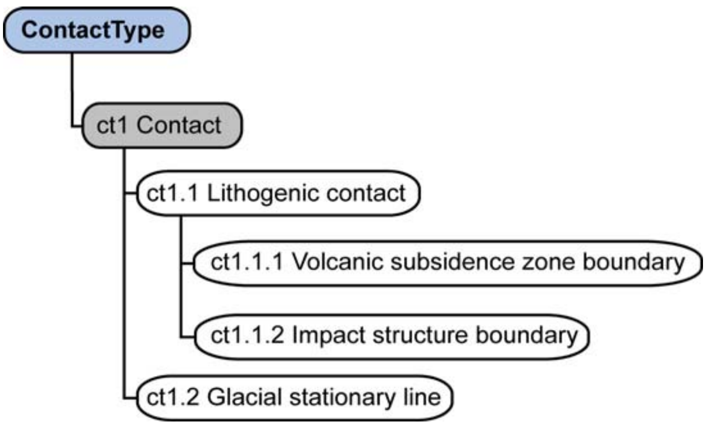

Figure 4-11: Hierarchical overview representation of the 1G-E vocabulary for ContactType.

Table 4-13: The 1G-E vocabulary for ContactType.

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ct1	Contact		A surface that separates geologic units [adapted from page 137 of Jackson, 1997]. Very general concept representing any kind of surface separating two geologic units, including primary boundaries such as depositional contacts, all kinds of unconformities, intrusive contacts, and gradational contacts, as well as faults that separate geologic units. Note that usage of geologic unit here is per NADM C1 2004, denoting a body of material. Lines on geologic maps may also delineate featured defined geomorphically-- craters, terraces, shorelines, scarps that are not inherently geologic unit boundaries in this sense.	CGI/GeoSciML.	contact	urn:cgi:classifier:CGI:ContactType:201001:contact
ct1.1	Lithogenetic contact	contact	A non-faulted contact separating bodies of material in the earth that have different lithologic character or geologic history.	CGI/GeoSciML.	lithogenetic_contact	urn:cgi:classifier:CGI:ContactType:201001:lithogenetic_contact
ct1.1.1	Volcanic subsidence zone boundary	lithogenetic_contact	Boundary around a body of rock that is within a zone of subsidence or cratering produced by volcanic activity. See also: caldera, cauldron, crater.	CGI/GeoSciML.	volcanic_subsidence_zone_boundary	urn:cgi:classifier:CGI:ContactType:201001:volcanic_subsidence_zone_boundary
ct1.1.2	Impact structure boundary	lithogenetic_contact	Surface that bounds a body of rock affected by an extraterrestrial impact event.	CGI/GeoSciML.	impact_structure_boundary	urn:cgi:classifier:CGI:ContactType:201001:impact_structure_boundary
ct1.2	Glacial stationary line	contact	A boundary between a subglacial geomorphic unit and a periglacial geomorphic unit, marking the maximum extent of glacial cover. This can be thought of as the outcrop of the contact between a glacier and its substrate at some time at each point along the boundary. This contact type is included as an interim concept, assuming that in the future, there will be extensions to account better for geomorphic units and line types.*	CGI/GeoSciML.	glacial_stationary_line	urn:cgi:classifier:CGI:ContactType:201001:glacial_stationary_line

* A Glacial stationary line is an inferred limit of a glacier at its maximum (or some stable) extent; it marks a contact boundary of the ice and thus is an instance of this contact type, with metadata indicating observation method by inference.

4.5.2 FaultType

In GeoSciML the property FaultType belongs to the package ShearDisplacementStructure, which in turn belongs to the FeatureType GeologicStructure. The FaultType property must be populated with the URN of one of the concepts described in table 4-14 and figure 4-12.

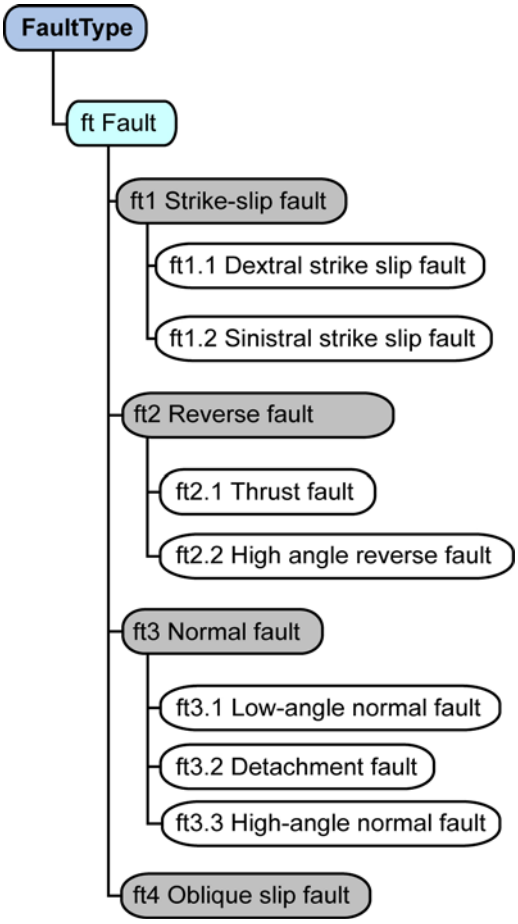

Figure 4-12: Hierarchical overview representation of the 1G-E vocabulary for FaultType.

Table 4-14: The 1G-E vocabulary for FaultType.

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ft	Fault		A discrete surface, or zone of discrete surfaces, w ith some thickness, separating tw o rock masses across w hich one mass has slid past the other and characterized by brittle deformation.	CGI/GeoSciML.	fault	urn:cgi:classifier:CGI:FaultType:201001:fault
ft1	Strike slip fault	fault	Fault w ith a strike-parallel displacement component of a 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.	CGI/GeoSciML.	strike_slip_fault	urn:cgi:classifier:CGI:FaultType:201001:strike_slip_fault
ft1.1	Dextral strike slip fault	strike_slip_fault	Fault w ith a right-lateral strike-parallel displacement component of a slip vector more than 10 times the dip-parallel component of the slip vector at at least one location along the fault, and a right-lateral displacement over more than half the mapped trace of the fault.	CGI/GeoSciML.	dextral_strike_slip_fault	urn:cgi:classifier:CGI:FaultType:201001:dextral_strike_slip_fault
ft1.2	Sinistral strike slip fault	strike_slip_fault	Fault w ith a left-lateral strike-parallel displacement component of a slip vector more than 10 times the dip-parallel component of the slip vector at at least one location along the fault, and a left-lateral displacement over more than half the mapped trace of the fault.	CGI/GeoSciML.	sinistral_strike_slip_fault	urn:cgi:classifier:CGI:FaultType:201001:sinistral_strike_slip_fault
ft2	Reverse fault	fault	Fault w ith a dip-parallel displacement component of a 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 w ith the hanging w all displaced up relative to the footw all over at least half the mapped trace of the fault.	CGI/GeoSciML.	reverse_fault	urn:cgi:classifier:CGI:FaultType:201001:reverse_fault
ft2.1	Thrust fault	reverse_fault	Fault that dips less than 45 degrees over more than half of the recognised extent of the fault, w ith a hanging w all displaced from a structurally deeper position relative to footw all rocks.	CGI/GeoSciML.	thrust_fault	urn:cgi:classifier:CGI:FaultType:201001:thrust_fault
ft2.2	High angle reverse	reverse_fault	Reverse fault that dips at least 45 degrees over more than half of its recognised extent, for w hich slip or separation is not explicitly specified.	CGI/GeoSciML.	high_angle_reverse	urn:cgi:classifier:CGI:FaultType:201001:high_angle_reverse

Table 4-14: The 1G-E vocabulary for FaultType (continued).

1G-E ID	1G-E Term	1G-E Broader Concepts	Definition	Source	CGI_URN	Complete URN
ft3	Normal fault	fault	Fault w ith a dip-parallel displacement component of a slip vector more than 10 times the strike-parallel component of the slip vector over more than half recognized extent of the fault, and the fault dips consistently in the same direction, and for w hich the hanging w all has been displaced dow n relative to the footw all.	CGI/GeoSciML.	normal_fault	urn:cgi:classifier:CGI:FaultType:201001:normal_fault
ft3.1	Low -angle normal fault	normal_fault	Fault that dips less than 45 degrees over more than half of the recognised extent of the fault w ith the hanging w all displaced from a structurally higher position relative to footw all rocks.	CGI/GeoSciML.	low _angle_normal_fault	urn:cgi:classifier:CGI:FaultType:201001:low _angle_normal_fault
ft3.1.1	Detachment fault	low _angle _normal_fault	A regional-scale, large displacement, low -angle normal fault.	CGI/GeoSciML.	detachment_fault	urn:cgi:classifier:CGI:FaultType:201001:detachment_fault
ft3.2	High-angle normal fault	normal_fault	Fault that dips at least 45 degrees over more than half of the recognised extent of the fault w ith the hanging w all displaced from a structurally higher position relative to footw all rocks.	CGI/GeoSciML.	high_angle_normal_fault	urn:cgi:classifier:CGI:FaultType:201001:high_angle_normal_fault
ft4	Oblique slip fault	fault	Fault w ith a slip vector that has a ratio of a strike-parallel to dip-parallel displacement betw een 10 to 1 and 1 to 10 at at least one location along the mapped trace of the fault.	CGI/GeoSciML.	oblique_slip_fault	urn:cgi:classifier:CGI:FaultType:201001:oblique_slip_fault

4.6 Complex Rocks

Geological processes often produce complex rock sequences of heterogeneous geological units comprising diverse lithologies of different genesis and age. As such products of a complicated geological history are difficult to describe, geoscientists have defined terms that are neither purely lithological, nor genetic or age-related, and therefore cannot be described in the properties/categories of this Data Specification.

For 1G-E such GeologicUnits are described as ‘composite terms’ and guidelines on how to describe them in GeoSciML are provided here.

4.6.1 Flysch and Molasse

Flysch consists of repeated sedimentary cycles with upwards fining sediments. For example, coarse conglomerates or breccias might occur at the bottom of each cycle, grading upwards into sandstone and shale or claystone. Flysch is formed under deep marine circumstances, in a quiet and low-energy depositional environment.

Molasse is similar to Flysch, but has more clastic lithologies (sandstone, conglomerate, shale and marls) and a more-paralic, less-rythmic facies (partly marine, partly continental or deltaic).
For each lithology present in the Flysch or Molasse sequence, one CompositionPart (see section 4.2) has to be encoded.
The CompositionPart role property (GeologicUnitPartRole, see section 4.2) for all CompositionParts should be set to ‘cyclic_bedding_package’.
The EventEnvironment property of GeologicEvent (see section 3.4.1) should be set to one of the marine setting environments listed in table 4-9. For Flysch this could be e.g. ‘bathyal’; for Molasse it could be either ‘epicontinental_marine_setting’, ‘piedmont_slope_system_setting’ or ‘deltaic_system_setting’.

4.6.2 Olistostrome

An Olistostrome is defined as a debris-flow deposit consisting of a chaotic mass of intimately mixed heterogeneous materials (such as blocks and muds) that accumulated by submarine gravity sliding or slumping of unconsolidated sediments. It can best be described as a diamictite of the 1G-E Lithology vocabulary (tables 4-5, 4-6, 4-7, 4-8); the CompositionPart lithology property should therefore be set to ‘diamictite’.
The EventProcess property of GeologicEvent (see section 4.4.2) ought to be set to ‘debris_flow’, the EventEnvironment property of GeologicEvent (see section 4.4.2) to ‘subaqueous setting’.

4.6.3 Turbidite

The characteristic feature of Turbidites is that they are deposited by turbidity currents in an ocean environment, which can result in a consolidated or unconsolidated rock normally with a graded bedding and moderate sorting.

Like in the description of Flysch and Molasse, every lithology occurring within the Turbidite has to be encoded as one CompositionPart. The property GeologicUnitPartRole should be set to ‘cyclic_bedding_package’ for all CompositionParts. The EventProcess property ought to be set to ’turbidity_current_deposition’, the EventEnvironment property to one of the marine setting environments listed in table 4-9, e.g. ‘bathyal’.

4.6.4 Ophiolitic mélange

An Ophiolitic mélange can like the Olistostrome best be described as a diamictite. Characteristic of this kind of diamictite are ophiolitic rock fragments such as serpentinite and/or peridotite in a pelitic to psammitic groundmass.

Each lithology occurring in the mélange needs to be described as one CompositionPart. The role of each groundmass CompositionPart (GeologicUnitPartRole) has to be defined as ‘geologic_unit_matrix’; that of the rock fragment CompositionParts as ‘blocks’.

4.6.5 Tectonic mélange

A Tectonic mélange is similar to an ophiolitic one, but the rock fragments are ordinarily not ophiolitic, and the whole sequence is commonly metamorphosed.

Each lithology occurring in the mélange needs to be decribed as one CompositionPart.
The GeologicUnitRolePart should be set to ‘blocks’.
The EventProcess property (table 4-10) ought to be set to ’tectonic_process’; the EventEnvironment property(table 4-9) should be set to either
‘low_pressure_high_temperature_setting’, or
‘high_pressure_low_temperature_earth_interior_setting’, or
‘ultra_high _pressure_low_temperature_crustal_setting’.

The metamorphism can be described with one term of the MetamorphicFacies property (see section 4.5.1, table 4-11), e.g. ‘greenshist_metamorphic_facies’ and one term of the MetamorphicGrade property (see section 3.5.2, table 4-12), e.g. ‘low_metamorphic_grade’.

4.6.6 Ophiolite complex

An Ophiolite complex is an assemblage of distinct lithologies formed by particular tectonic processes. In GeoSciML it can be built up as a set of CompositionParts, one for each of the lithologies along with an appropriate GeologicUnitPartRole like e.g. ‘layer_lithosome’.
For the EventProcess property the term ‘tectonic_process’ and for the EventEnvironment the term ‘tectonic_setting’ should be chosen.
To describe the metamorphism the properties MetamorphicFacies and MetamorphicGrade (see section 4.5) ought to be used.

4.7 Orogenic Events

Where a GeologicUnit were formed or affected by orogenic processes, this can be described as follows:
if it was formed by an orogeny, the PreferredAge of GeologicEvents should be used; if it was only affected (e.g. folded or metamorphosed) by the orogeny, GeologicHistory of GeologicEvents should be chosen (the property PreferredAge will then be used to describe the original formation of the rock).

The name of the orogeny can be assigned within the Name property of GeologicEvents (for both PreferredAge and GeologicHistory) by using one of the terms given in table 4-15. The corresponding concept hierarchy is shown in figure 4-13. These definitions are Europe specific and will not form a part of the global CGI vocabulary. For GeologicHistory there might be several GeologicEvents referencing the same orogenic events, for example different periods of folding that occurred within the orogeny.

The description of the orogenic events in table 4-15 includes an age range and the EventAge should be consistent with this. The age range given in EventAge can be the same as the orogenic event, or it can be contained within it, indicating that the GeologicUnit was formed or affected during part of the orogenic event.

In addition to the name and age of the orogenic event the recording of an EventProcess, which should be consistent with the formation or modification of the GeologicUnit, is required. This could include for example a tectonic or metamorphic process (table 4-10, section 4.3.2). The definition of an EventEnviroment is optional; if used, it should be populated with a URN from table 4-9 (see section 4.3.1).

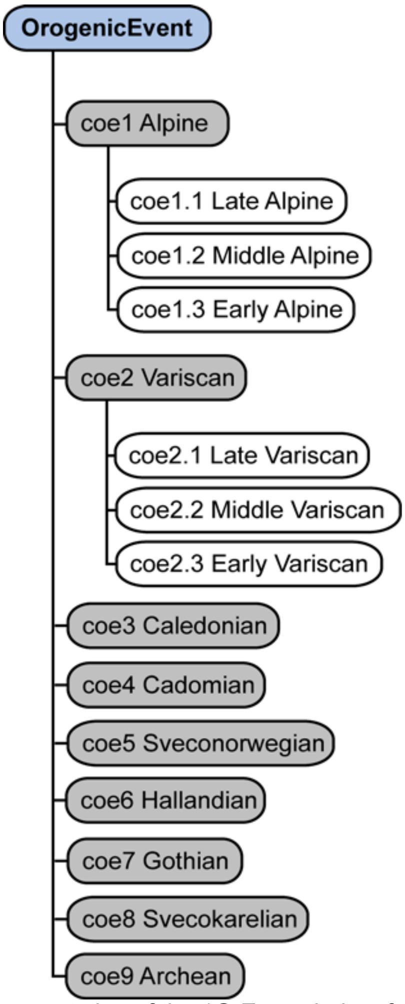

Figure 4-13: Hierarchical overview representation of the 1G-E vocabulary for OrogenicEvents.

Table 4-15: The 1G-E vocabulary for OrogenicEvents.

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Proposed Complete URN
coe.1	Alpine		Youngest Orogeny which took place between 221 Ma (Upper Triassic) and 0,01 Ma (Pleistocene/Holocene). Alpine subdivisions: Late Alpine, Middle Alpine and Early Alpine.	Trümpy, 1982; HSÜ, 1982.	alpine	urn:cgi:classifier:CGI:OrogenicEvent:2009:alpine
coe.1.1	Late Alpine	Alpine	Youngest subdivision of Alpine Orogeny took place between 19 Ma and 0.01 Ma (Burdigalien to Pleistocene/Holocene).	Van Eysinga, 1975.	late_alpine	urn:cgi:classifier:CGI:OrogenicEvent:2009:late_alpine
coe.1.2	Middle Alpine	Alpine	Intermediate subdivision of Alpine Orogeny took place between 63 Ma and 19 Ma (Danian to Burdigalien).	Van Eysinga, 1975.	middle_alpine	urn:cgi:classifier:CGI:OrogenicEvent:2009:middle_alpine
coe.1.3	Early Alpine	Alpine	Oldest subdivision of Alpine Orogeny took place between 221 Ma and 63 Ma (Carnian to Danian).	Van Eysinga, 1975.	early_alpine	urn:cgi:classifier:CGI:OrogenicEvent:2009:early_alpine
coe.2	Variscan		Variscan/Moldanubician Orogeny took place between (480??) 373 ±5 Ma and 262 ±2 Ma ((Tremadocian) Famennian to Capitanian). *	GSSR/SGUDS[1]; Matte, 2001; Linnemann, 2003.	variscan	urn:cgi:classifier:CGI:OrogenicEvent:2009:variscan
coe.2.1	Late Variscan	Variscan	Youngest subdivision of the Variscan/Moldanubician Orogeny took place between 320 Ma and 290 Ma (Serpukhovian to Sakmarian).	GSSR/SGUDS[1].	late_variscan	urn:cgi:classifier:CGI:OrogenicEvent:2009:late_variscan
coe.2.2	Middle Variscan	Variscan	Intermediate subdivision of the Variscan/Moldanubician Orogeny took place between 360 Ma and 330 Ma (Famennian to Visean).	GSSR/SGUDS[1].	middle_variscan	urn:cgi:classifier:CGI:OrogenicEvent:2009:middle_variscan
coe.2.3	Early Variscan	Variscan	Oldest subdivision of the Variscan/Moldanubician Orogeny took place between 373 ±5 Ma and 360 Ma (Famennian).	GSSR/SGUDS[1].	early_variscan	urn:cgi:classifier:CGI:OrogenicEvent:2009:early_variscan
coe.3	Caledonian		Caledonian Orogeny took place between 490 Ma and 383 ± 3 Ma (Furongian Stage 10 to Frasnian).	McKerrow et al., 2002; Plašienka et al., 1997.	caledonian	urn:cgi:classifier:CGI:OrogenicEvent:2009:caledonian

* Matte (2001) extends Variscan orogeny to include the Caledonian orogeny.

Table 4-15: The 1G-E vocabulary for OrogenicEvents (continued).

1G-E ID	1G-E Term	1G-E Broader Concept	Definition	Source	CGI_URN	Proposed Complete URN
coe.4	Cadomian		Cadomian Orogeny took place between 752 ±8 Ma and 502 ±3 Ma (Cryogenian to Guzhangian).	Putiš, et al., in press.	cadomian	urn:cgi:classifier:CGI:OrogenicEvent:2009:cadomian
coe.5	Sveconorwegian		Sveconorwegian Orogeny took place between 1140 Ma and 920 Ma (Stanian 1 to Tonian 1).	Bingen et al., 2008; Koistinen et al., 2001.	sveconorwegian	urn:cgi:classifier:CGI:OrogenicEvent:2009:sveconorwegian
coe.6	Hallandian		Hallandian Orogeny took place between 1470 Ma and 1420 Ma (Calymmian 3 to Calymmian 4).	Bingen et al., 2008; Koistinen et al., 2001.	hallandian	urn:cgi:classifier:CGI:OrogenicEvent:2009:hallandian
coe.7	Gothian		Gothian Orogeny took place between 1700 Ma and 1520 Ma (Statherian 3 to Calymmian 1).	Bingen et al., 2008; Koistinen et al., 2001.	gothian	urn:cgi:classifier:CGI:OrogenicEvent:2009:gothian
coe.8	Svecokarelian		Svecokarelian Orogeny took place between 1900 Ma 1750 Ma (Orosirian 1 to Statherian 2).	Koistinen et al., 2001.	svecokarelian	urn:cgi:classifier:CGI:OrogenicEvent:2009:svecokarelian
coe.9	Archean		Archean Orogeny took place between 2850 and 2600 Ma (Mesoarchean to Neoarchean).	Koistinen et al., 2001.	archean	urn:cgi:classifier:CGI:OrogenicEvent:2009:archean

5. Topographic Base: EuroGlobalMap

The topographic base for 1G-E is the 1:1 million EuroGlobalMap (EGM) by EuroGeographics.
The offer to use this topographic base was made by the Chief Executive of EuroGeographics (also managing a current eContentplus project – ESDIN) at the 1G-E Kick-off meeting in Rome. The offer was accepted by the Consortium and confirmed by the Operational Magnagement Group (OMG).

The EGM is a seamless and harmonised digital topographical dataset that covers Europe at the scale of 1:1 million and is regarded as the most appropriate base. It is produced in cooperation with the National Mapping and Cadastral Agencies of Europe, using official National Databases and contains 6 themes including administrative boundaries, hydrography, transport, settlement, elevation and named locations (i.e. geographical names). The harmonisation was synchronized with DIGEST standard and the metadata were designed according to the standard ISO 19115.

The EGM version 2.1 is available in ESRI v9.1 GeoDatabase as an ArcGIS 9.1 personal geodatabase, as shapefile format, and as MapInfo MID/MIF file format. It can be delivered as a 'Full Europe' version in addition to the standard country-by-country version. The map covers the following countries: Austria; Belgium; Luxembourg; Croatia; Czech Republic; Cyprus; Denmark including Greenland and the Faroe Islands; Estonia; Finland; France including Monaco; Germany; Great Britain; Greece; Hungary; Iceland; Ireland; Italy including San Marino and The Vatican City; Latvia; Lithuania; Malta; Moldova; Northern Ireland; Norway; Poland; Portugal; Romania; Slovakia; Slovenia; Spain and Andorra; Sweden; Switzerland and Liechtenstein; The Netherlands; and Ukraine.

The coordinate system is based on the ETRS89 spatial reference system, which corresponds to WGS84. The geographical coordinates are given in degrees (longitude, latitude) with alphanumerical fraction 9 significant digits. This corresponds to an accuracy of around 5 cm.

An overview over the properties of the EGM is given in table 5-1.

Table 5-1: Overview over the properties of the EuroGlobalMap (EGM).

Property	EGM version 2.1
Database structure	ArcGIS Geodatabase v9.1
Database specifications	Version 3.1
Specs harmonisation with ERM	Done
Topology	Defined in specifications
Platform dependency	Specifications platform independent
Coordinate accuracy	9 digits, 5 cm
Formats for customers	ESRI Geodatabase, ESRI shapefile, MapInfo MID/MIF
Data area	32 countries

The agreement for the use of the EuroGlobalMap by 1G-E was formalised in February 2009 by EuroGeographics. 1G-E uses the dataset under an evaluation license for the length of the project. The EuroGlobalMap is used within the 1G-E project GeoPortal. The data is served either via ftp or possibly WMS.

6. Portrayal

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 expert user it is important to be able to recognise familiar patterns and schemes, so that relevant information can be drawn from the spatial data base immediately.

A portrayal scheme for lithology, age and contacts and faults was developed for 1G-E with special attention paid to the particularities of the different European countries. Compromises were made by all participants in order to create a uniform scheme, shown in figures 6-1 and 6-2 and table 6-1 and 6-2. This portrayal, together with the vocabulary presented in this document, is the foundation for the semantic and geometric harmonisation of the 1G-E European geological data base.

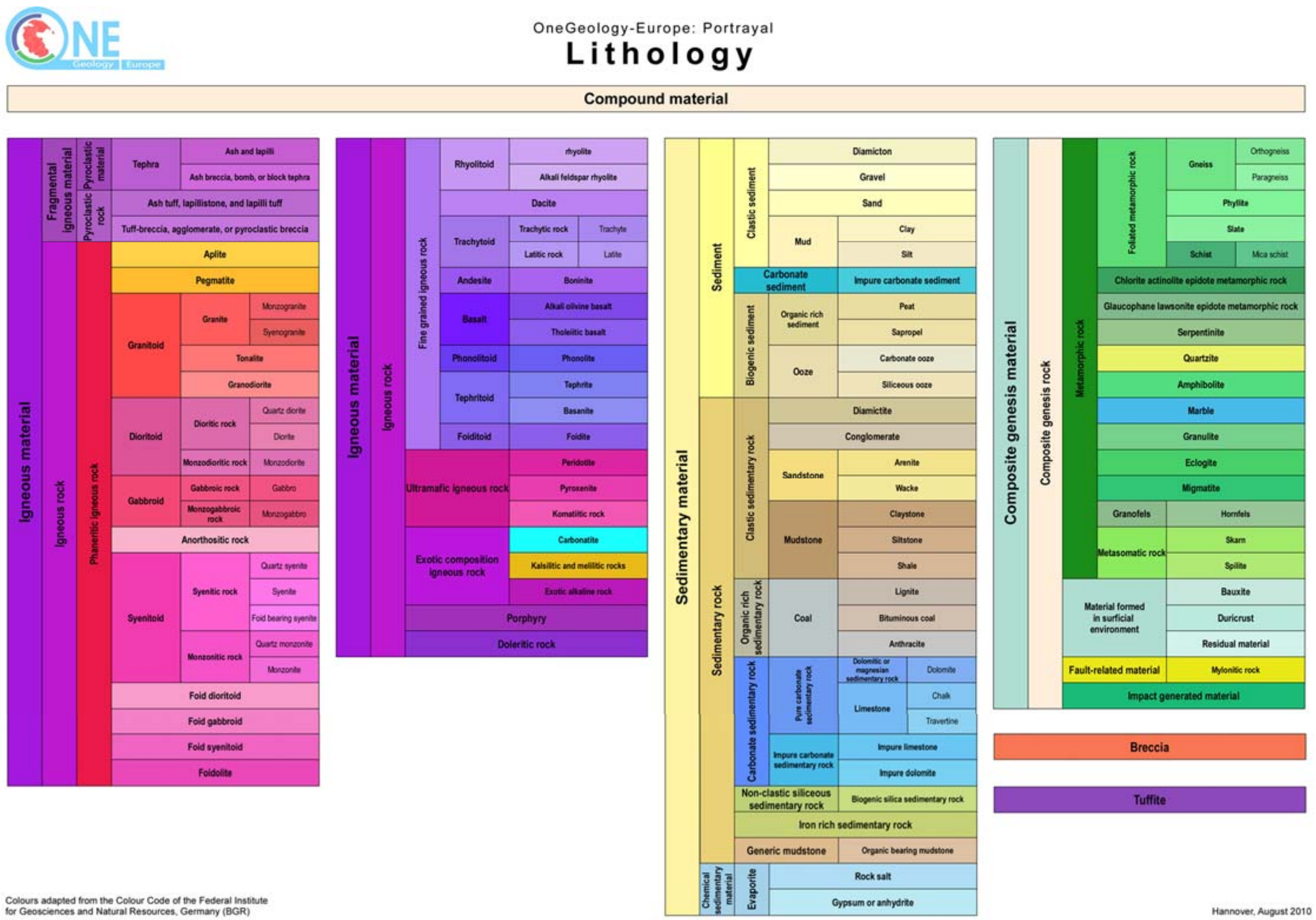

Figure 6-1: The 1G-E portrayal for the lithology.

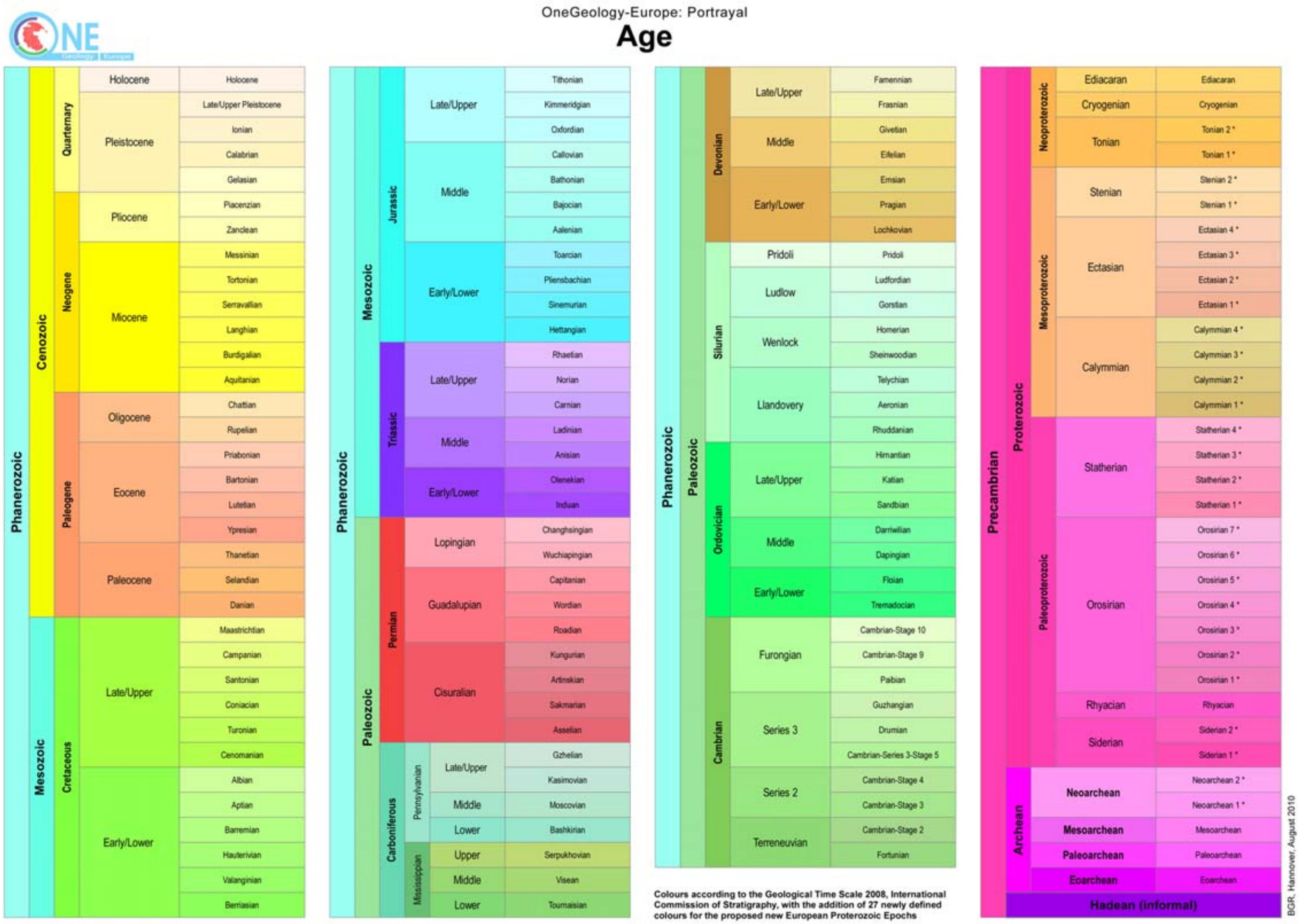

Figure 6-2: The 1G-E portrayal for the age.

Table 6-1: The 1G-E portrayal for Contacts

1G-E ID	1G-E Term	Symbol [lw = line width in pixel]	R	G	B
ct1	Contact	lw 1 px	194	193	193
ct1.1	Lithogenetic contact	lw 1 px	194	193	193
ct1.1.1	Volcanic subsidence zone boundary	lw 3 px	80	240	16
ct1.1.2	Impact structure boundary	lw 2 px	80	240	16
ct1.2	Glacial stationary line	lw 2 px	116	40	110

Table 6-2: The 1G-E portrayal for Faults

1G-E ID	1G-E Term	Symbol [lw = line width in pixel]	R	G	B
ft	Fault	lw 2 px	0	0	0
ft1	Strike slip fault	lw 2 px	0	0	0
ft1.1	Dextral strike-slip fault	lw 2 px	0	0	0
ft1.2	Sinistral strike-slip fault	lw 2 px	0	0	0
ft2	Reverse fault (no dip)	lw 2 px	0	0	0
ft2.1	Thrust fault	lw 2 px	0	0	0
ft2.2	High angle reverse	lw 2 px	0	0	0
ft3	Normal fault (no dip)	lw 3 px	0	0	0
ft3.1	Low-angle normal fault	lw 3 px	0	0	0
ft3.1.1	Detachment fault	lw 3 px	0	0	0
ft3.2	High-angle normal fault	lw 3 px	0	0	0
ft4	Oblique slip fault	lw 2 px	0	0	0

7. Outlook

The GeoSciML scheme and the CGI/GeoSciML vocabularies, both developed by the Concept Definition Task Group (CDTG) within the Interoperability Working Group (IWG) of the IUGS Commission for the Management and Application of Geoscience Information (CGI), built a major basis for this Data Specification.

The Operational Management Group of 1G-E has decided that this geological Data Specification should contribute to, and take forward, the single global (IUGS endorsed) scheme. The additions or amendments required by the 1G-E project (tab. 7-1) were proposed to, discussed with and accepted by the CGI CDTG. Any issues or conflicts arising were resolved jointly by the IWG and the WP 3 team and therefore a single unified global scheme results was ensured; apart from two additional elements in the 1G-E vocabulary that are not globally applicable and are therefore a part of a specific European, rather than a global vocabulary: European terms for orogenic events and additional sub-divisions of the Pre-Cambrian at epoch level.

Table 7-1 displays the features where amendments of terms were deemed necessary and indicates where the CGI/GeoSciML vocabulary could be used as a subset or in full. It also shows, which amendments were proposed to the IUGS-CGI IWG Geoscience Concept Definitions Task Group.

Table 7-1: GeoSciML domains used and amended by 1G-E

Classes in GeoSciML Application Schema	Used by 1G-E	Amended by 1G-E
MineralOccurence	no	no
Boreholes and observations	no	no
Concepts and vocabularies	yes	yes
Earth Material	yes	no
Fossil	no	no
GSML collection	yes	no
Geological Age	yes	yes
Geological Feature	yes	no
Geological Relation	yes	no
Geological Structure	yes	no
Geological Unit	yes	no
Metadata links	no	no
Generic values	yes	no
Geometric values	no	no

From the 25. to 27.08.2010 the first International GeoScience Language Workshop (including sessions and connected break-out groups and the GeoSciML Open Day; IGSL 2010) took place in Berlin under the patronage of the Federal Ministry of Economics and Technology. The workshop was initiated by the CGI and coorganised by the 1G-E WP3. 66 participants from six different continents took part and contributed to this workshop. During the Workshop four break-out groups discussed the following topics:

(1) The need for a coherent geoscience language
(2) Vocabularies, thesauri and regional examples
(3) Harmonisation and terms – aspirations and reality in Europe
(4) Current state of the art in machine use of vocabulary services

Within the scope of the break-out groups and the subsequent discussion the following 15 major points, concerning future requirements of geoscience language and harmonisation, were gathered and ordered according to priorities:

1. Clarify the end user needs (1). It is important to identify the user needs as a base for defining the suitable level of harmonisation (3). Find an accepted method to collect user needs.
2. Identify a persistent & authoritative CGI web location for vocabularies; and a CGI-IUGS namespace for publishing & development (4).
3. A project for global harmonisation. (3) Knowledge transfer from 1G-E to all other efforts.
4. Need for international standard for vocabulary services. CGI representative on W3C incubator group (4).
5. Requirement of an agreed standard guideline and methodology to work on national data harmonisation (policy and practice) (3).
6. Explore and adopt best practice from other communities (2).
7. CGI establishes vocabulary content provision arrangements with other IUGS domains (4).
8. Improve collaboration with other ML groups (1).
9. Need to define concepts for categories to create vocabularies (2).
10. Clarify scope of information resources for CGI interoperability activities (1).
11. Definition of a conceptual harmonisation process is needed and served by technical means (e.g. transformation services) (3).
12. Identify achievable deliverables for Brisbane 2012, the next International Geoscience Language Workshop. (1)
13. Need to define top level categories (2).
14. Provide term mapping to other languages and to other users (2).
15. Working Group establishes best practice for construction & use of URIs (Uniform Resource Identifiers) (4).

This clearly shows the interest solving semantic interoperability and harmonisation issues for spatial geological data sets by using and enhancing the 1G-E Data Specification and CGI/GeoSciML standards on a scope exceeding 1G-E.

8. Abbreviations

BGR Federal Institute for Geosciences and Natural Resources

1 G-E OneGeology-Europe

CDTG Concept Definition Task Group

CIPW normative mineralogy calculation developed by Cross, Iddings, Pirsson and Washington

CGI Commission for the Management and Application of Geoscience Information

CGMW Commission of the Geological Map of the World

CoGeoInfo Commission on Management and Application of Geoscience Information

CRC LEME Cooperation Research Centre for Landscape Evolution and Mineral Exploration

DoW Description of Work

DIGEST Digital Geographic Information Exchange Standard

EC European Commission

ECE-UN Economic Commission for Europe, Committee on Sustainable Energy - United Nations

ECP European Conferences on Planning

ESDIN European Spatial Data Infrastructure

ETRS89 Europäisches Terrestrisches Referenzsystem 1989

EU European Union

EU INSPIRE Directive (2007/2/EC)

Directive of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) to support Community environmental policies, and policies or activities which may have an impact on the environment.

EC INSPIRE Directive Annex I, II, III

Metadata and implementing rules of the spatial data sets concerning themes like e.g. Hydrography, Geology, Soil etc.

EC Soil Directive

Directive of the European Parliament and of the Council of 22nd September 2006 to protect soils across the EU.

EC Water Directive

Directive of the European Parliament and of the Council (98/83/EC) to protect the health of the consumers in the EU and to make sure the water is wholesome and clean.

ftp file transfer protocol

GeoSciML Geo Science Markup Language is a GML Application Schema that can be used to transfer information about Geology

GIS Geographic Information System

GML Geography Markup Language (GML) is the XML grammar defined by the Open Geospatial Consortium (OGC) to express geographical features

GSSR Geologická služba Slovenskej republicky (until 2000, since then SGUDS)

ID	identification number
INSPIRE	INfrastructure for SPatial Information in Europe - May 2007
ISO	International Organization for Standardization
IUGS	International Union of Geological Sciences (non-governmental organization)
IUGS-CGI	Data Model Collaboration Working Group
IWG	Interoperability Working Group
MID/MIF	MapInfo Interchange Format
M8	month 8 = May 2009
M10	month 10 = July 2009
NACSN	North American Commission on Stratigraphic Nomenclature
NADMSC	North American Geologic Map Data Model Steering Committee
NGO	Non-Governmental Organisation
OGC	Open Geospatial Consortium
QAFP	Quartz - Alkali feldspar - Plagioclase - Foids Classification Schema
SCMR	Subcommission on the Systematics of Metamorphic Rocks
SDI	Spatial Data Infrastructure
SGUDS	State Geological Institute of Dionye Stur (since 2000, before that GSSR)
SLTT	Science Language Technical Team (SLTT) of the North American Geologic Map Data Model Steering Committee (NADMSC)
TAS	Total Alkali Silica Classification Schema
UML	Unified Modelling Language. It is an open method used to specify, visualise, construct and document the artefacts of an object-oriented software-intensive system under development
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URN	Uniform Resource Name
WFS	Web Feature Service
WGS84	World Geodetic System 1984
WMS	Web Map Service
WP	Work Package
WP 1	OneGeology-Europe Work Package on project management
WP 2	OneGeology-Europe Work Package on user cases and best practice in meeting stakeholder needs
WP 3	OneGeology-Europe Work Package on 1:1 million pan-European geological Data Specification, identification and sourcing
WP 4	OneGeology-Europe Work Package on data inventory and multilingual discovery metadata catalogue
WP 5	OneGeology-Europe Work Package on informatics specification, data model, interoperability and standards
WP 6	OneGeology-Europe Work Package on web portal and Registry development and implementation

WP 7	OneGeology-Europe Work Package on access and licensing protocols
WP 8	OneGeology-Europe Work Package on communication, dissemination and awareness
WP 9	OneGeology-Europe Work Package on access to high resolution geological & applied datasets in national & cross border situations
WP 10	OneGeology-Europe Work Package on liaison with related groups and initiatives
XMML	eXploration and Mining Markup Language (XMML) is a GML-based XML transfer format for mineral exploration and geoscience data

9. Glossary

Term	Definition	Reference
Application Schema	A set of conceptual schema for data required by one or more applications. An application schema contains selected parts of the base schemas presented in the ORM Information Viewpoint. Designers of application schemas may extend or restrict the types defined in the base schemas to define appropriate types for an application domain. Application schemas are information models for a specific information community.	http://www.opengeospatial.org/ogc/
Attribute	Descriptive information about features or elements of a database. For a database feature like census tract, attributes might include many demographic facts including total population, average income, and age. In statistical parlance, an attribute is a \`variable,\` whereas the database feature represents an \`observation\` of the variable.	http://www.opengeospatial.org/ogc/
Catalog	A collection of entries, each of which describes and points to a feature collection. Catalogs include indexed listings of feature collections, their contents, their coverages, and other metadata. Registers the existence, location, and description of feature collections held by an Information Community. Catalogs provide the capability to add and delete entries. At a minimum Catalog will include the name for the feature collection and the locational handle that specifies where this data may be found. The means by which an Information Community advertises its holdings to members of the Information Community and to the rest of the world. Each catalog is unique to its Information Community.	http://www.opengeospatial.org/ogc/
Class	"…the primary declarative construct of Object-Oriented Programming; a cohesive unit of Attributes and Operations; a compile-time template for an Object. …"	http://en.wikipedia.org/wiki/Glossary_of_Unified_Modeling_Language_terms
Concept	Concepts are merely a distillation or abstraction from perceptions of the world of experience. Therefore, the significance of concepts depends solely on the perceptions that are its references.	http://en.wikipedia.org/wiki/Concept
Conceptual Data Model	The general idea of a structural design (model: description or analogy used to help visualize something that cannot be directly observed.	(Meriam-Webster)
Content Model	Models of this kind show the contents of a user interface and its different components. Aesthetics and behavior details are not included in this kind of models as it is in usage-centered design models. In usage-centered design, the modeling task is to show how the actual presentation of a planned system and how the user interaction is supposed to happen. This is probably the most praised approach, and it has been used successfully on a variety of small and large-scale projects. Its strengths are in complex problems.	http://en.wikipedia.org/wiki/User_Interface_Modeling#Content_models
Controlled Concept	At its simplest a ControlledConcept will have a name and, commonly, a description. VocabRelations enable the relationship between ControlledConcepts to be described and can be used to implement thesaurus type relationships like 'broader than', 'narrower than', 'related term', and 'synonym'.	(from "GeoSciML Cookbook: How To Map Data to CGGeoSciML Version 2")

Term	Definition	Reference
Controlled Vocabularies	"… provide a way to organize knowledge for subsequent retrieval. They are used in subject indexing schemes, subject headings, thesauri and taxonomies. Controlled vocabulary schemes mandate the use of predefined, authorised terms that have been preselected by the designer of the vocabulary, in contrast to natural language vocabularies, where there is no restriction on the vocabulary. …"	http://en.wikipedia.org/wiki/Controlled_vocabulary
Data Model	"An abstraction of the real world which incorporates only those properties thought to be relevant to the application at hand. The data model would normally define specific groups of entities, and their attributes and the relationships between these entities. A data model is independent of a computer system and its associated data structures. A map is one example of an analogue data model."	http://www.opengeospatial.org/ogc/
Dataset	Collection of datasets sharing the same product specification	http://www.opengeospatial.org/ogc/
Feature	The starting point for modeling of geographic information. Abstraction of a real world phenomenon. "A digital representation of a real world entity or an abstraction of the real world. It has a spatial domain, a temporal domain, or a spatial/temporal domain as one of its attributes. Examples of features include almost anything that can be placed in time and space, including desks, buildings, cities, trees, forest stands, ecosystems, delivery vehicles, snow removal routes, oil wells, oil pipelines, oil spill, and so on. Features are usually managed in groups as feature collections. The terms feature and object are often used synonymously. The terms feature, feature collection and coverage are defined in line with OpenGIS."	http://www.opengeospatial.org/ogc/ ; Source: The OpenGIS® Abstract Specification Topic 6: The Coverage Type and its 1G-E Subtypes Version 6. http://www.opengis.org/techno/abstract/00-106.pdf
Harmonisation	With respect to standards: activities undertaken by communities of experts to align standards. For example, to define common metadata and application schema from legacy sources, harmonization will consider: -- Architecture - multiple viewpoints that capture high level requirements, use cases, scenarios, information flows and computational flows. -- Data modelling - definition and UML encoding of feature type, attribute type, data type, coding, dependency mapping -- Schema modelling - UML mapping and encoding to GML, mapping of profiles to one another, and delineation to service types -- Iteration and development - build a little, see if it works, build more- -- Delivery to standards organizations for approval.	http://www.opengeospatial.org/ogc/
INSPIRE Directive	The purpose of this Directive is to lay down general rules aimed at the establishment of the Infrastructure for Spatial Information in the European Community (hereinafter referred to as Inspire), for the purposes of Community environmental policies and policies or activities which may have an impact on the environment.	http://ec.europa.eu/gmes/pdf/Dir_INSPIRE_L108.pdf

Term	Definition	Reference
Interoperability	Capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units ISO 2382-1. "The ability for a system or components of a system to provide information portability and interapplication, cooperative process control. Interoperability, in the context of the OpenGIS Specification, is software components operating reciprocally (working with each other) to overcome tedious batch conversion tasks, import/export obstacles, and distributed resource access barriers imposed by heterogeneous processing environments and heterogeneous data.	http://www.opengeospatial.org/ogc/
Metadata	Data about data or a service. Metadata is the documentation of data. In human-readable form, it has primarily been used as information to enable the manager or user to understand, compare and interchange the content of the described data set. In the Web Services context, XML-encoded (machine-readable and human-readable) metadata stored in catalogs and registries enables services to use those catalogs and registries to find data and services.	ISO 19115
Portrayal	The presentation of information to humans, e.g., a map. In the context of the Web, portrayal refers to how data is presented for the user. Map portrayal, for example, is concerned with shape and color of symbols representing features, rules for displaying text labels, rules for showing/not showing symbols based on zoom extent, etc	http://www.opengeospatial.org/ogc/
Property	A facet or attribute or an object referenced by a name.	http://www.opengeospatial.org/ogc/
Schema / Sheme	A structured framework. A metadata schema specifies the order and types and labels of information elements describing a geodata set.	http://www.opengeospatial.org/ogc/
SDI /GDI	"(Geo)Spatial Data Infrastructure: a comprehensive package of consensus and initiatives required to enable complete provision of data, access and privacy within the territory of the designated infrastructure."	http://www.gsdi.org/SDILinks.php
Semantic	A collection of mappings between a target Information Community`s data model and a source Information Community`s data model, generally held and maintained by the target Information Community, though both Information Communities may participate in configuring it. Usually expressed in terms of metadata, features, attributes and rules that permit information integration to occur when a feature collection is imported to the target Information Community from a source Information Community.	http://www.opengeospatial.org/ogc/
Spatial data	Also known as geospatial data or geographic information it is the data or information that identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is usually stored as coordinates and topology, and is data that can be mapped. Spatial data is often accessed, manipulated or analyzed through Geographic Information Systems	http://www.webopedia.com/TERM/S/spatial_data.html
Specification	A document written by a consortium, vendor, or user that specifies a technological area with a well-defined scope, primarily for use by developers as a guide to implementation. A specification is not necessarily a formal standard.	http://www.opengeospatial.org/ogc/

Term	Definition	Reference
Standard	A document that specifies a technological area with a well-defined scope, usually by a formal standardization body and process.	http://www.opengeospatial.org/ogc/
Term	A word or expression that has a precise meaning in some uses or is peculiar to a science, art, profession, or subject	(Meriam-Webster).
Vocabulary	A collection of vocabulary terms, usually linked to a document that defines the precise meaning of the descriptors and the domain in which the vocabulary is expected to be used. When associated with a schema, attributes are expressed as URI references. [This definition is an amalgam of those provided in Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies 1.0 and OWL Web Ontology Language Guide.]	http://www.w3.org/2005/Incubator/geo/XGR-geo-20071023/#glossary

10. Selected Standards

ISO Geographic Information, Symbols and Nomenclature:
ISO 710-7 (1984): Graphical symbols for use on detailed maps, plans and geological cross-sections, Part 7: Tectonic symbols.
http://www.iso.org/iso/catalogue_detail.htm?csnumber=4926

ISO14689-1 (2003): Geotechnical investigation and testing —Identification and classification of rock, Part 1:Identification and description.
http://www.iso.org/iso/catalogue_detail?csnumber=35572

ISO/TC 211 (2009): Geographic Information/Geomatics.
http://www.isotc211.org/Outreach/ISO_TC%20_211_Standards_Guide.pdf

Open Geospatial Consortium technical specifications (standards):
Introduction and overview:
http://www.opengeospatial.org/standards

Some web service interface specifications of particular interest:
Web Service Common:
http://www.opengeospatial.org/standards/common

Web Map Service:
http://www.opengeospatial.org/standards/wms

Web Map Context:
http://www.opengeospatial.org/standards/wmc

Styled Layer Descriptor:
http://www.opengeospatial.org/standards/sld

Web Feature Service:
http://www.opengeospatial.org/standards/wfs

Web Coverage Service:
http://www.opengeospatial.org/standards/wcs

Catalogue Services Specification:
http://www.opengeospatial.org/standards/cathttp://portal.opengeospatial.org/files/?artifact_id=5929&version=2

Methodology of Data Specification:
Drafting Team "Data Specifications" Methodology for the development of data Specifications (2007):
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/inspireDataspecD2_6v2.0.pdf

Some metadata schemas of interest:
INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119. (2009):
http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/metadata/MD_IR_and_ISO_20090218.pdf

ISO 19115 (Dataset Metadata):
http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=26020

ISO 19115 Corrigendum:
http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=44361
ISO 19119 (Service Metadata):
http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=39890

ISO 19136 Annex E for GML 3.2.1, 2009:
Geoinformation – Geography Markup Language (GML)
Annex E (normative): UML- to GML application schema encoding rules

ANZLIC Metadata:
http://www.anzlic.org.au/infrastructure_metadata.html

FGDC Metadata:
http://www.fgdc.gov/metadata

ISO DTS 19139 (XML Schema):
https://www.seegrid.csiro.au/subversion/xmml/gml/trunk/gml/3.2.0/gmd/gmd.xsd

Ontology/thesaurus/vocabulary principles and management technologies:
Intro: "The Ontology Spectrum and Semantics Models" (Leo Orbrst):
http://ontolog.cim3.net/file/resource/presentation/LeoObrst_20060112/OntologySpectrumSemanticModels--LeoObrst_20060112.ppt

GeoSciML Vocabulary model:
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/GeologicVocabulary

CoGeoInfo Multilingual Thesaurus of Geosciences:
http://www.bgs.ac.uk/cgi_web/Multilingual_thesaurus_of_geoscience.pdf

Geoscience data standards:
GeoSciML, a GML Application Schema for geology:
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/ GeoSciML
GeoSciML model and schema:
https://www.seegrid.csiro.au/subversion/xmml/ GeoSciML/trunk/
https://www.seegrid.csiro.au/subversion/GeoSciML/tags/2.0_20080702/model/

XML Schema for the Geologic Timescale:
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/GeologicTime

CoGeoInfo Multilingual Thesaurus of Geosciences:
http://www.bgs.ac.uk/cgi_web/Multilingual_thesaurus_of_geoscience.pdf

Geoscience Australia data standards:
http://www.ga.gov.au/standards/standards.jsp

BGS data dictionaries:
http://www.bgs.ac.uk/data/dictionaries.html

USGS/AASG mapping standards and guidelines:
http://ngmdb.usgs.gov/Info/standards/index.html

GeoSciML documentation:
http://www.geosciml.org/geosciml/2.0/doc/

GeoSciML encoding 'cookbook':
http://www.geosciml.org/geosciml/2.0/cookbook/GeoSciML_Data_CookBook_V2.pdf.

Create URN following the CGI pattern described at
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIIdentifierScheme.

A full list of registered CGI parties, who are able to register resources, is available at
https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/CGIPartyRegister.

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12. List of Tables

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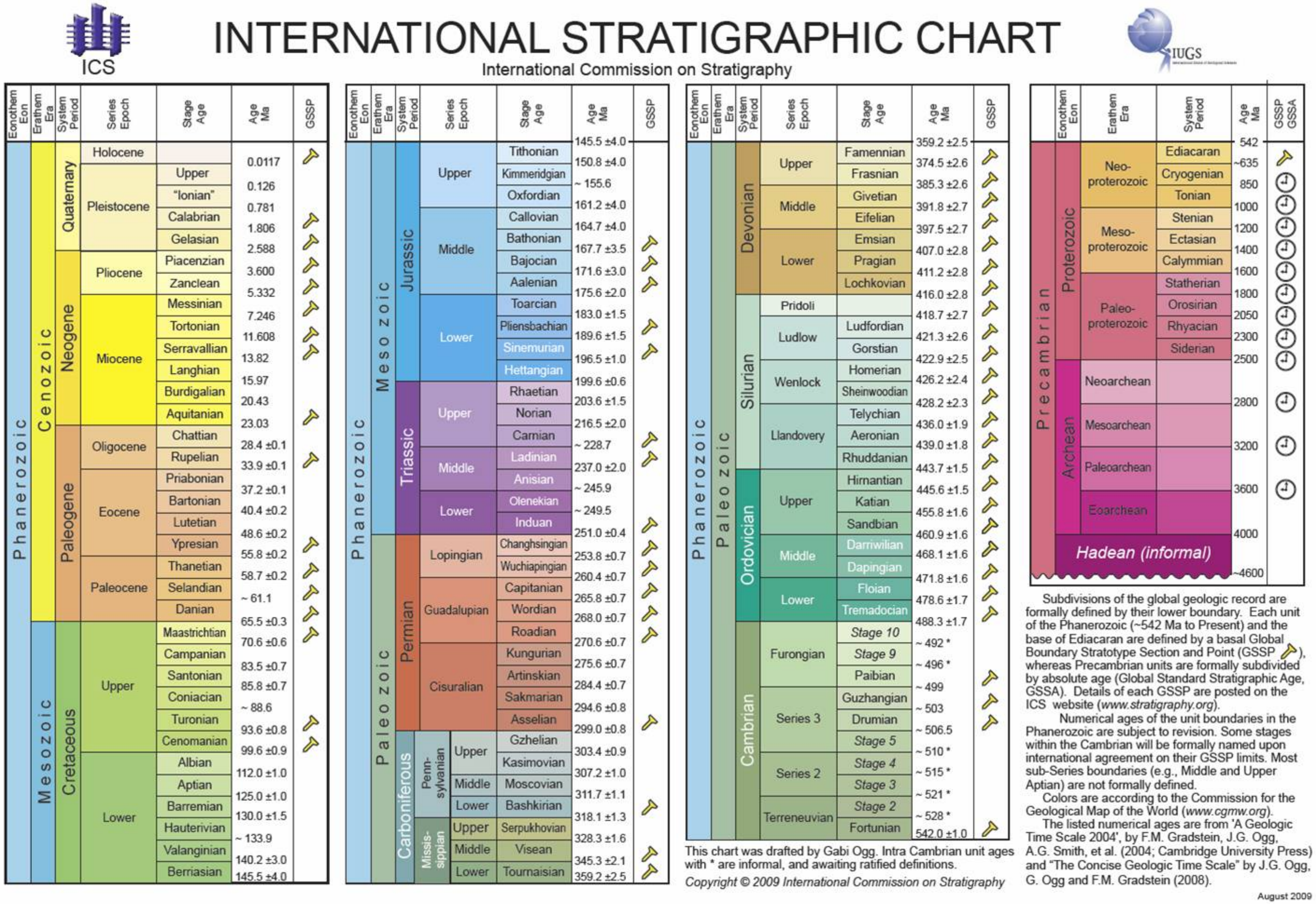
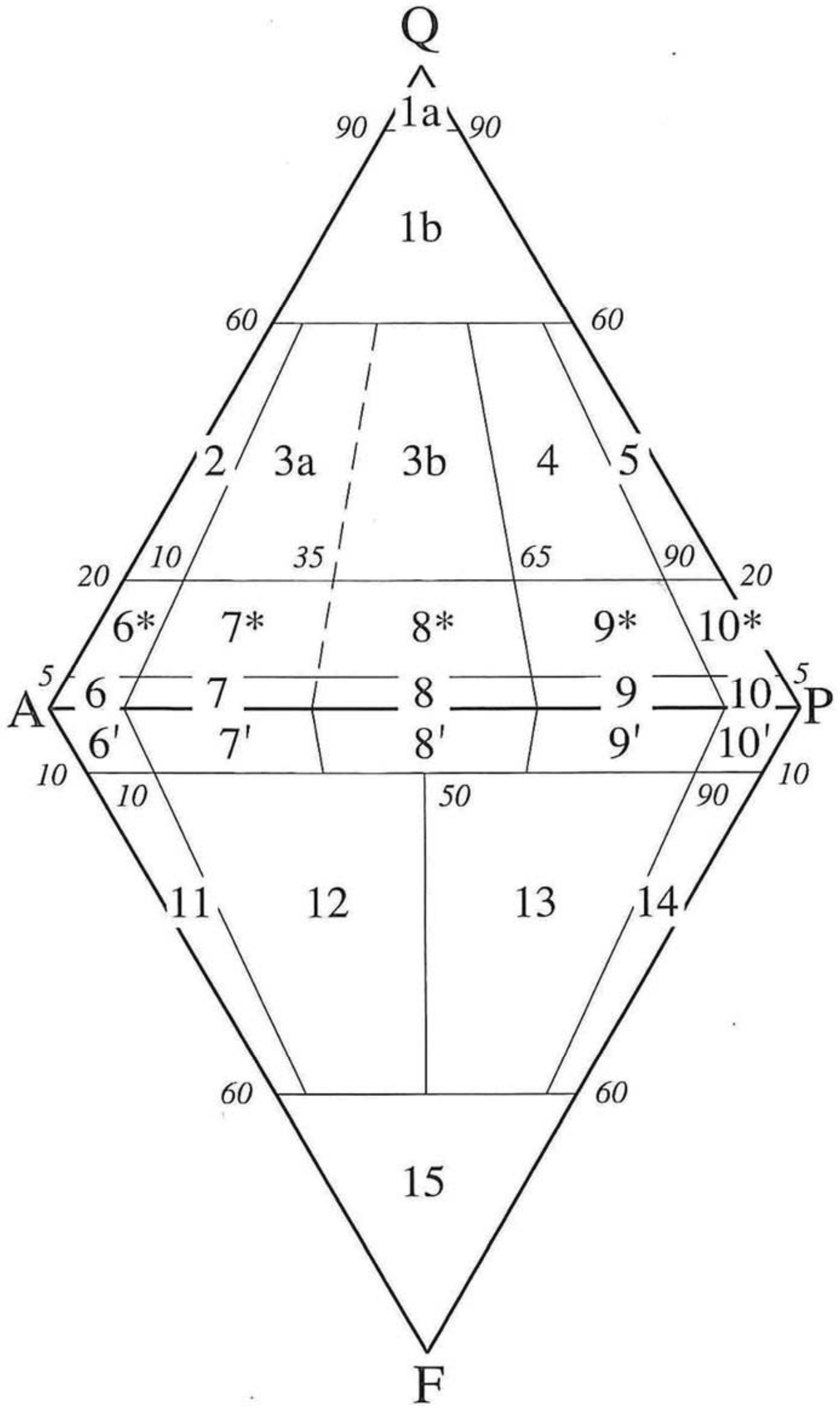
ANNEX I : IUGS Stratigraphic Chart



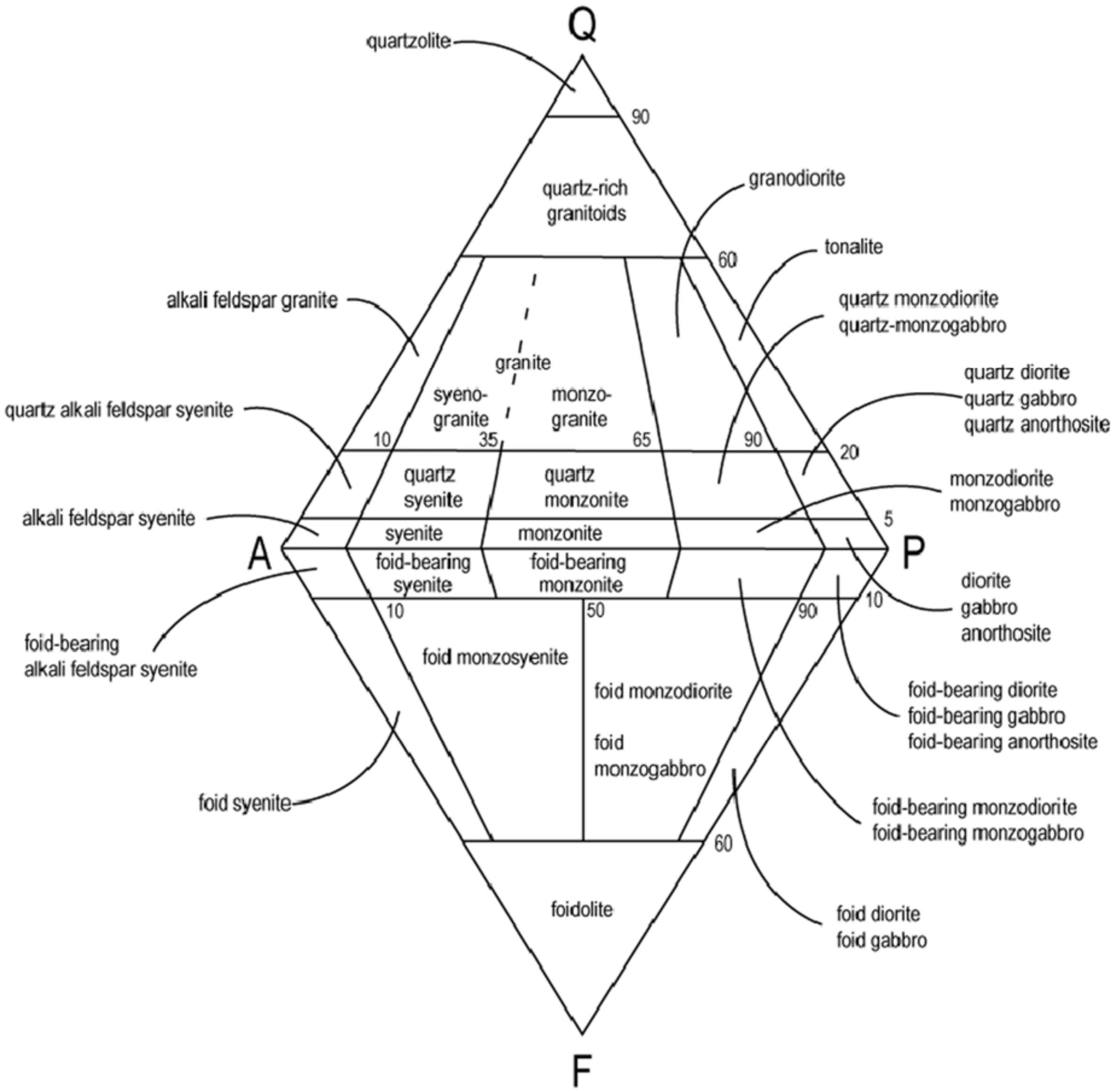
ANNEX II : IUGS Classification Schemas for Igneous Rocks

QAPF modal classification of plutonic and volcanic rocks (Q = quartz, A = alkali feldspar, P = plagioclase, F = feldspathoid) (LeMaitre et. al. 2002)



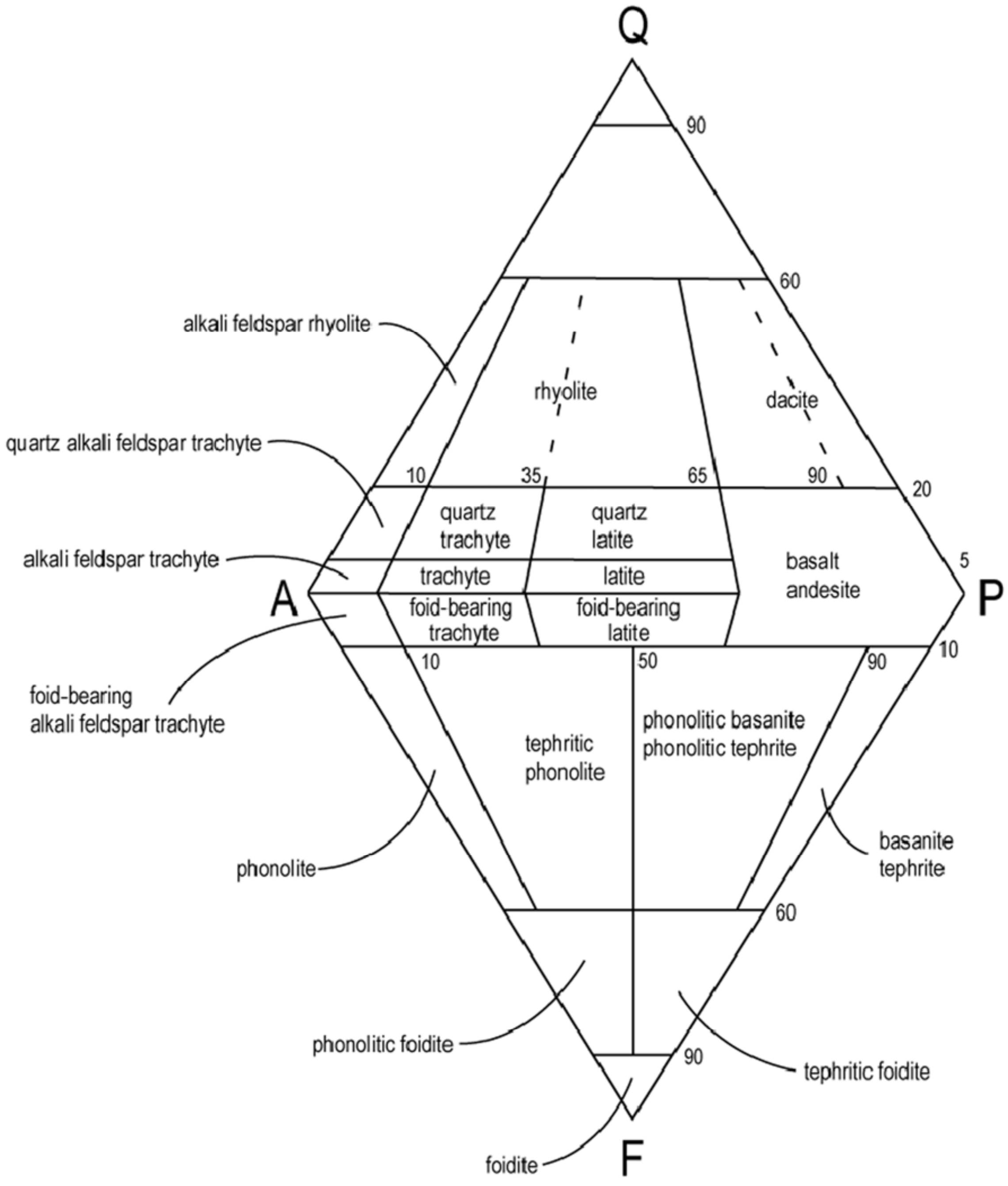
QAPF modal classification of plutonic and volcanic rocks (Q = quartz, A = alkali feldspar, P = plagioclase, F = feldspathoid)

Plutonic Rocks

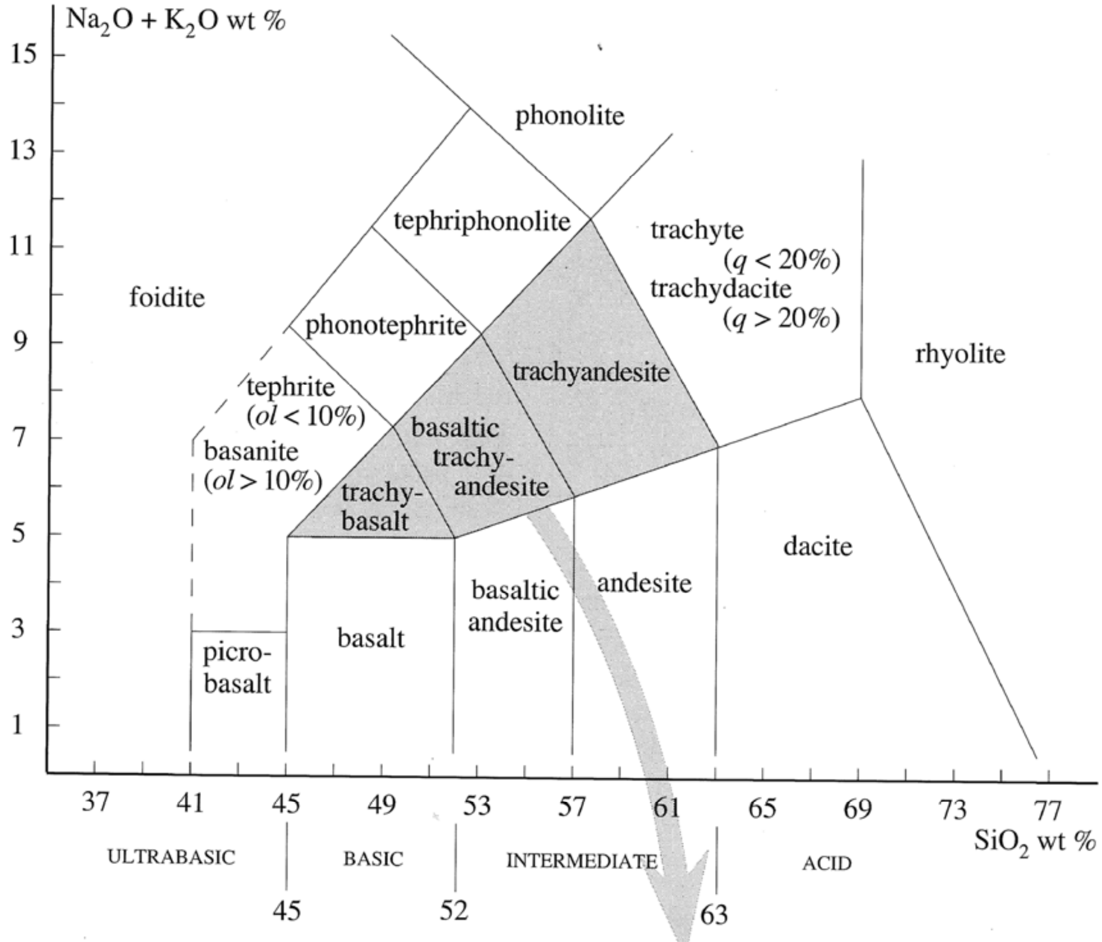


QAPF modal classification of plutonic and volcanic rocks (Q = quartz, A = alkali feldspar, P = plagioclase, F = feldspathoid)

Volcanic Rocks



Additional chemical classification of volcanic rocks (Total Alkali – Silica, TAS)



Further subdivisions of shaded fields	trachybasalt	basaltic trachyandesite	trachyandesite
$Na_2O - 2.0 \geq K_2O$	hawaiite	mugearite	benmoreite
$Na_2O - 2.0 < K_2O$	potassic trachybasalt	shoshonite	latite

Additional chemical classification of volcanic rocks (Total Alkali – Silica, TAS)