

GeoSciML 4.0 Encoding Cookbook for OneGeology and INSPIRE

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1 Introduction

GeoSciML is an application-neutral encoding format for geosciences information. It is based on Geography Markup Language v3.2 (GML) (ISO 19136:2007) for representation of features and geometry. GeoSciML was developed by the CGI (Commission for the Management and Application of Geoscience Information), a Commission of the International Union of Geological Sciences, and is an internationally agreed domain standard for geology.

GeoSciML has a wide scope allowing the encoding of most information depicted on geological maps, as well as information about boreholes and laboratory analyses. This cookbook, however, concentrates on just those parts of GeoSciML necessary for (i) encoding the INSPIRE Geology application schema and (ii) delivering geological age and lithology information through OneGeology services.

The INSPIRE geology data specification (D2.8.II.4 Data Specification on Geology – Draft Technical Guidelines) describes the geological information that needs to be made available through INSPIRE conformant web services. INSPIRE services can be encoded using GeoSciML v4.0 in order to achieve maximum global interoperability and to enable the INSPIRE geology data specification to be extended to include other geosciences information. A mapping between the INSPIRE specification and GeoSciML v4.0 is given in Annex 1. Note that the INSPIRE Geology Data Specification also includes application schema for hydrogeology and geophysics which are not covered by this cookbook.

Geological age and lithology are used as the basis for querying and portrayal in OneGeology and this cookbook covers the parts of GeoSciML required to be delivered as part of a 5 star OneGeology service.

To facilitate semantic interoperability it is important to use shared vocabularies. The CGI has developed suitable vocabularies for many GeoSciML properties and these are available from the GeoSciML resources website (<http://resource.geosciml.org/>). For INSPIRE the vocabularies that must be used are included in the data specification and are available from the INSPIRE registry (<http://inspire.ec.europa.eu/registry/>). The OneGeology portal can query services using either CGI or INSPIRE vocabularies. Both sets of vocabularies use http URIs as concept identifiers.

This cookbook is designed to assist users map their data to the GeoSciML data model. In most cases users with digital geoscience data will have their own formalised model of some type, although this will not always be the case. Where a formalised user data model exists then the process of mapping data to GeoSciML will largely involve mapping features/entities in the user model to their equivalents in the GeoSciML logical data model. Where no such user model exists then mapping must be carried out direct from the data.

To carry out the mapping, from either a model or direct from data, requires staff with geoscientific knowledge, familiarity with the user's own data and data model, and an understanding of the UML formalisation used in documenting GeoSciML. These staff are likely to be geoscientists, possibly those who were involved in developing the organisation's own data model, and it is these people who are seen as the main users of this cookbook.

Materials and documentation on GeoSciML have been produced by the CGI Interoperability Working Group (IWG) and are available "as is" for download from <http://www.geosci.ml.org/>. The supporting materials most relevant to this cookbook include:

- Full documentation of the GeoSciML model. This is generated automatically from the GeoSciML UML diagrams and draws on the scope notes in those diagrams. This full documentation, however, does not include any best practice guidance
- An Enterprise Architect version of the UML for the CGI packages
- GeoSciML examples

There are also XML Schema documents which enable validation of the GeoSciML instance documents that you produce from your mapped data. These are listed at <http://schemas.geosci.ml.org/geosci.ml/4.0/>. For the parts covered by this cookbook you will need <http://schemas.geosci.ml.org/geosci.ml/4.0/geosci.mlBasic.xsd> and, if you are providing borehole data, <http://schemas.geosci.ml.org/geosci.ml/4.0/borehole.xsd>. You can also find some Schematron files here which provide extra validation for the INSPIRE profile of GeoSciML.

http://schemas.geosci.ml.org/geosci.ml/4.0/geosci.mlBasic_inspire_mandatory.sch checks that all properties required by INSPIRE have been provided and http://schemas.geosci.ml.org/geosci.ml/4.0/geosci.ml_inspire_vocabularies.sch checks that the appropriate INSPIRE vocabulary terms have been used.

Although use of GeoSciML is open to the geoscience community, in order to ensure the integrity of the GeoSciML standard across the community the IWG requests that the following points be applied to any work involving GeoSciML:

1. full compliance with existing GeoSciML conformance criteria
2. the IWG and its GeoSciML products are not misrepresented or misused
3. the IWG retains full copyright to all IWG and GeoSciML names and products, including logos, text, images and technical materials
4. the GeoSciML name and associated namespaces, as well as the IWG name and associated task group names, are reserved strictly for IWG activities and products
5. the GeoSciML products developed by the IWG may be freely copied and used within third-party information systems, with acknowledgements as per (8) below

6. the GeoSciML products developed by the IWG are not to be modified by third-parties, except as part of the revision process within the IWG
7. extensions to GeoSciML by third-parties remain distinct from GeoSciML, exist in non-GeoSciML namespaces, and are not to be represented as IWG or GeoSciML products
8. acknowledgement of GeoSciML and the IWG is made in all communications and products related to work involving GeoSciML or the IWG, with appropriate citation
9. the IWG gives no warranty, expressed or implied, as to the quality or accuracy of the information supplied, or to the information's suitability for any use. The IWG accepts no liability whatever in respect of loss, damage, injury or other occurrence however caused

2 GeoSciML model and INSPIRE encoding

There are six packages in GeoSciML. Two are required for INSPIRE services: GeoSciML-Basic and Borehole. Only GeoSciML-Basic is required for a 5 star OneGeology service. This section will describe those parts of these packages which are the minimum requirement for conformance with the INSPIRE geology application schema. The parts required for a One Geology service are a subset of the INSPIRE ones and are highlighted as they are covered.

In GeoSciML most properties are optional. For a OneGeology service you may decide whether to omit or include properties that are not specified below as required. If you wish to provide explicit reasons for some missing values you can include the relevant property, add an `xsi:nil="true"` attribute and use a `nilReason` attribute to specify the reason the value is not being supplied. Unless your service is also an INSPIRE service, one of the `nilReasons` defined in ISO 19136:2007 section 8.2.3.1 should be used:

- **inapplicable** - there is no value
- **missing** - the correct value is not readily available to the sender of this data. Furthermore, a correct value may not exist
- **template** - the value will be available later
- **unknown** - the correct value is not known to, and not computable by, the sender of this data. However, a correct value probably exists
- **withheld** - the value is not divulged

However, for INSPIRE services all attributes in the data specification should be provided. 'Voidable' does not mean 'optional' in INSPIRE. Where no value is provided for an INSPIRE voidable attribute then a `nilReason` must be provided. One of the `nilReasons` defined in the INSPIRE [VoidReasonValue](#) codelist should be used:

- <http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unpopulated> - The characteristic is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world.

- <http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unknown> - the correct value for the specific spatial object is not known to, and not computable by, the data provider. However, a correct value may exist.
- <http://inspire.ec.europa.eu/codelist/VoidReasonValue/Withheld> - the characteristic may exist, but it is confidential and not divulged by the data provider.

This doesn't apply to attributes that exist in GeoSciML but that aren't part of the INSPIRE data specification. Where no value is provided for these they may have any nilReason permitted by GeoSciML or may simply be omitted if permitted by GeoSciML. Figure 1 shows examples of how to provide nil values.

```
<gmlb:geologicUnitType xsi:nil="true" nilReason="http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unknown" />
<gmlb:rank xsi:nil="true" nilReason="inapplicable" />
```

Figure 1 Examples of encoding nil values

As GeoSciML is a GML schema all objects must have a value for the mandatory gml:id attribute. This provides an identifier for the XML element representing the object, and must be unique within the XML document. XML elements representing a particular object, for example a specific GeologicUnit, need only be described once in the document. Subsequent occurrences can reference the element using the gml:id. The gml:id attribute should not be used for the global identifier of the object, it is simply an identifier within the XML document.

Vocabulary concepts should be encoded by reference. This enables information about the concept, such as a full description, to be accessed from the relevant vocabulary service. The general pattern is that the href attribute provides the URI of the concept and the title attribute provides a human readable label for it.

An example of encoding the INSPIRE Geology application schema in GeoSciML is given in Annex 2. This example is structured as a GeologicCollection with one of each type of INSPIRE feature included. It is designed to illustrate GeoSciML encoding rather than illustrate what a real INSPIRE service might look like.

An example of a response that would be suitable for a OneGeology 5 star WFS is given in Annex 3.

2.1 Mapped Feature and Geologic Feature

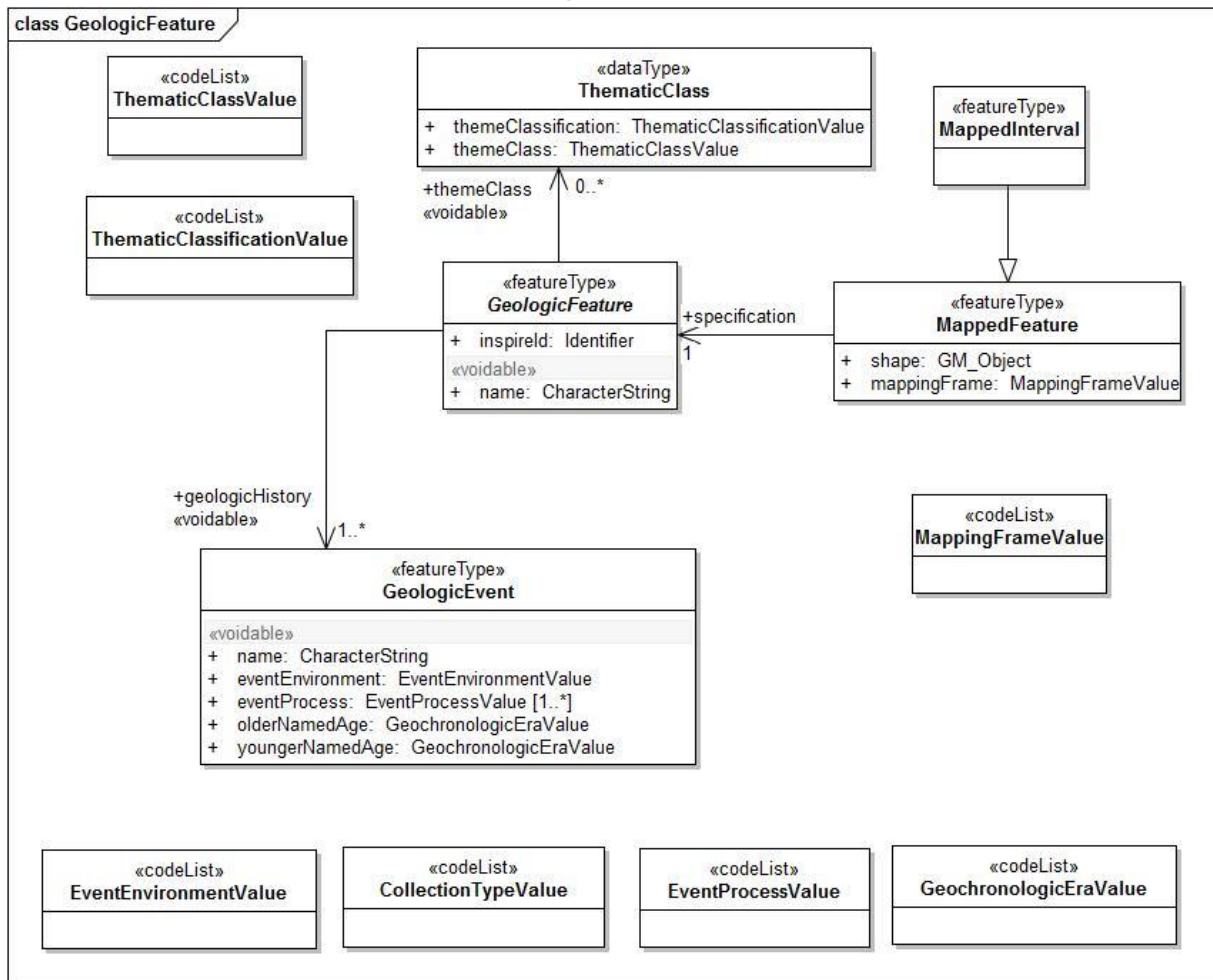


Figure 2: INSPIRE UML class diagram for GeologicFeature, MappedFeature, GeologicEvent and ThematicClass

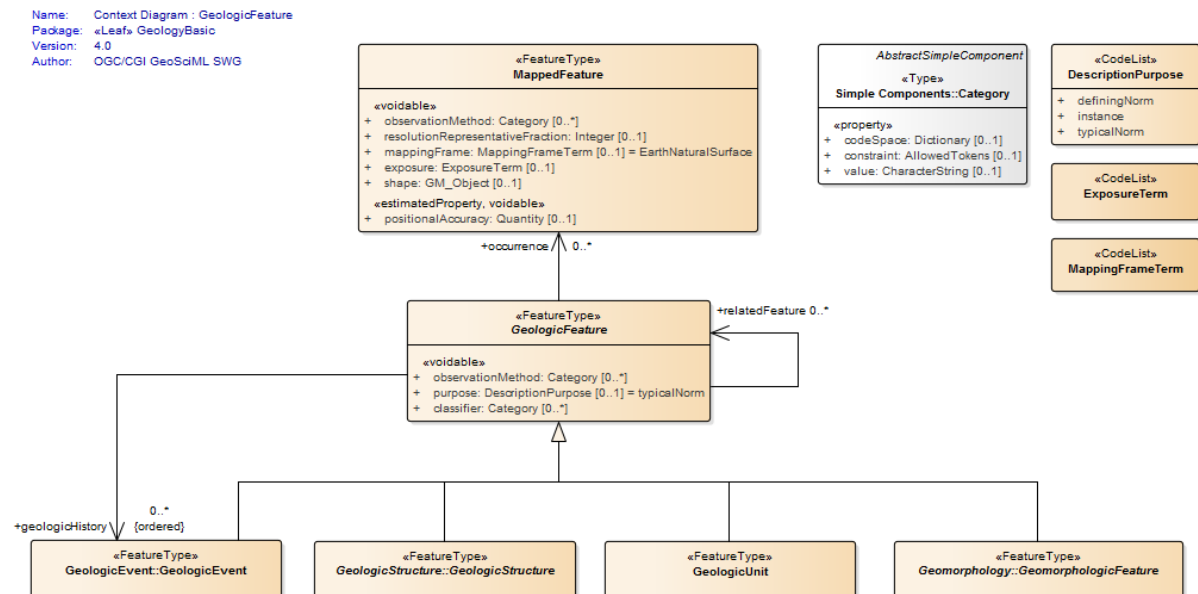


Figure 3: UML context diagram for GeoSciML GeologicFeature

The INSPIRE UML class diagram for GeologicFeature, MappedFeature, GeologicEvent and ThematicClass is shown in Figure 2 and the UML of the equivalent GeoSciML classes in Figure 3.

The MappedFeature and GeologicFeature objects are at the core of GeoSciML. A MappedFeature can be considered an occurrence, such as a polygon on a geologic map, of a real world GeologicFeature the full extent of which is unknown. It is independent of geometry, so the same GeologicFeature can have different MappedFeature instances, representing mapped polygons at different scales or a modelled volume for example. Each MappedFeature, however, can be specified by only one GeologicFeature. The specification association, from MappedFeature to GeologicFeature, is required by INSPIRE. An INSPIRE service provides a collection of MappedFeatures. A OneGeology service provides a collection of MappedFeatures specified by GeologicUnit features.

GeologicFeature is the abstract parent class for GeologicUnit, GeologicStructure, GeomorphologicFeature and GeologicEvent. This section will describe those properties which apply to all GeologicFeatures, but these will always be encoded as part of one of the specialist child classes. The INSPIRE GeologicFeature class has two associations, themeClass and geologicHistory. The themeClass association should be encoded using the GeoSciML classifier association, which will be explained in section 2.6, and geologicHistory should be encoded using the GeoSciML geologicHistory property which has GeologicEvent values, explained in section 2.2.

2.1.1 Mapped Feature - mapping frame

The INSPIRE mappingFrame property is equivalent to the GeoSciML mappingFrame. Each MappedFeature has a mappingFrame property constrained by a vocabulary term that indicates the spatial reference frame within which the MappedFeatures have been observed, such as a surface of mapping. Values should be drawn from the MappingFrameValue vocabulary (<http://inspire.ec.europa.eu/codelist/MappingFrameValue>). Currently there is no equivalent CGI vocabulary.

```
<gsmlb:mappingFrame
  xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/topOfBedrock"
  xlink:title="top of bedrock"/>
```

Figure 4: Example of the encoding of sampling frame

2.1.2 Mapped Feature - geometry (shape)

The geometry of each MappedFeature is provided by the shape association to GM_Object. Figure 5 gives an example of encoding a polygon. This property is (obviously) required for a OneGeology service and should have Polygon values.

```
<gsmlb:shape>
  <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326" gml:id="LOCAL_ID_0">
    <gml:exterior>
```

```

    <gml:LinearRing>
      <gml:posList srsDimension="2" count="8">55.0760921318516 -3.31719604609088 55.0833753209835 -
3.31853455922777 55.0825574334633 -3.31921378657955 55.0801997429522 -3.31978309699423 55.0768616358466 -
3.3194575613054 55.0741365291192 -3.31966903508197 55.0756843873373 -3.31747948721346 55.0760921318516 -
3.31719604609088</gml:posList>
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>
</gmlb:shape>

```

Figure 5: Example of the encoding of MappedFeature geometry (shape)

2.1.3 Geologic Feature – inspireId

The INSPIRE inspireId property is of type Identifier and provides the persistent identifier used for the object by the data provider, for example the code from a stratigraphic lexicon in the case of a GeologicUnit. In GeoSciML this should be encoded using gml:identifier which requires both the identifier value, equivalent to Identifier.localId, and the codespace, equivalent to Identifier.namespace, identifying the data source (Figure 6).

2.1.4 Geologic Feature – name

The INSPIRE name property provides the name of the GeologicFeature, for example the expansion of the code provided by inspireId. It should be encoded using gml:name (Figure 6). If the feature does not have a name use “Unnamed feature”.

```

<gmlb:GeologicUnit gml:id="INV-SDSM">
  <gml:identifier
codeSpace="http://data.bgs.ac.uk/">http://data.bgs.ac.uk/id/Lexicon/NamedRockUnit/INV</gml:identifier>
  <gml:name>INVERCLYDE GROUP</gml:name>

```

Figure 6: Example of the encoding of identifier and name for a GeologicUnit

2.2 Geologic Age

In INSPIRE the geologicHistory association from GeologicFeature to GeologicEvent is the way in which geologic age is described (Figure 2). This applies to all types of GeologicFeature: GeologicUnit, GeologicStructure and GeomorphologicFeature. In GeoSciML age is modeled similarly, although GeologicEvent is itself a type of GeologicFeature and may have further geologicHistory properties. At least one GeologicEvent needs to be provided per GeologicUnit. The OneGeology Portal has a query tool which will retrieve units of a specified age or ages. The interpretation of the results of this particular query tool will be clear if you were to provide only a single GeologicEvent for each GeologicUnit and consider this event represents the formation of the unit.

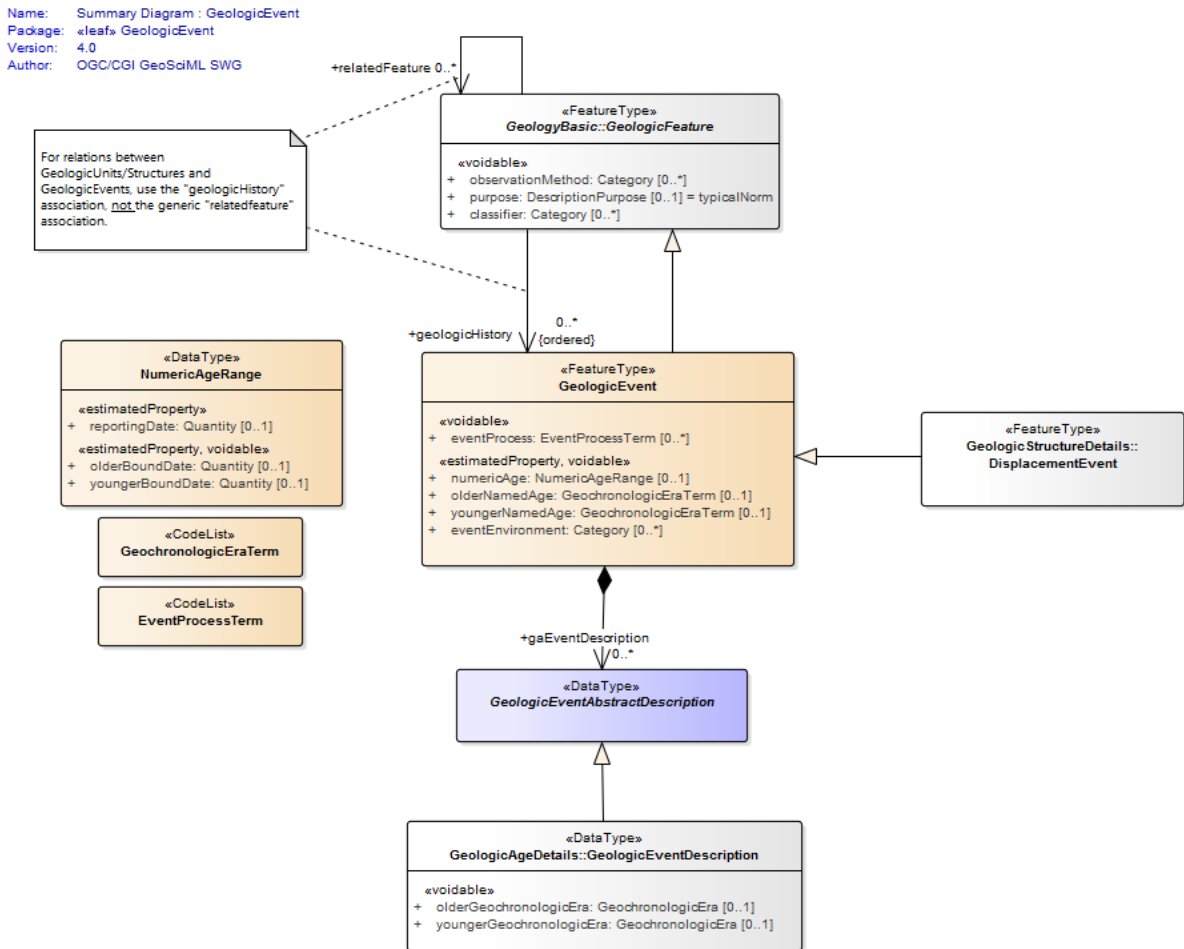


Figure 7: UML summary diagram for GeoSciML GeologicEvent

2.2.1 Geologic Event – name

The INSPIRE name property provides the name of the GeologicEvent, for example ‘Hercynian Orogeny’. Only major events such as orogenies are likely to have names and other events should be recorded as ‘Unnamed event’. The field should be encoded using gml:name.

2.2.2 Geologic Event – youngerNamedAge and olderNamedAge

In INSPIRE it is necessary to provide geologic age expressed using a geochronologic era defined according to a geologic time scale. Geochronologic era names must be drawn from the GeochronologicEraValue vocabulary (<http://inspire.ec.europa.eu/codelist/GeochronologicEraValue>), which is based on the International Commission for Stratigraphy (ICS) international stratigraphic chart supplemented with a more detailed chronology for parts of the Precambrian and Quaternary. Both the olderNamedAge and the youngerNamedAge attributes should be populated, giving the age of the start and end of the GeologicEvent respectively. It may be that the GeologicEvent age is fully enclosed by a single geochronologic era, in which case the olderNamedAge and the youngerNamedAge attributes should both be populated with the same value.

These properties are required for OneGeology services. If the service is not also an INSPIRE service the values must be drawn from the CGI vocabulary <http://resource.geosciml.org/vocabulary/timescale/isc2014.rdf> which is based on the International Commission for Stratigraphy (ICS) international stratigraphic chart or the supplement http://resource.geosciml.org/vocabulary/timescale/1GE_PCEExtension.rdf which contains a more detailed chronology for parts of the Precambrian.

2.2.3 Geologic Event - eventProcess

The eventProcess property describes one or more processes that took place during the event to modify the related GeologicFeature. For an INSPIRE service it should be encoded using terms drawn from the EventProcessValue vocabulary (<http://inspire.ec.europa.eu/codelist/EventProcessValue>). If it is provided for a non-INSPIRE OneGeology service the CGI Event process vocabulary (<http://resource.geosciml.org/vocabulary/cgi/201211/eventprocess.rdf>) should be used.

2.2.4 Geologic Event - eventEnvironment

The eventEnvironment property describes the environment within which the event took place. It is of type 'Category' which provides the resolvable URI for the vocabulary containing the eventEnvironment concepts in the codeSpace attribute, the URI identifier for the eventEnvironment concept in the identifier attribute, and a human readable version of the concept in the label attribute. For an INSPIRE service the codeSpace should have the URI for the EventEnvironmentValue vocabulary (<http://inspire.ec.europa.eu/codelist/EventEnvironmentValue>) and the values in the identifier should be taken from this vocabulary. If it is provided for a non-INSPIRE OneGeology service values from the CGI Event environment vocabulary (<http://resource.geosciml.org/vocabulary/cgi/201211/eventenvironment.rdf>) should be used for identifier and the URI <http://resource.geosciml.org/vocabulary/cgi/201211/eventenvironment> for the codeSpace.

```
<gsmlb:eventEnvironment>
  <swe:Category
    definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
    <swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/riverPlainSystemSetting</swe:identifier>
    <swe:label>river plain system setting</swe:label>
    <swe:codeSpace
      xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"/>
    </swe:Category>
  </gsmlb:eventEnvironment>
```

Figure 8: Example of encoding eventEnvironment

2.3 Geologic Unit and Earth Material

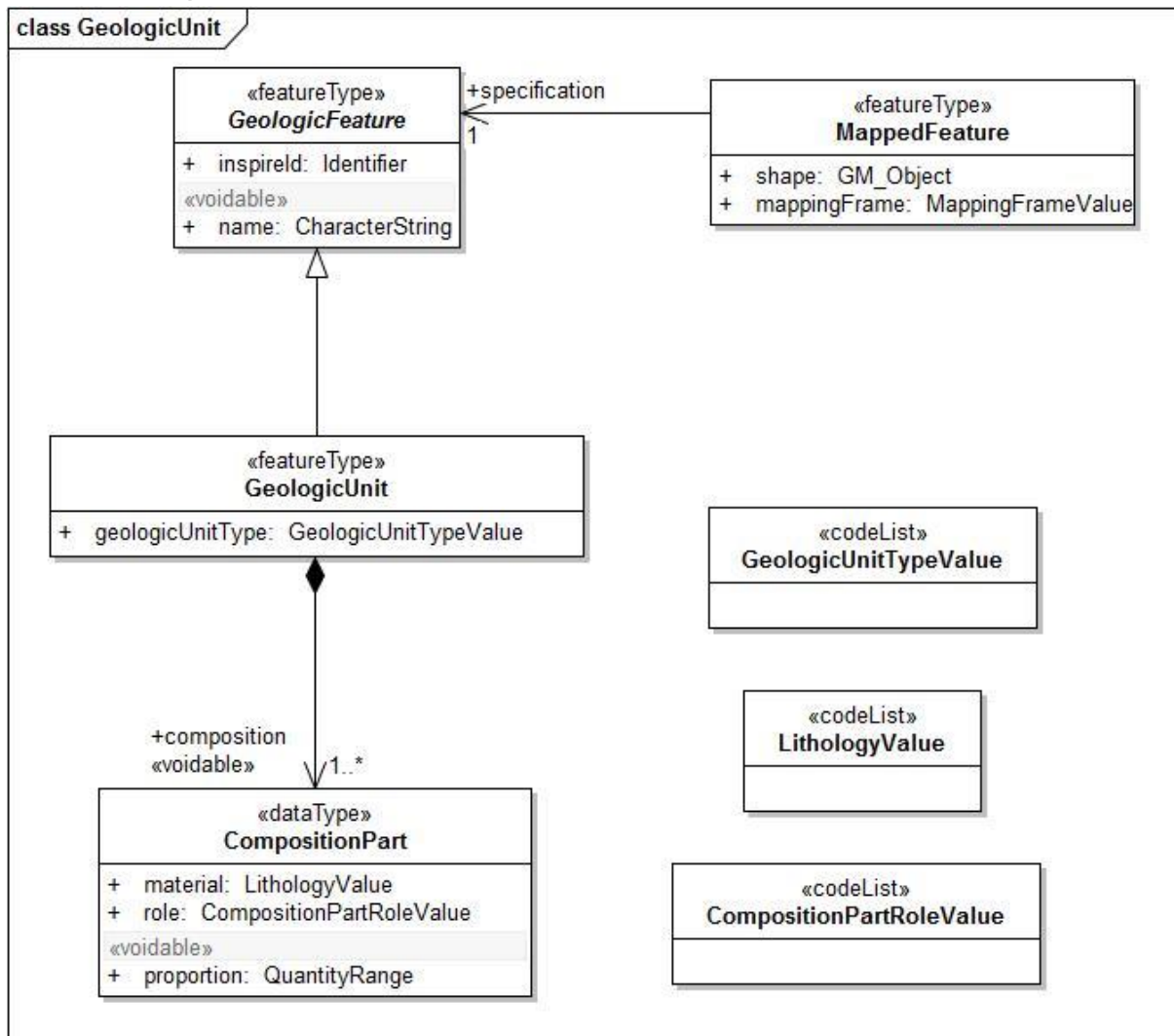


Figure 9: INSPIRE UML class diagram for GeologicUnit

Name: Context Diagram : GeologicUnit
 Package: «Leaf» GeologyBasic
 Version: 4.0
 Author: OGC/CGI GeoSciML SWG

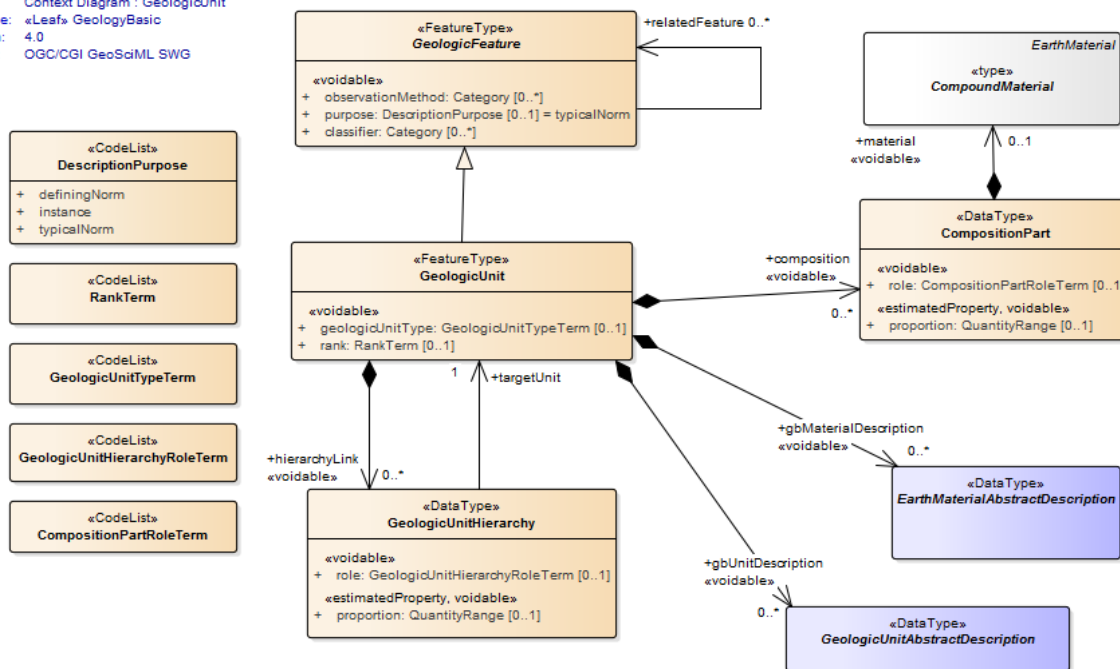


Figure 10: UML context diagram for GeoSciML GeologicUnit

The INSPIRE UML class diagram for GeologicUnit is shown in Figure 9 and the UML of the GeoSciML GeologicUnit package in Figure 10. GeologicUnit is a specialisation of GeologicFeature. In INSPIRE only the geologicUnitType property is required, along with the association to compositionPart, and as can be seen this is modelled in an identical way in GeoSciML.

2.3.1 Geologic Unit – geologic unit type

The only GeologicUnit attribute that is mandatory for INSPIRE is geologicUnitType. This indicates the type of the geologic unit, for example a lithostratigraphic unit or a lithologic unit. Values must be drawn from the GeologicUnitTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue>). If it is provided for a non-INSPIRE OneGeology service the CGI Geologic unit type vocabulary (<http://resource.geosciml.org/vocabulary/cgi/201211/geologicunittype.rdf>) should be used.

2.3.2 Geologic Unit – composition

The composition association from GeologicUnit to CompositionPart provides the means for describing the lithology of the GeologicUnit. In INSPIRE a GeologicUnit must have at least one CompositionPart, but can have several where the GeologicUnit is composed of several different lithologies. For each CompositionPart values for three attributes must be provided: role, material and proportion. The requirements are the same for a OneGeology service.

2.3.3 Composition Part - role

Role defines the relationship of the compositionPart to the GeologicUnit as a whole, e.g. vein, interbedded constituent, layers, dominant constituent. Values should be

drawn from the CompositionPartRoleValue vocabulary (<http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue>). If it is provided for a non-INSPIRE OneGeology service the CGI Geologic unit part role vocabulary (<http://resource.geosciml.org/vocabulary/cgi/201211/geologicunitpartrole.rdf>) should be used.

2.3.4 Composition Part - proportion

The proportion attribute defines the proportion of the GeologicUnit as a whole that the CompositionPart comprises. It is expressed as two fractions giving the upper and lower limits of the range within which the CompositionPart proportion is considered to lie. It can be serialised with an swe:QuantityRange element in both INSPIRE and GeoSciML. However, GeoSciML also provides the gsmlb:GSML_QuantityRange element which can be substituted here. The latter expresses the limits both as a space separated tuple compatible with SWE and in separate elements which enables querying in a WFS. A OneGeology service must use the gsmlb:GSML_QuantityRange element.

```
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange>
<swe:uom code="%" xlink:href="http://unitsofmeasure/ucum.html#para-29"
xlink:title="percent"/>
<swe:value>5.0 50.0</swe:value>
<gsmlb:lowerValue>5.0</gsmlb:lowerValue>
<gsmlb:upperValue>50.0</gsmlb:upperValue>
</gsmlb:GSML_QuantityRange>
</gsmlb:proportion>
```

Figure 11 Example of the encoding of proportion

2.3.5 Composition Part - material

The material attribute provides the lithology of the CompositionPart and is of type LithologyValue (a codelist) in INSPIRE (Figure 9) whereas in GeoSciML it is modelled as a CompoundMaterial (Figure 12). CompoundMaterial is a specialisation of EarthMaterial and the parent class of RockMaterial. The RockMaterial.lithology property is the equivalent of INSPIRE CompositionPart.material.

Name: Context Diagram : RockMaterial
 Package: «Leaf» GeologyBasic
 Version: 4.0
 Author: OGC/CGI GeoSciML SWG

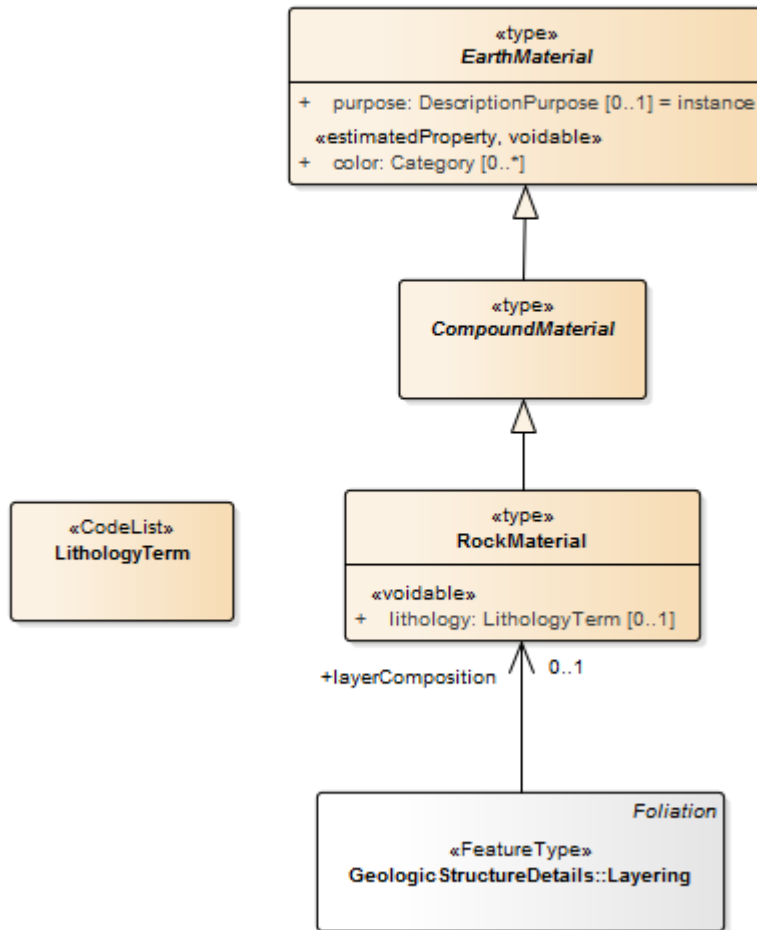


Figure 12: UML context diagram for GeoSciML RockMaterial

2.3.6 Rock Material - lithology

The lithology attribute provides the lithology of the CompositionPart. GeoSciML allows multiple lithologies for each CompositionPart, but in INSPIRE each CompositionPart should be restricted to a single lithology, although, as indicated in section 2.3.2, a GeologicUnit can have multiple CompositionParts. Values for lithology should be drawn from the LithologyValue vocabulary (<http://inspire.ec.europa.eu/codelist/LithologyValue>). This attribute is required for a OneGeology service and the same restriction on having a single lithology per CompositionPart applies. For a non-INSPIRE OneGeology service the CGI Simple lithology vocabulary (<http://resource.geosciml.org/vocabulary/cgi/201211/simplelithology.rdf>) must be used.

2.4 Geologic Structure

GeologicStructure is an abstract specialization of GeologicFeature and in INSPIRE only two types of GeologicStructure are required, ShearDisplacementStructure (faults) and Fold (Figure 13).

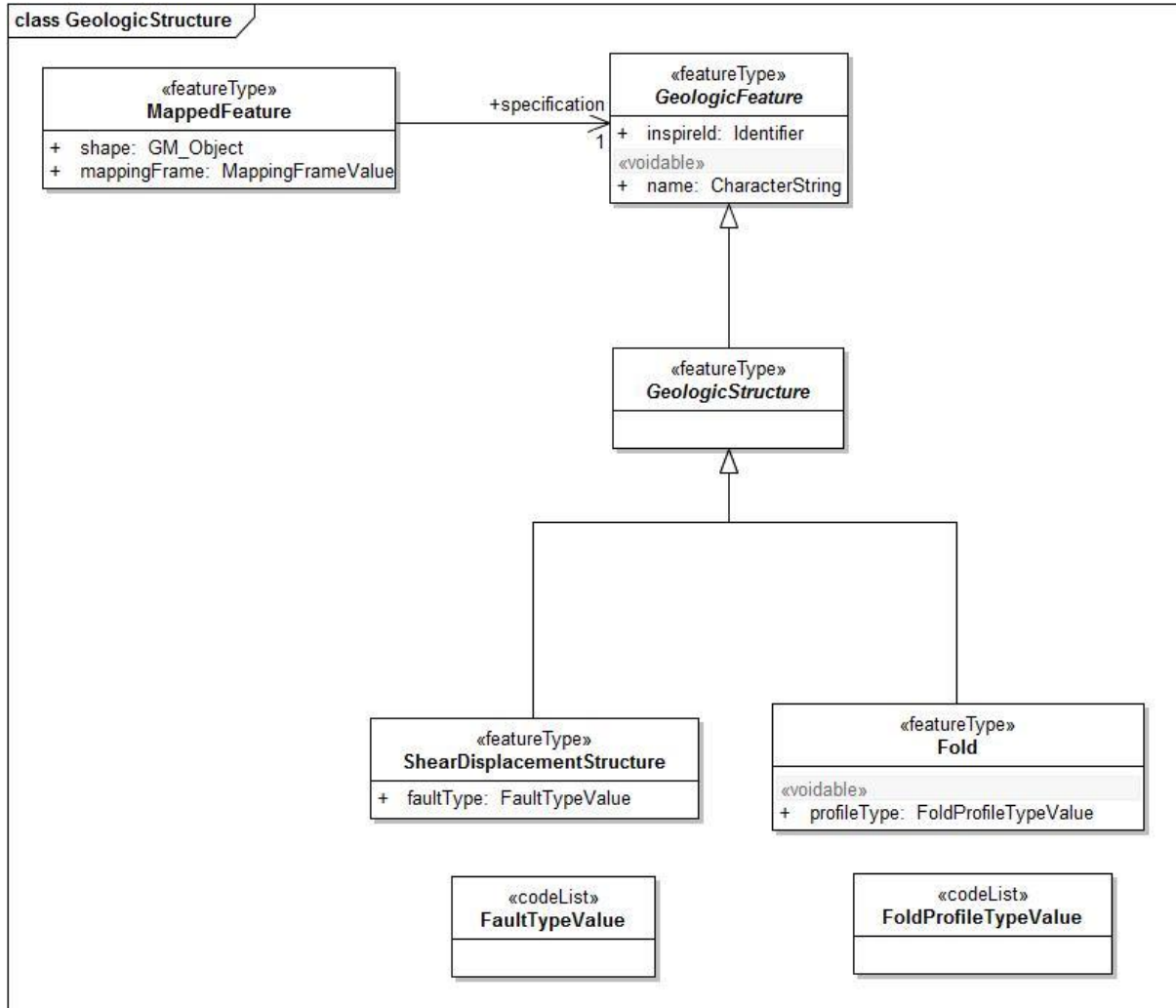


Figure 13: INSPIRE UML class diagram for GeologicStructure

The GeoSciML modelling of ShearDisplacementStructure is shown in Figure 14, and of Fold in Figure 15.

Name: Context Diagram : ShearDisplacementStructure
 Package: «leaf» GeologicStructure
 Version: 4.0
 Author: OGC/CGI GeoSciML SWG

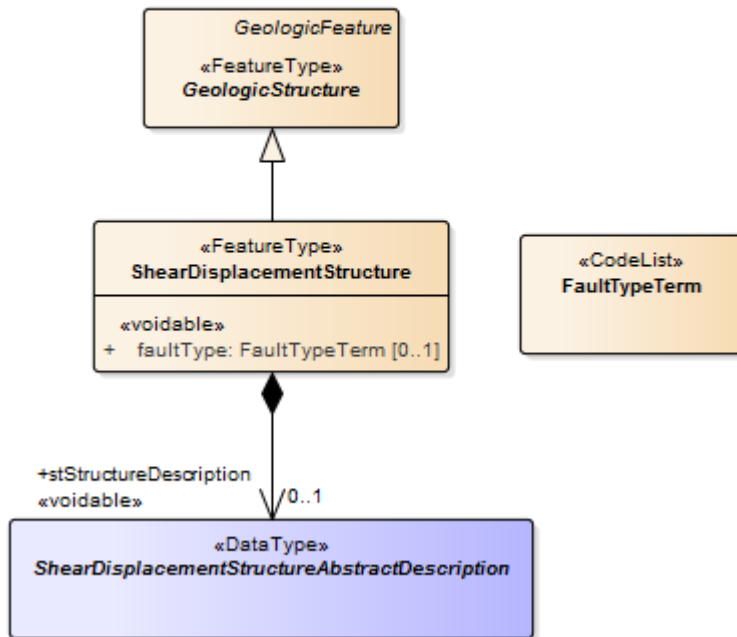


Figure 14: UML context diagram for GeoSciML ShearDisplacementStructure

Name: Context Diagram : Fold
 Package: «leaf» GeologicStructure
 Version: 4.0
 Author: OGC/CGI GeoSciML SWG

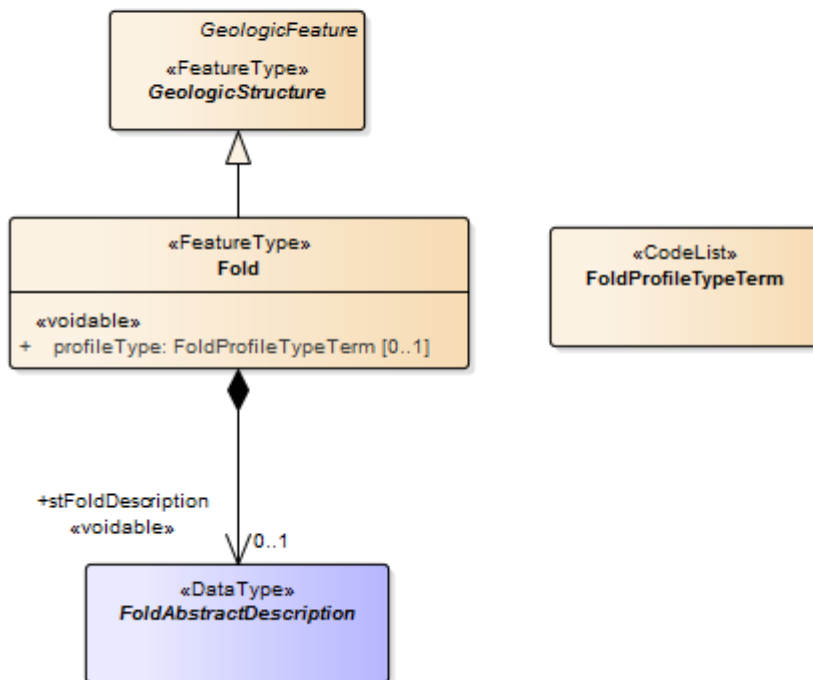


Figure 15: UML context diagram for GeoSciML Fold

As can be seen in Figure 13, the only properties required by INSPIRE are faultType for ShearDisplacementStructure, and profileType for Fold.

2.4.1 Shear Displacement Structure - faultType

The faultType property describes the type of ShearDisplacementStructure and should be populated with a value drawn from the FaultTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/FaultTypeValue>).

2.4.2 Fold - profileType

The profileType property describes the type of fold defined according to its geometry and the younging direction of the strata. It should be populated using values from the FoldProfileTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/FoldProfileTypeValue>).

2.5 Geomorphologic Feature

Figure 16 shows the INSPIRE UML class diagram for geomorphology, and Figure 17 the equivalent GeoSciML modeling. As can be seen these are modeled in an identical way. GeomorphologicFeature is an abstract specialization of GeologicFeature with two sub-types, AnthropogenicGeomorphologicFeature and NaturalGeomorphologicFeature.

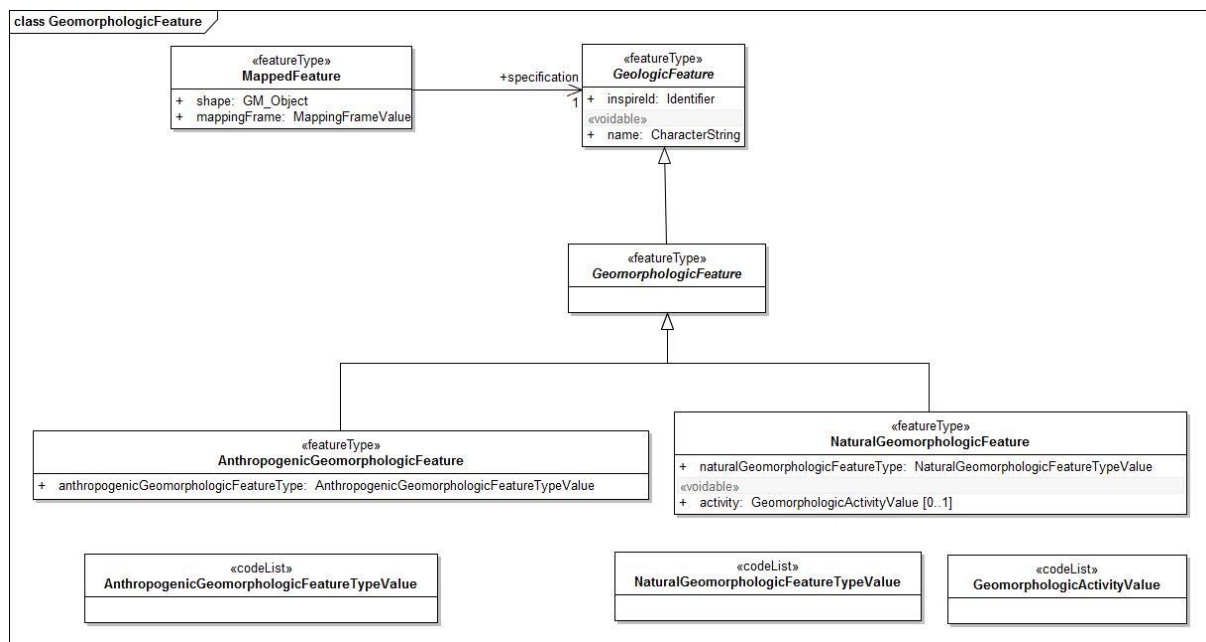


Figure 16: INSPIRE UML class diagram for GeomorphologicFeature

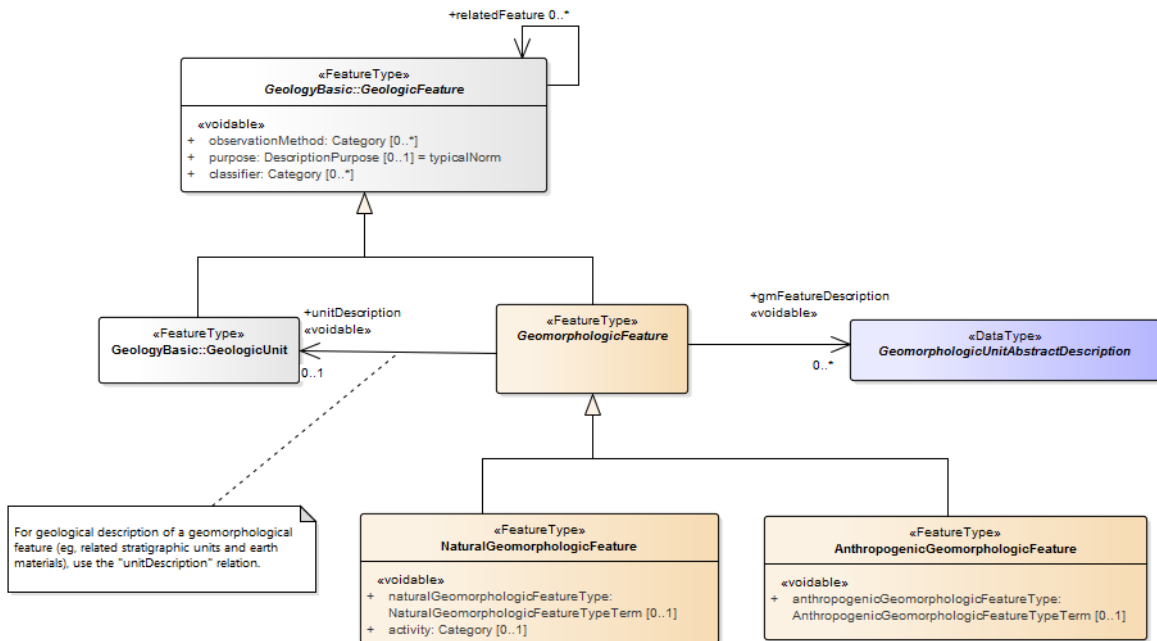


Figure 17: UML context diagram for GeoSciML GeomorphologicFeature

2.5.1 Natural Geomorphologic Feature - NaturalGeomorphologicFeatureType

The NaturalGeomorphologicFeatureType property describes the type of NaturalGeomorphologicFeature and should be populated with a value drawn from the NaturalGeomorphologicFeatureTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/NaturalGeomorphologicFeatureTypeValue>).

2.5.2 Natural Geomorphologic Feature – activity

The activity property describes the level of activity of a NaturalGeomorphologicFeature and should be populated with a value from the GeomorphologicActivityValue vocabulary (<http://inspire.ec.europa.eu/codelist/GeomorphologicActivityValue>).

2.5.3 Anthropogenic Geomorphologic Feature – AnthropogenicGeomorphologicFeatureType

The AnthropogenicGeomorphologicFeatureType property describes the type of AnthropogenicGeomorphologicFeature and should be populated with a value drawn from the AnthropogenicGeomorphologicFeatureTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/AnthropogenicGeomorphologicFeatureTypeValue>).

2.6 Thematic Class

The INSPIRE Thematic Class datatype (Figure 2) is designed to enable information on thematic maps to be delivered. Thematic maps commonly take a standard geological map and reclassify it using some vocabulary of concepts, for example a standard lithostratigraphic map might be reclassified into ‘engineering geology units’

based on various generalized physical properties of the lithostratigraphic units. This doesn't involve any new mapping, although it may lead to units being merged together.

There is no standard for thematic maps and therefore each data provider must provide their own vocabulary for classifying a particular map for a particular theme.

2.6.1 Geologic Feature – classifier

There is no direct equivalent of Thematic Class in GeoSciML but it can nevertheless be encoded in GeoSciML using the classifier association from GeologicFeature to ControlledConcept (Figure 3). This provides the URI of the relevant value in the thematic classification vocabulary being used.

```
<gsmlb:GeologicUnit gml:id="INV-SDSM">
  <gml:identifier
    codeSpace="http://data.bgs.ac.uk/">http://data.bgs.ac.uk/id/Lexicon/NamedRockUnit/INV</gml:identifier>
  <gml:name>INVERCLYDE GROUP</gml:name>
  <gsmlb:geologicHistory> [37 lines]
  <!-- -->
  <!-- Example of a thematic classification of a GeologicUnit -->
  <!-- -->
  <gsmlb:classifier
    xlink:href="http://data.bgs.ac.uk/ref/EngineeringGeologyTheme/strongSandstone"
    xlink:title="Engineering Geology theme: Strong Sandstone"/>
```

Figure 18: Example of encoding a GeologicUnit with a thematic classifier

2.7 Borehole

The INSPIRE UML class diagram for Borehole is shown in 19 and the UML of the GeoSciML Borehole package in Figure 20. Although the modelling of boreholes in GeoSciML is more complex it includes everything required for INSPIRE which can therefore be encoded with GeoSciML. One of the main differences is that in GeoSciML Borehole is modelled as a type of SamplingCurve, drawn from the OGC Observations & Measurements model.

The logElement association from Borehole to BoreholeInterval is the means by which the borehole log is encoded. There should be one BoreholeInterval (logElement) for every discrete unit described down the borehole. A borehole encoded as a series of logElements can be seen as a 'vertical geological map' with each BoreholeInterval specified by a GeologicFeature in the same way as polygons on the map. It is also possible in GeoSciML to encode the borehole as a series of observations, using the OGC Observations & Measurements model, but as this isn't a requirement for INSPIRE it won't be described further here.

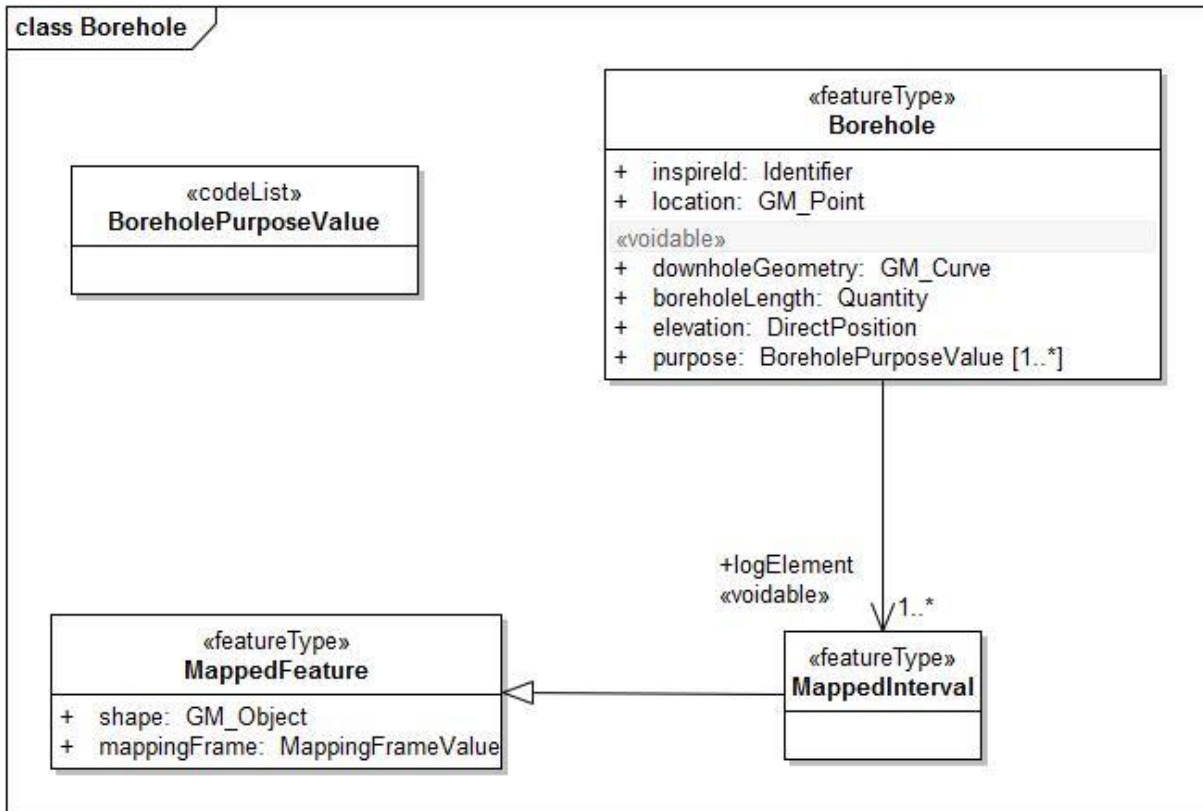


Figure 19: INSPIRE UML class diagram for Borehole

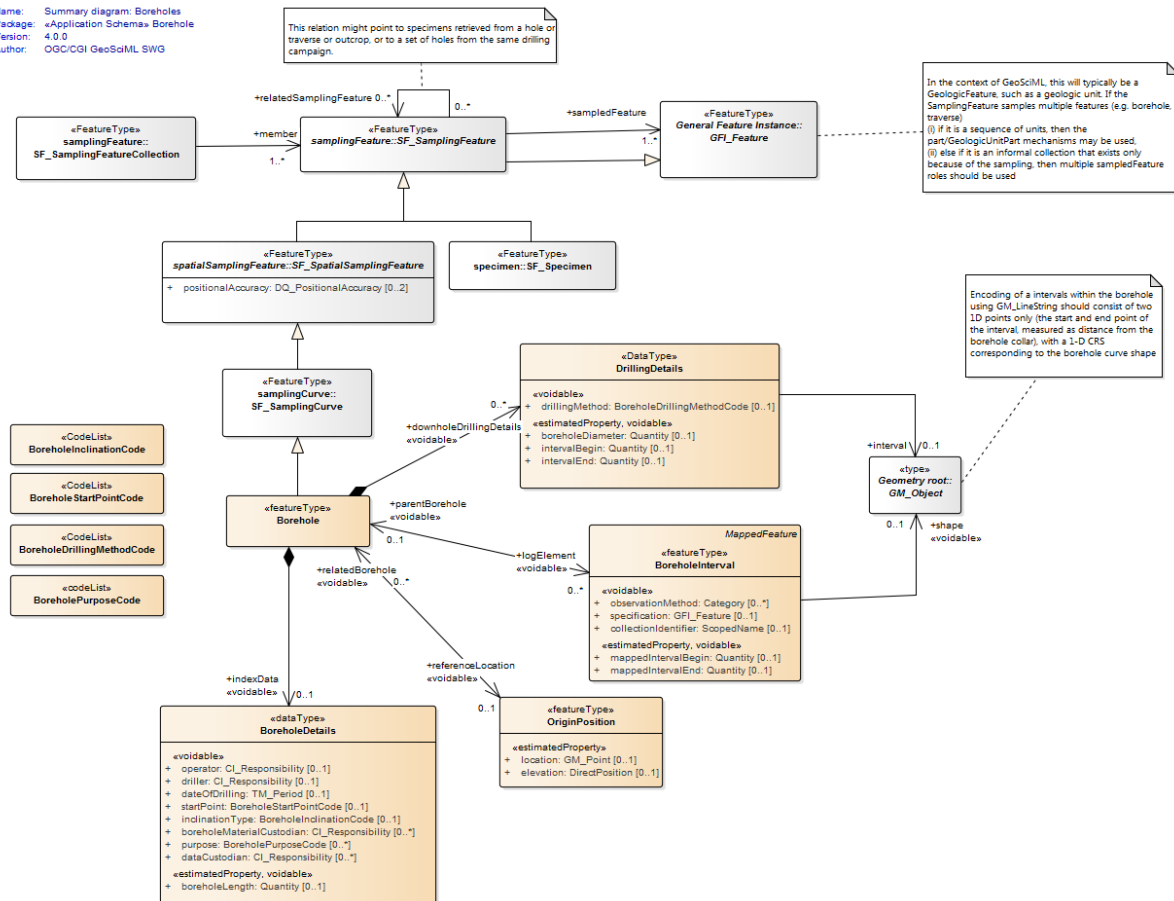


Figure 20: UML for the GeoSciML Borehole package

2.7.1 Borehole – inspireId

The INSPIRE inspireId property is of type Identifier and provides the persistent identifier used for the borehole by the data provider. In GeoSciML this should be encoded using gml:identifier which requires both the identifier value, equivalent to Identifier.localId, and the codespace, equivalent to Identifier.namespace, identifying the data source (Figure 6).

2.7.2 Borehole – sampledFeature

This property isn't required by INSPIRE but is mandatory for SamplingFeature and thus Borehole in GeoSciML. In a typical borehole being encoded the sampledFeatures will be the features, such as GeologicUnits, which the borehole penetrates and which specify the log elements (see section 2.7.9). There should be one sampledFeature encoded for each distinct feature sampled by the borehole. The positions where these features are intersected by the borehole may be described in the log. Each feature only needs to be described fully once and then can be referenced with an internal xlink:href using the gml:id value of the feature. No extra information is therefore required to encode this property.

2.7.3 Borehole – downholeGeometry

This should be encoded using the SF_SpatialSamplingFeature shape association to GM_Object to provide a LineString with the 3D geometry of the borehole (Figure 21).

Where the borehole is vertical the X and Y co-ordinates will be the same for all positions. The LineString should be given an identifier using gml:id for use in referencing the log elements (section 2.7.8)

```
<sams:shape>
  <gml:LineString gml:id="bh.ns94se5.shape" srsName="urn:ogc:def:crs:EPSG:6.15:7405">
    <gml:posList srsDimension="3" count="7">-30.7111 134.2059 321. -30.7112 134.2058 315.
      -30.7113 134.2057 303. -30.7114 134.2056 296.
      -30.7115 134.2055 272. -30.7116 134.2054 271.
      -30.7117 134.2053 270.</gml:posList>
    </gml:LineString>
  </sams:shape>
```

Figure 21: Example of encoding the downhole geometry of a borehole

2.7.4 Borehole – location and elevation

The referenceLocation association from borehole to OriginPosition allows the encoding of both location and elevation. Location should be encoded as a two dimensional point and elevation as a one dimensional value (Figure 22).

```
<gsmlbh:referenceLocation>
  <gsmlbh:OriginPosition gml:id="op1">
    <gsmlbh:location>
      <gml:Point gml:id="pt1" srsName="urn:ogc:def:crs:EPSG:6.15:27700" srsDimension="2">
        <gml:pos>-30.7 134.2</gml:pos>
      </gml:Point>
    </gsmlbh:location>
    <gsmlbh:elevation srsName="urn:ogc:def:crs:EPSG:6.15:5701" srsDimension="1"
      >321.0</gsmlbh:elevation>
  </gsmlbh:OriginPosition>
</gsmlbh:referenceLocation>
```

Figure 22: Example of encoding the location and elevation of a borehole

2.7.5 Borehole – purpose

The purpose property describes the purpose for which the Borehole was drilled and should be populated with a value from the BoreholePurposeValue vocabulary (<http://inspire.ec.europa.eu/codelist/BoreholePurposeValue>). In GeoSciML this property is inside indexData/BoreholeDetails.

2.7.6 Borehole – boreholeLength

The boreholeLength records the total length down the borehole and should be encoded as a Quantity value, which requires the units of measurement to be recorded along with the value (Figure 23). The unit of measure should reference the URI of an OGC definition. Again this is found inside the indexData/BoreholeDetails element.


```

<gsmlbh:indexData>
  <gsmlbh:BoreholeDetails>
    <gsmlbh:purpose
      xlink:href="http://inspire.ec.europa.eu/codelist/BoreholePurposeValue/geologicalSurvey"
      xlink:title="geological Survey"/>
    <gsmlbh:boreholeLength>
      <swe:Quantity>
        <swe:uom code="m" xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
          xlink:title="metre"/>
        <swe:value>51.0</swe:value>
      </swe:Quantity>
    </gsmlbh:boreholeLength>
  </gsmlbh:BoreholeDetails>
</gsmlbh:indexData>

```

Figure 23: Example of encoding the purpose and boreholeLength

2.7.7 Borehole Interval - mappingFrame

The BoreholeInterval in GeoSciML v4 does not have a mappingFrame / samplingFrame property as this will always be the borehole to which it belongs. Thus, although in the INSPIRE geology theme Schema the property is encoded by referencing the gml:id of the borehole, for GeoSciML nothing needs specifying explicitly.

2.7.8 Borehole Interval – geometry (shape)

The geometry of the BoreholeInterval is the one dimensional linear segment down the borehole that the BoreholeInterval refers to. The reference system is the geometry of the borehole, which can be referenced using the gml:id of the borehole shape property (Figure 21). An example of encoding BoreholeInterval geometry is given in Figure 24.

```

<gsmlbh:shape>
  <gml:LineString gml:id="ls1" srsName="#bh.ns94se5.shape">
    <gml:posList srsDimension="1" count="2">0.0 2.0</gml:posList>
  </gml:LineString>
</gsmlbh:shape>

```

Figure 24: Example of encoding BoreholeInterval geometry

2.7.9 Borehole Interval – specification

A BoreholeInterval is specified by a GeologicFeature in exactly the same way as described in section 2.1 for MappedFeature. The encoding of a GeologicFeature specifying a MappedInterval is therefore identical to that described above for MappedFeatures and won't be repeated here.

2.7.10 Borehole Interval – mappedIntervalBegin & mappedIntervalEnd

The mappedIntervalBegin and mappedIntervalEnd properties hold the one dimensional co-ordinates of the start and end of the mappedInterval, as measured down the borehole, encoded as Quantity values (Figure 25). This information duplicates that held in the shape property, but queries such as 'find all

MappedIntervals within 10m of the surface' are difficult to implement with current technology using the shape property and the mappedIntervalBegin and mappedIntervalEnd properties have been introduced to address this problem.

```

<gsmlbh:mappedIntervalBegin>
  <swe:Quantity>
    <swe:uom code="m" xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>0.0</swe:value>
  </swe:Quantity>
</gsmlbh:mappedIntervalBegin>
<gsmlbh:mappedIntervalEnd>
  <swe:Quantity>
    <swe:uom code="m" xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>2.0</swe:value>
  </swe:Quantity>
</gsmlbh:mappedIntervalEnd>

```

Figure 25: Example of encoding mappedIntervalBegin and mappedIntervalEnd

2.8 Geologic Collection

The GeologicCollection in INSPIRE is designed to enable features which comprise a higher level object, such as a geological map or a borehole exploration programme, to be grouped together. This enables information such as metadata to be provided for the collection of features as a whole. It is not necessary to use a GeologicCollection where features do not form part of such a higher level object. The INSPIRE UML class diagram for GeologicCollection is shown in Figure 26.

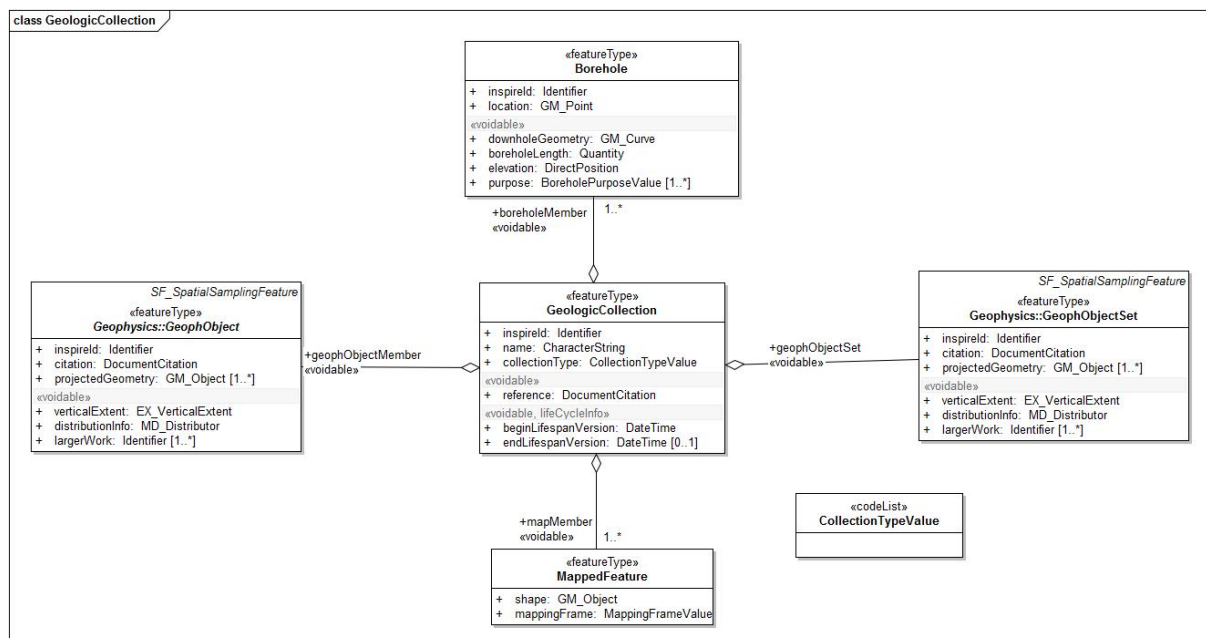


Figure 26: INSPIRE UML class diagram for GeologicCollection

In GeoSciML collections are modelled with the GSML feature (Figure 28).

Where features are not part of a GSML collection each individual feature is a member of a wfs:FeatureCollection. GSML is a GML feature so where a GSML collection is being delivered it is the GSML collection which is a member of the wfs:FeatureCollection and individual features are members of the GSML collection (Figure 27).

```

<wfs:member>
  <gsmlb:GSML gml:id="col1">
    <gml:metaDataProperty> [81 lines]
    <gml:identifier codeSpace="http://data.bgs.ac.uk">http://data.bgs.ac.uk/id/625KGeologyMap</gml:identifier>
    <gml:name>BGS 1:625 000 Digital Geological Map</gml:name>
    <gsmlb:collectionType
      xlink:href="http://inspire.ec.europa.eu/codelist/CollectionTypeValue/geologicalMap"
      xlink:title="geological map"/>
    <gsmlb:member>
      <gsmlb:MappedFeature gml:id="mf.16">
        ...
  
```

Figure 27: Example of encoding a GSML collection as a member of a wfs:FeatureCollection and a MappedFeature as a member of the GSML collection

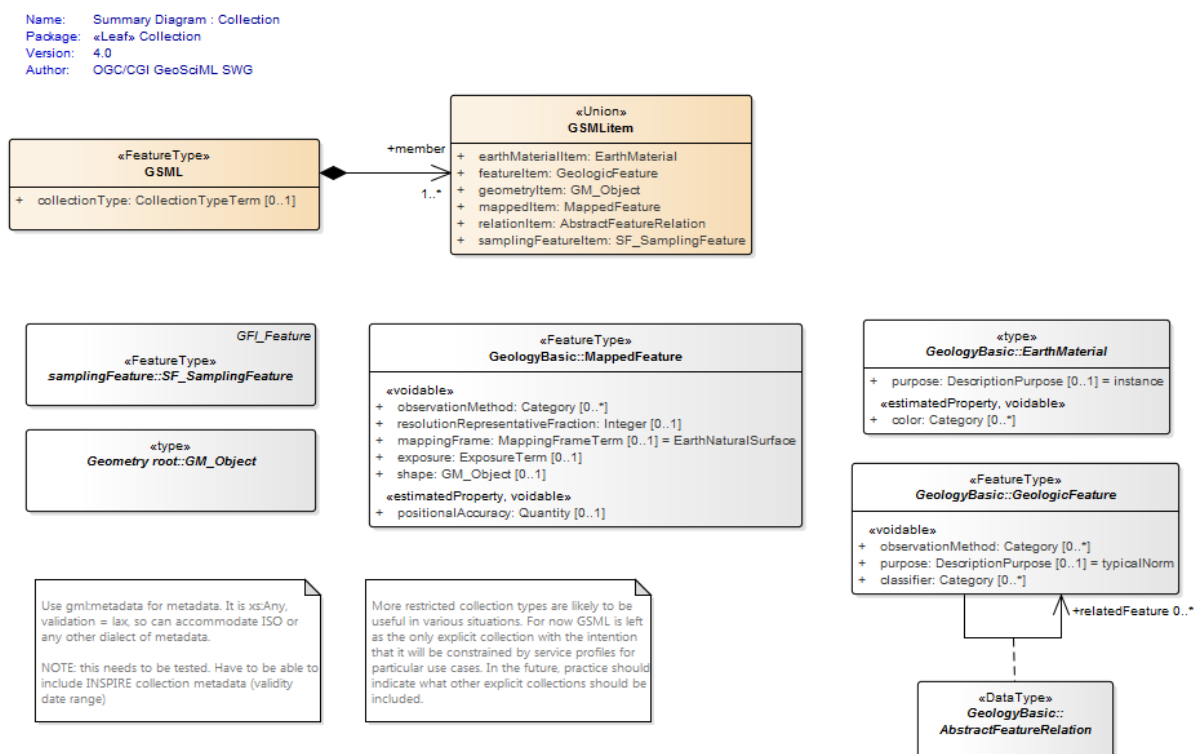


Figure 28: UML class diagram for GeoSciML Collection package

The INSPIRE reference, beginLifespanVersion and endLifespanVersion properties can all be implemented in GeoSciML using the standard gml:metaDataProperty to contain elements from the ISO 19139 metadata schema. The use of MD_Metadata also requires certain other mandatory properties to be encoded which are not required by the INSPIRE data specification.

2.8.1 Geologic Collection – inspireId

The INSPIRE inspireId property is of type Identifier and provides the persistent identifier used for the GeologicCollection by the data provider. In GeoSciML this should be encoded using gml:identifier which requires both the identifier value, equivalent to Identifier.localId, and the codespace, equivalent to Identifier.namespace, identifying the data source (Figure 28).

2.8.2 Geologic Collection – name

The INSPIRE name property provides the name of the GeologicCollection. It should be encoded using gml:name (Figure 28).

2.8.3 Geologic Collection – collectionType

The collectionType property describes the type of collection and should be populated with a value from the CollectionTypeValue vocabulary (<http://inspire.ec.europa.eu/codelist/CollectionTypeValue>) (Figure 28).

2.8.4 Geologic Collection – member

In INSPIRE there are four types of feature which can be members of a GeologicCollection: MappedFeature; Borehole; GeophObject; and GeophObjectSet (Figure 26). GeophObject and GeophObjectSet are features in the geophysics application schema and won't be discussed further here. In GeoSciML the member association from GSML to GSMLItem allows the members of a GSML collection to be any of the types in the GSMLItem union class. The types of member of an INSPIRE GeologicCollection can be mapped to these: MappedFeature maps to mappedItem and Borehole to samplingFeatureItem (Figure 28). Figure 27 shows the encoding of a MappedFeature as a member of a GSML collection.

2.8.5 MD_Metadata - contact

Although the MD_Metadata contact property is not required by INSPIRE it is mandatory for MD_Metadata. It identifies the organisation providing the metadata and its role with respect to the metadata. It is of type CI_ResponsibleParty which requires the encoding of the organisationName and role properties, the latter with values drawn from the CI_RoleCode vocabulary (http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode). Figure 29 gives an example of the encoding of contact.

```
<gmd:contact>
  <gmd:CI_ResponsibleParty>
    <gmd:organisationName>
      <gco:CharacterString>British Geological Survey (BGS)</gco:CharacterString>
    </gmd:organisationName>
    <gmd:role>
      <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode"
        codeListValue="owner">owner</gmd:CI_RoleCode>
    </gmd:role>
  </gmd:CI_ResponsibleParty>
</gmd:contact>
```

Figure 29: Example of encoding MD_Metadata.contact

2.8.6 MD_Metadata - dateStamp

Although the MD_Metadata dateStamp property is not required by INSPIRE it is mandatory for MD_Metadata. It provides the date when the metadata was created and should follow the format defined in ISO8601. An example of encoding dateStamp is given in Figure 30.

```
<gmd:dateStamp>
  <gco:Date>2011-03-08</gco:Date>
</gmd:dateStamp>
```

Figure 30: Example of encoding MD_Metadata.dateStamp

2.8.7 Geologic Collection - reference

The reference property is of type DocumentCitation which requires the provision of a name, shortName, date and link (URL). The first three of these properties can be encoded using the MD_DataIdentification.citation property which is of type CI_Citation.

2.8.7.1 Document Citation – name

The DocumentCitation.name property can be encoded with CI_Citation.title (Figure 31). This property duplicates the information encoded in gml:name (section 2.8.2).

2.8.7.2 Document Citation – shortName

The DocumentCitation.shortName property can be encoded with CI_Citation.alternateTitle (Figure 31). This property is optional in INSPIRE and should be used where the GeologicCollection has a well recognised short name.

2.8.7.3 Document Citation – date

The DocumentCitation.date refers to the date cited in the reference, such as publication date or revision date. It can be encoded with CI_Citation.date (Figure 31) which is of type CI_Date requiring both the date and the dateType to be provided. The dateType property identifies what the date is referring to and should be encoded using a value drawn from the CI_DateTypeCode vocabulary (http://www.isotc211.org/2005/resources/Codelist/gmxCodellists.xml#CI_DateTypeCode).

```
<gmd:CI_Citation>
  <gmd:title>
    <gco:CharacterString>BGS 1:625 000 Digital Geological Map</gco:CharacterString>
  </gmd:title>
  <gmd:alternateTitle>
    <gco:CharacterString>BGS 625k Map</gco:CharacterString>
  </gmd:alternateTitle>
  <gmd:date>
    <gmd:CI_Date>
      <gmd:date>
        <gco:Date>2008</gco:Date>
      </gmd:date>
      <gmd:dateType>
        <gmd:CI_DateTypeCode
```

codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodellists.xml#CI_DateTypeCode"

```

        codeListValue="revision">revision</gmd:CI_DateTypeCode>
    </gmd:dateType>
</gmd:CI_Date>
</gmd:date>
<gmd:date>
</gmd:CI_Citation>

```

Figure 31: Example of encoding DocumentCitation using CI_Citation

2.8.7.4 Document Citation – link

The DocumentCitation.link property is defined as providing an online link to the document (not to the citation of the document), and so should provide the URL of the GeologicCollection. This can be encoded using the MD_Metadata.dataSetURI property (Figure 32). However in the revised version of ISO19115 this property will be deprecated and a new property, MD_DigitalTransferOptions.online, should be used.

```

<gmd:dataSetURI>
  <gco:CharacterString>http://www.bgs.ac.uk/products/digitalmaps/digmapgb_625.html</gco:CharacterString>
</gmd:dataSetURI>

```

Figure 32: Example of encoding DocumentCitation.link using MD_Metadata.dataSetURI

2.8.8 Geologic Collection – beginLifespanVersion & endLifespanVersion

The beginLifespanVersion and endLifespanVersion properties can both be encoded using the CI_Citation.date property (section 2.8.7.3), but with different values for the dateType property. The date should be encoded using the format defined in ISO8601. In the revised version of ISO19115 the CI_DateTypeCode vocabulary has been significantly extended and beginLifespanVersion should have a dateType code value of validityBegins and endLifespanVersion should have a dateType code value of validityEnds (Figure 33). The endLifespanVersion property should not be encoded if the GeologicCollection is still valid.

```

    <gmd:date>
      <gmd:CI_Date>
        <gmd:date>
          <gco:Date>2008</gco:Date>
        </gmd:date>
        <gmd:dateType>
          <gmd:CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodellists.xml#CI_DateTypeCode"
            codeListValue="validityBegins">validityBegins</gmd:CI_DateTypeCode>
          </gmd:dateType>
        </gmd:CI_Date>
      </gmd:date>
    <gmd:date>
      <gmd:CI_Date>
        <gmd:date>
          <gco:Date>2013</gco:Date>
        </gmd:date>
        <gmd:dateType>
          <gmd:CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodellists.xml#CI_DateTypeCode"
            codeListValue="validityEnds">validityEnds</gmd:CI_DateTypeCode>
          </gmd:dateType>
        </gmd:CI_Date>
      </gmd:date>
    </gmd:CI_Citation>

```

```

    </gmd:dateType>
  </gmd:CI_Date>
</gmd:date>

```

Figure 33: Example of encoding beginLifespanVersion and endLifespanVersion using CI_Citation.date

2.8.9 MD_DataIdentification - abstract

Although the MD_DataIdentification abstract property is not required by INSPIRE it is mandatory for MD_DataIdentification. It should be populated with a text description of the GeologicCollection (Figure 34).

2.8.10 MD_DataIdentification – language

Although the MD_DataIdentification language property is not required by INSPIRE it is mandatory for MD_DataIdentification. It identifies the language(s) used in the GeologicCollection and should be encoded using the language codes defined in ISO639-2 (Figure 34).

2.8.11 MD_DataIdentification – topicCategory

Although the MD_DataIdentification topicCategory property is not required by INSPIRE it is mandatory for MD_DataIdentification where the metadata is referring to a dataset. A GeologicCollection can be considered a dataset. MD_DataIdentification topicCategory should be populated with a value from the MD_TopicCategory_Code vocabulary

(http://www.isotc211.org/2005/resources/Codelist/gmxCodetlists.xml#MD_TopicCategoryCode) (Figure 34).

```

<gmd:abstract>
  <gco:CharacterString>The data shows polygonal and selected linear geological information, sourced
  from published BGS 1:625 000 scale maps of Great Britain. However, geological units are identified
  using the most up-to-date nomenclature that may differ from that on the printed maps. The maps are
  generally based on published material at 1:50 000 scale and compiled using techniques of selection,
  generalisation and exaggeration. The geology is fitted to a relevant topographic base at the time
  of production. Full UK coverage is available. The data is available in vector format. BGS licensing
  terms and conditions apply to external use of the data. The data can be used free of charge for
  non commercial use and is downloadable from the website.</gco:CharacterString>
</gmd:abstract>
<gmd:language>
  <gco:CharacterString>eng</gco:CharacterString>
</gmd:language>
<gmd:topicCategory>
  <gmd:MD_TopicCategoryCode>geoscientificInformation</gmd:MD_TopicCategoryCode>
</gmd:topicCategory>

```

Figure 34: Example of encoding MD_Identification.abstract, MD_Identification.language and MD_Identification.topicCategory

3 OneGeology-Global querying

The OneGeology-Global portal at present implements three queries which will be briefly explained here: spatial, lithology and age. These queries can be combined so as to select, for example, all those MappedFeatures of a particular age and lithology within a specified area. The purpose of the queries is to enable the delivery of just a

sub-set of the data provided by the service, to more closely meet the requirements of the user.

3.1 Spatial querying

Spatial querying is possible using a defined rectangle. In the query (Figure 35) the BBOX operator is used to filter for all those MappedFeatures where the geometry given by the shape attribute (section 2.1.2) lies within a rectangle defined by upper and lower corner points.

```
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd
http://www.opengis.net/gml/3.2 http://schemas.opengis.net/gml/3.2.1/gml.xsd"
xmlns:wfs="http://www.opengis.net/wfs/2.0"
xmlns:fes="http://www.opengis.net/fes/2.0"
xmlns:gsmbl="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
xmlns:gml="http://www.opengis.net/gml/3.2"
service="WFS" version="2.0.0" count="100">
<wfs:Query typeName="gsmbl:MappedFeature">
<fes:Filter>
<fes:BBOX>
<fes:ValueReference>gsmbl:shape</fes:ValueReference>
<gml:Envelope srsName="urn:ogc:def:crs:EPSG::4326">
<gml:lowerCorner>56.08643859340388 -4.0004826736994445</gml:lowerCorner>
<gml:upperCorner>56.165510496146474 -3.8381055732299343</gml:upperCorner>
</gml:Envelope>
</fes:BBOX>
</fes:Filter>
</wfs:Query>
</wfs:GetFeature>
```

Figure 35: Example of a spatial query using a rectangle

3.2 Lithology querying

The first lithology query (Figure 36) filters on the lithology attribute (section 2.3.6), looking for an exact match with the specified value. Note that the portal client by default adds any child concepts for lithologies you select to the query so in this example, where limestone was selected, the sub-types of limestone (chalk and travertine) are also included in the query. As explained in section 2.3.2 a GeologicUnit can have multiple CompositionParts describing the different lithological components of the GeologicUnit. This lithology query takes no account of the proportion attribute and will retrieve GeologicUnits where any CompositionPart is of the specified lithology, not just those where the specified lithology is predominant.

```
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd"
xmlns:wfs="http://www.opengis.net/wfs/2.0"
xmlns:fes="http://www.opengis.net/fes/2.0"
xmlns:gsmbl="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
xmlns:xlink="http://www.w3.org/1999/xlink"
service="WFS" version="2.0.0" count="100">
<wfs:Query typeName="gsmbl:MappedFeature">
<fes:Filter>
<fes:Or>
```



```

<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmlb:specification/gsmlb:GeologicUnit/gsmlb:composition/gsmlb:CompositionPart/gsmlb:material/g
smlb:RockMaterial/gsmlb:lithology/@xlink:href</fes:ValueReference>
  <fes:Literal>http://resource.geosciml.org/classifier/cgi/lithology/limestone</fes:Literal>
</fes:PropertyIsEqualTo>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmlb:specification/gsmlb:GeologicUnit/gsmlb:composition/gsmlb:CompositionPart/gsmlb:material/g
smlb:RockMaterial/gsmlb:lithology/@xlink:href</fes:ValueReference>
  <fes:Literal>http://resource.geosciml.org/classifier/cgi/lithology/chalk</fes:Literal>
</fes:PropertyIsEqualTo>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmlb:specification/gsmlb:GeologicUnit/gsmlb:composition/gsmlb:CompositionPart/gsmlb:material/g
smlb:RockMaterial/gsmlb:lithology/@xlink:href</fes:ValueReference>
  <fes:Literal>http://resource.geosciml.org/classifier/cgi/lithology/travertine</fes:Literal>
</fes:PropertyIsEqualTo>
</fes:Or>
</fes:Filter>
</wfs:Query>
</wfs:GetFeature>

```

Figure 36: Example of a lithology query

In addition there is a query on a single lithology only which will take into account the proportion attribute and allow you to restrict the returned features to those where the requested lithology has a proportion range with lower bound at least as large as some user specified value (Figure 37). This allows you not to retrieve features where the specified lithology is only present in minor amounts.

```

<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd"
xmlns:wfs="http://www.opengis.net/wfs/2.0" xmlns:fes="http://www.opengis.net/fes/2.0"
xmlns:gsmlb="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
xmlns:xlink="http://www.w3.org/1999/xlink" service="WFS" version="2.0.0" count="100">
<wfs:Query typeName="gsmlb:MappedFeature">
<fes:Filter>
<fes:PropertyIsGreaterThanOrEqualTo>

<fes:ValueReference>gsmlb:specification/gsmlb:GeologicUnit/gsmlb:composition/gsmlb:CompositionPart[gsmlb:material/g
smlb:RockMaterial/gsmlb:lithology/@xlink:href =
'http://resource.geosciml.org/classifier/cgi/lithology/clastic_mudstone']/gsmlb:proportion/gsmlb:GSML_QuantityRange/gsm
lb:lowerValue</fes:ValueReference>
  <fes:Literal>50</fes:Literal>
</fes:PropertyIsGreaterThanOrEqualTo>
</fes:Filter>
</wfs:Query>
</wfs:GetFeature>

```

Figure 37 Example of a lithology query conditional on proportion

3.3 Age querying

The age query (Figure 38) filters on the olderNamedAge attribute (section 2.2.2), looking for an exact match with the specified value. This means that only GeologicUnits the upper boundary of which lies with the specified geochronologic

unit will be retrieved, not those which encompass the geochronologic unit or have their lower boundary within it. Note that the portal client by default adds any child named ages to the query so, in the example given in Figure 38 where the Pliocene epoch was selected, the Piacenzian and Zanclean stages are also included in the query, so a GeologicUnit with its upper boundary in either of these geochronologic units would be retrieved. The query does not look at any properties of GeologicEvent to determine if the event is that which formed the GeologicUnit and it would therefore retrieve any GeologicEvent matching the age criteria. Only the GeologicEvent responsible for the formation of the GeologicUnit should therefore be provided in the OneGeology-Global service.

```
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd"
xmlns:wfs="http://www.opengis.net/wfs/2.0"
xmlns:fes="http://www.opengis.net/fes/2.0"
xmlns:gsmblb="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
xmlns:xlink="http://www.w3.org/1999/xlink"
service="WFS" version="2.0.0" count="100">
<wfs:Query typeName="gsmblb:MappedFeature">
<fes:Filter>
<fes:Or>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmblb:specification/gsmblb:GeologicUnit/gsmblb:geologicHistory/gsmblb:GeologicEvent/gsmblb:younger
NamedAge/@xlink:href</fes:ValueReference>
<fes:Literal>http://resource.geosciml.org/classifier/ics/ischart/LowerDevonian</fes:Literal>
</fes:PropertyIsEqualTo>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmblb:specification/gsmblb:GeologicUnit/gsmblb:geologicHistory/gsmblb:GeologicEvent/gsmblb:younger
NamedAge/@xlink:href</fes:ValueReference>
<fes:Literal>http://resource.geosciml.org/classifier/ics/ischart/Emsian</fes:Literal>
</fes:PropertyIsEqualTo>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmblb:specification/gsmblb:GeologicUnit/gsmblb:geologicHistory/gsmblb:GeologicEvent/gsmblb:younger
NamedAge/@xlink:href</fes:ValueReference>
<fes:Literal>http://resource.geosciml.org/classifier/ics/ischart/Lochkovian</fes:Literal>
</fes:PropertyIsEqualTo>
<fes:PropertyIsEqualTo>

<fes:ValueReference>gsmblb:specification/gsmblb:GeologicUnit/gsmblb:geologicHistory/gsmblb:GeologicEvent/gsmblb:younger
NamedAge/@xlink:href</fes:ValueReference>
<fes:Literal>http://resource.geosciml.org/classifier/ics/ischart/Pragian</fes:Literal>
</fes:PropertyIsEqualTo>
</fes:Or>
</fes:Filter>
</wfs:Query>
</wfs:GetFeature>
```

Figure 38: Example of an age query

Annex 1: Mapping of INSPIRE GE classes and properties to GeoSciML equivalents

INSPIRE GE class	INSPIRE GE property /association	GeoSciML class	GeoSciML property / association
AnthropogenicGeomorphologicFeature		AnthropogenicGeomorphologicFeature	
AnthropogenicGeomorphologicFeature	anthropogenic GeomorphologicFeatureType	AnthropogenicGeomorphologicFeature	anthropogenic GeomorphologicFeatureType
AnthropogenicGeomorphologicfeatureTypeValue		AnthropogenicGeomorphologicfeatureTypeTerm	
Borehole		Borehole	
Borehole	inspireId	Borehole	gml:identifier
Borehole	downholeGeometry	Borehole	sams:shape
Borehole	location	OriginPosition	location
Borehole	boreholeLength	BoreholeDetails	boreholeLength
Borehole	elevation	OriginPosition	elevation
Borehole	purpose	BoreholeDetails	purpose
Borehole	logElement	Borehole	logElement
BoreholePurposeValue		BoreholePurposeCode	
CollectionTypeValue		CollectionTypeTerm	
CompositionPart		CompositionPart	
CompositionPart	material	RockMaterial	lithology
CompositionPart	role	CompositionPart	role
CompositionPart	proportion	CompositionPart	proportion
CompositionPartRoleValue		CompositionPartRoleTerm	
EventEnvironmentValue			
EventProcessValue		EventProcessTerm	
FaultTypeValue		FaultTypeTerm	
Fold		Fold	
Fold	profileType	Fold	profileType
FoldProfileTypeValue		FoldProfileTypeTerm	
GeochronologicEraValue		GeochronologicEra	
GeologicCollection		GSML	
GeologicCollection	inspireId	GSML	gml:identifier

GeologicCollection	name	GSML	gml:name
GeologicCollection	collectionType	GSML	collectionType
GeologicCollection	reference	GSML	metadata
GeologicCollection	beginLifespanVersion	GSML	metadata
GeologicCollection	endLifeSpanVersion	GSML	metadata
GeologicCollection	boreholeMember	GSML	member (where GSMLitem = samplingFeatureItem)
GeologicCollection	mapMember	GSML	member (where GSMLitem = mappedItem)
GeologicCollection	geophObjectMember	GSML	member (where GSMLitem = samplingFeatureItem)
GeologicCollection	geophObjectSet	GSML	member (where GSMLitem = samplingFeatureItem)
GeologicEvent		GeologicEvent	
GeologicEvent	name	GeologicFeature	gml:name
GeologicEvent	eventEnvironment	GeologicEvent	eventEnvironment
GeologicEvent	eventProcess	GeologicEvent	eventProcess
GeologicEvent	olderNamedAge	GeologicEvent	olderNamedAge
GeologicEvent	youngerNamedAge	GeologicEvent	youngerNamedAge
GeologicFeature		GeologicFeature	
GeologicFeature	inspireId	GeologicFeature	gml:identifier
GeologicFeature	name	GeologicFeature	gml:name
GeologicFeature	themeClass	GeologicFeature	classifier
GeologicFeature	geologicHistory	GeologicFeature	geologicHistory
GeologicStructure		GeologicStructure	
GeologicUnit		GeologicUnit	
GeologicUnit	geologicUnitType	GeologicUnit	geologicUnitType
GeologicUnit	composition	GeologicUnit	composition
GeologicUnitTypeValue		GeologicUnitTypeTerm	
GeomorphologicActivityValue		ActivityStatus	
GeomorphologicFeature		GeomorphologicFeature	
LithologyValue		LithologyTerm	
MappedFeature		MappedFeature	
MappedFeature	shape	MappedFeature	shape
MappedFeature	mappingFrame	MappedFeature	mappingFrame
MappedFeature	specification	MappedFeature	specification
MappedInterval		MappedInterval	
MappingFrameValue			
NaturalGeomorphologicFeature		NaturalGeomorphologicFeature	

NaturalGeomorphologicFeature	naturalGeomorphologicFeatureType	NaturalGeomorphologicFeature	naturalGeomorphologicFeatureType
NaturalGeomorphologicFeature	activity	NaturalGeomorphologicFeature	activity
NaturalGeomorphologicFeatureTypeValue		NaturalGeomorphologicFeatureTypeTerm	
ShearDisplacementStructure		ShearDisplacementStructure	
ShearDisplacementStructure	faultTypeTerm	ShearDisplacementStructure	faultTypeTerm
ThematicClass		GeologicFeature	
ThematicClass	themeClassification	GeologicFeature	classifier
ThematicClass	themeClass	GeologicFeature	classifier
ThemeClassValue			
ThemeClassificationValue			

Annex 2: Example of encoding the INSPIRE Geology application schema in GeoSciML

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:FeatureCollection xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gss="http://www.isotc211.org/2005/gss"
xmlns:gts="http://www.isotc211.org/2005/gts"
xmlns:gsr="http://www.isotc211.org/2005/gsr"
xmlns:swe="http://www.opengis.net/swe/2.0"
xmlns:sam="http://www.opengis.net/sampling/2.0"
xmlns:om="http://www.opengis.net/om/2.0"
xmlns:sams="http://www.opengis.net/samplingSpatial/2.0"
xmlns:gsmlb="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
xmlns:gsmlbh="http://xmlns.geosciml.org/Borehole/4.0"
xmlns:wfs="http://www.opengis.net/wfs/2.0"
xsi:schemaLocation="http://xmlns.geosciml.org/GeoSciML-Basic/4.0 http://schemas.geosciml.org/geosciml/4.0/borehole.xsd
http://xmlns.geosciml.org/Borehole/4.0 http://schemas.geosciml.org/geosciml/4.0/borehole.xsd
http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd"
numberMatched="1" numberReturned="1" timeStamp="2013-03-05T16:05:36">
<!-- -->
<!-- All features have been included in a GSML collection as an example -->
<!-- -->
<wfs:member>
<gsmlb:GSML gml:id="col1">
<!-- -->
<!-- The metadata for the GSML collection -->
<!-- -->
<gml:metaDataProperty>
<gml:GenericMetaData>
```

```

<gmd:MD_Metadata>
  <gmd:contact>
    <gmd:CI_ResponsibleParty>
      <gmd:organisationName>
        <gco:CharacterString>British Geological Survey (BGS)</gco:CharacterString>
      </gmd:organisationName>
      <gmd:role>
        <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="owner">owner</gmd:CI_RoleCode>
      </gmd:role>
    </gmd:CI_ResponsibleParty>
  </gmd:contact>
  <gmd:dateStamp>
    <gco:Date>2011-03-08</gco:Date>
  </gmd:dateStamp>
  <gmd:dataSetURI>
    <gco:CharacterString>http://www.bgs.ac.uk/products/digitalmaps/digmapgb_625.html</gco:CharacterString>
  </gmd:dataSetURI>
  <gmd:identificationInfo>
    <gmd:MD_DataIdentification>
      <gmd:citation>
        <gmd:CI_Citation>
          <gmd:title>
            <gco:CharacterString>BGS 1:625 000 Digital Geological Map</gco:CharacterString>
          </gmd:title>
          <gmd:alternateTitle>
            <gco:CharacterString>BGS 625k Map</gco:CharacterString>
          </gmd:alternateTitle>
          <gmd:date>
            <gmd:CI_Date>
              <gmd:date>
                <gco:Date>2008</gco:Date>
              </gmd:date>
              <gmd:dateType>
                <gmd:CI_DateTypeCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="revision">revision</gmd:CI_DateTypeCode>
              </gmd:dateType>
            </gmd:CI_Date>
          </gmd:date>
        </gmd:CI_Citation>
      </gmd:citation>
    </gmd:MD_DataIdentification>
  </gmd:identificationInfo>
</gmd:MD_Metadata>

```

```

</gmd:CI_Date>
</gmd:date>
<gmd:date>
<gmd:CI_Date>
<gmd:date>
<gco>Date>2008</gco>Date>
</gmd:date>
<gmd:dateType>
<gmd:CI_DateTypeCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="validityBegins">validityBegins</gmd:CI_DateTypeCode>
</gmd:dateType>
</gmd:CI_Date>
</gmd:date>
<gmd:date>
<gmd:CI_Date>
<gmd:date>
<gco>Date>2013</gco>Date>
</gmd:date>
<gmd:dateType>
<gmd:CI_DateTypeCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="validityEnds">validityEnds</gmd:CI_DateTypeCode>
</gmd:dateType>
</gmd:CI_Date>
</gmd:date>
</gmd:CI_Citation>
</gmd:citation>
<gmd:abstract>
<gco:CharacterString>The data shows polygonal and selected linear geological information, sourced
from published BGS 1:625 000 scale maps of Great Britain. However, geological units are identified
using the most up-to-date nomenclature that may differ from that on the printed maps. The maps are
generally based on published material at 1:50 000 scale and compiled using techniques of selection,
generalisation and exaggeration. The geology is fitted to a relevant topographic base at the time
of production. Full UK coverage is available. The data is available in vector format. BGS licensing
terms and conditions apply to external use of the data. The data can be used free of charge for
non commercial use and is downloadable from the website.</gco:CharacterString>
</gmd:abstract>

```



```

<gmd:language>
  <gco:CharacterString>eng</gco:CharacterString>
</gmd:language>
<gmd:topicCategory>
  <gmd:MD_TopicCategoryCode>geoscientificInformation</gmd:MD_TopicCategoryCode>
</gmd:topicCategory>
</gmd:MD_DataIdentification>
</gmd:identificationInfo>
</gmd:MD_Metadata>
</gml:GenericMetaData>
</gml:metaDataProperty>
<gml:identifier codeSpace="http://data.bgs.ac.uk">http://data.bgs.ac.uk/id/625KGeologyMap</gml:identifier>
<gml:name>BGS 1:625 000 Digital Geological Map</gml:name>
<gsmlb:collectionType
  xlink:href="http://inspire.ec.europa.eu/codelist/CollectionTypeValue/geologicalMap"
  xlink:title="geological map"/>
<!-- -->
<!-- A Geologic Unit example -->
<!-- -->
<gsmlb:member>
<gsmlb:MappedFeature gml:id="mf.16">
  <gsmlb:mappingFrame
    xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/topOfBedrock"
    xlink:title="top of bedrock"/>
  <!-- -->
  <!-- The MappedFeature is specified by a GeologicUnit -->
  <!-- -->
  <gsmlb:specification>
  <gsmlb:GeologicUnit gml:id="INV-SDSM">
    <gml:identifier codeSpace="http://data.bgs.ac.uk">http://data.bgs.ac.uk/id/Lexicon/NamedRockUnit/INV</gml:identifier>
    <gml:name>INVERCLYDE GROUP</gml:name>
    <!-- -->
    <!-- Example of a thematic classification of a GeologicUnit -->
    <!-- -->
    <gsmlb:classifier
      xlink:href="http://data.bgs.ac.uk/ref/EngineeringGeologyTheme/strongSandstone"

```

```

xlink:title="Engineering Geology theme: Strong Sandstone"/>
<gsmlb:geologicHistory>
<gsmlb:GeologicEvent gml:id="EVENT_1">
  <!-- In INSPIRE GeologicEvent is not a type of GeologicFeature and doesn't
have an inspireId so no need for a gml:identifier here. -->
  <gml:name>UNNAMED EVENT</gml:name>
  <!-- Schema needs fixing to encode eventProcess properly -->
  <gsmlb:eventProcess
xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/mechanicalDeposition"
xlink:title="mechanical deposition"/>
  <!-- numericAgeDate is not in INSPIRE model so omit if don't have
it or don't want to report it -->
  <gsmlb:olderNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
xlink:title="Tournaisian"/>
  <gsmlb:youngerNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/visean"
xlink:title="Visean"/>
  <gsmlb:eventEnvironment>
  <swe:Category
definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
  <swe:extension>
  <swe:Category
definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
  <swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
  <swe:label>always</swe:label>
  <swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"
  />
  </swe:Category>
  </swe:extension>
  <swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/riverPlainSystemSetting</swe:identifier>
  <swe:label>river plain system setting</swe:label>
  <swe:codeSpace
xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"
  />

```

```

</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<!-- -->
<!-- -->
<gsmlb:geologicUnitType
xlink:href="http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue/lithostratigraphicUnit"
xlink:title="lithostratigraphic unit"/>
<!-- -->
<!-- The composition (lithology) of the GeologicUnit -->
<!-- There are three component lithologies in this example -->
<!-- -->
<gsmlb:composition>
<gsmlb:CompositionPart>
<gsmlb:role xlink:title="unspecified part role"
xlink:href="http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/unspecifiedPartRole"/>
<gsmlb:material>
<gsmlb:RockMaterial gml:id="LOCAL_ID_3">
<gsmlb:lithology
xlink:href="http://inspire.ec.europa.eu/codelist/LithologyValue/mudstone"
xlink:title="mudstone"/>
</gsmlb:RockMaterial>
</gsmlb:material>
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange>
<swe:uom code="%"
xlink:href="http://unitsofmeasure/ucum.html#para-29"
xlink:title="percent"/>
<swe:value>5.0 50.0</swe:value>
<gsmlb:lowerValue>5.0</gsmlb:lowerValue>
<gsmlb:upperValue>50.0</gsmlb:upperValue>
</gsmlb:GSML_QuantityRange>
</gsmlb:proportion>
</gsmlb:CompositionPart>
</gsmlb:composition>

```

```

<gsmlb:composition>
<gsmlb:CompositionPart>
<gsmlb:role xlink:title="unspecified part role"
xlink:href="http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/unspecifiedPartRole"/>
<gsmlb:material>
<gsmlb:RockMaterial gml:id="LOCAL_ID_4">
<gsmlb:lithology
xlink:href="http://inspire.ec.europa.eu/codelist/LithologyValue/sandstone"
xlink:title="sandstone"/>
</gsmlb:RockMaterial>
</gsmlb:material>
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange>
<swe:uom code="%"
xlink:href="http://unitsofmeasure/ucum.html#para-29"
xlink:title="percent"/>
<swe:value>50.0 95.0</swe:value>
<gsmlb:lowerValue>50.0</gsmlb:lowerValue>
<gsmlb:upperValue>95.0</gsmlb:upperValue>
</gsmlb:GSML_QuantityRange>
</gsmlb:proportion>
</gsmlb:CompositionPart>
</gsmlb:composition>
<gsmlb:composition>
<gsmlb:CompositionPart>
<gsmlb:role xlink:title="unspecified part role"
xlink:href="http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/unspecifiedPartRole"/>
<gsmlb:material>
<gsmlb:RockMaterial gml:id="LOCAL_ID_5">
<gsmlb:lithology
xlink:href="http://inspire.ec.europa.eu/codelist/LithologyValue/siltstone"
xlink:title="siltstone"/>
</gsmlb:RockMaterial>
</gsmlb:material>
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange>

```

```

<swe:uom code="%"
  xlink:href="http://unitsofmeasure/ucum.html#para-29"
  xlink:title="percent"/>
<swe:value>5.0 50.0</swe:value>
<gsmlb:lowerValue>5.0</gsmlb:lowerValue>
<gsmlb:upperValue>50.0</gsmlb:upperValue>
</gsmlb:GSML_QuantityRange>
</gsmlb:proportion>
</gsmlb:CompositionPart>
</gsmlb:composition>
</gsmlb:GeologicUnit>
</gsmlb:specification>
<gsmlb:shape>
<gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326" gml:id="LOCAL_ID_0">
  <gml:exterior>
  <gml:LinearRing>
  <gml:posList srsDimension="2" count="8">55.0760921318516
    -3.31719604609088 55.0833753209835 -3.31853455922777 55.0825574334633
    -3.31921378657955 55.0801997429522 -3.31978309699423 55.0768616358466
    -3.3194575613054 55.0741365291192 -3.31966903508197 55.0756843873373
    -3.31747948721346 55.0760921318516 -3.31719604609088</gml:posList>
  </gml:LinearRing>
  </gml:exterior>
  </gml:Polygon>
  </gsmlb:shape>
</gsmlb:MappedFeature>
</gsmlb:member>
<!-- -->
<!-- A Fault example -->
<!-- -->
<gsmlb:member>
<gsmlb:MappedFeature gml:id="mf.2">
  <gsmlb:mappingFrame
    xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/topOfBedrock"
    xlink:title="top of bedrock"/>
  <!-- -->

```

```

<!-- The MappedFeature is specified by a ShearDisplacementStructure (Fault) -->
<!-- -->
<gsmlb:specification>
<gsmlb:ShearDisplacementStructure gml:id="FAULT_ID_1">
<gml:identifier codeSpace="http://data.bgs.ac.uk/">http://data.bgs.ac.uk/ref/625KGeologyMap/Fault/bgsn_digmap20111213000010000_625k</gml:identifier>
<gml:name>UNNAMED FAULT</gml:name>
<gsmlb:purpose>typicalNorm</gsmlb:purpose>
<gsmlb:geologicHistory>
<gsmlb:GeologicEvent gml:id="EVENT_2">
<gml:name>UNNAMED EVENT</gml:name>
<gsmlb:eventProcess
xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/faulting"
xlink:title="faulting"/>
<gsmlb:olderNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
xlink:title="Tournaisian"/>
<gsmlb:youngerNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
xlink:title="Tournaisian"/>
<gsmlb:eventEnvironment>
<swe:Category
definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
<swe:extension>
<swe:Category
definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
<swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
<swe:label>always</swe:label>
<swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"
/>
</swe:Category>
</swe:extension>
<swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/crustalSetting</swe:identifier>
<swe:label>crustal setting</swe:label>
<swe:codeSpace
xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"

```

```

/>
</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<gsmlb:faultType
  xlink:href="http://inspire.ec.europa.eu/codelist/FaultTypeValue/normalFault"
  xlink:title="normal fault"/>
</gsmlb:ShearDisplacementStructure>
</gsmlb:specification>
<gsmlb:shape>
<gml:LineString srsName="urn:ogc:def:crs:EPSG::4326" gml:id="LOCAL_ID_20">
<gml:posList srsDimension="2" count="7">55.0760921318516
-3.31719604609088 55.0833753209835 -3.31853455922777 55.0825574334633
-3.31921378657955 55.0801997429522 -3.31978309699423 55.0768616358466
-3.3194575613054 55.0741365291192 -3.31966903508197 55.0756843873373
-3.31747948721346</gml:posList>
</gml:LineString>
</gsmlb:shape>
</gsmlb:MappedFeature>
</gsmlb:member>
<!-- -->
<!-- A Fold example -->
<!-- -->
<gsmlb:member>
<gsmlb:MappedFeature gml:id="mf.3">
<!-- -->
<!-- The MappedFeature is specified by a Fold -->
<!-- -->
<gsmlb:mappingFrame
  xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/topOfBedrock"
  xlink:title="top of bedrock"/>
</gsmlb:specification>
<gsmlb:Fold gml:id="FOLD_ID_1">
<gml:identifier codeSpace="http://data.bgs.ac.uk/">http://data.bgs.ac.uk/ref/625KGeologyMap/Fold/bgsn_digmap20111213000010000_625k</gml:identifier>
<gml:name>UNNAMED FOLD</gml:name>

```

```

<gsmlb:geologicHistory>
<gsmlb:GeologicEvent gml:id="EVENT_3">
<gml:name>HERCYNIAN OROGENY</gml:name>
<gsmlb:eventProcess
xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/folding"
xlink:title="folding"/>
<gsmlb:olderNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
xlink:title="Tournaisian"/>
<gsmlb:youngerNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
xlink:title="Tournaisian"/>
<gsmlb:eventEnvironment>
<swe:Category
definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
<swe:extension>
<swe:Category
definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
<swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
<swe:label>always</swe:label>
<swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"
/>
</swe:Category>
</swe:extension>
<swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/crustalSetting</swe:identifier>
<swe:label>crustal setting</swe:label>
<swe:codeSpace
xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"
/>
</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<gsmlb:profileType
xlink:href="http://inspire.ec.europa.eu/codelist/FoldProfileTypeValue/anticline"

```



```

    xlink:title="anticline"/>
  </gsmlb:Fold>
</gsmlb:specification>
<gsmlb:shape>
  <gml:LineString srsName="urn:ogc:def:crs:EPSG::4326" gml:id="LOCAL_ID_21">
    <gml:posList srsDimension="2" count="7">55.0760921318516
      -3.31719604609088 55.0833753209835 -3.31853455922777 55.0825574334633
      -3.31921378657955 55.0801997429522 -3.31978309699423 55.0768616358466
      -3.3194575613054 55.0741365291192 -3.31966903508197 55.0756843873373
      -3.31747948721346</gml:posList>
  </gml:LineString>
</gsmlb:shape>
</gsmlb:MappedFeature>
</gsmlb:member>
<!-- -->
<!-- A Natural Geomorphologic Feature example -->
<!-- -->
<gsmlb:member>
  <gsmlb:MappedFeature gml:id="mf.4">
    <gsmlb:mappingFrame
      xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/surfaceGeology"
      xlink:title="surface geology"/>
    <!-- -->
    <!-- The MappedFeature is specified by a NaturalGeomorphologicFeature -->
    <!-- -->
  </gsmlb:specification>
  <gsmlb:NaturalGeomorphologicFeature gml:id="GEOMORPH_1">
    <gml:identifier codeSpace="http://data.bgs.ac.uk/">http://data.bgs.ac.uk/ref/625KGeologyMap/GeomorphologicFeature/bgsn_digmap20111213000010001_625k</gml:identifier>
    <gml:name>UNNAMED GLACIAL OUTWASH CHANNEL</gml:name>
    <gsmlb:geologicHistory>
      <gsmlb:GeologicEvent gml:id="EVENT_4">
        <gml:name>DEVENSIAN GLACIATION</gml:name>
        <gsmlb:eventProcess
          xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/waterErosion"
          xlink:title="water erosion"/>
        <gsmlb:olderNamedAge

```

```

xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/latePleistocene"
xlink:title="Late/Upper Pleistocene"/>
<gsmlb:youngerNamedAge
xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/latePleistocene"
xlink:title="Late/Upper Pleistocene"/>
<gsmlb:eventEnvironment>
<swe:Category
definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
<swe:extension>
<swe:Category
definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
<swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
<swe:label>always</swe:label>
<swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"
/>
</swe:Category>
</swe:extension>
<swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/glacialOutwashPlainSetting</swe:identifier>
<swe:label>glacial outwash plain setting</swe:label>
<swe:codeSpace
xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"
/>
</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<gsmlb:naturalGeomorphologicFeatureType
xlink:href="http://inspire.ec.europa.eu/codelist/NaturalGeomorphologicFeatureTypeValue/glacial"
xlink:title="glacial, glaciofluvial, glaciolacustrine and glaciomarine features"/>
<gsmlb:activity
xlink:href="http://inspire.ec.europa.eu/codelist/GeomorphologicActivityValue/inactive"
xlink:title="inactive"/>
</gsmlb:NaturalGeomorphologicFeature>
</gsmlb:specification>
<gsmlb:shape>

```

```

<gml:LineString srsName="urn:ogc:def:crs:EPSG::4326" gml:id="LOCAL_ID_22">
  <gml:posList srsDimension="2" count="7">55.0760921318516
    -3.31719604609088 55.0833753209835 -3.31853455922777 55.0825574334633
    -3.31921378657955 55.0801997429522 -3.31978309699423 55.0768616358466
    -3.3194575613054 55.0741365291192 -3.31966903508197 55.0756843873373
    -3.31747948721346</gml:posList>
</gml:LineString>
</gsmlb:shape>
</gsmlb:MappedFeature>
</gsmlb:member>
<!-- -->
<!-- Borehole example -->
<!-- -->
<gsmlb:member>
  <gsmlbh:Borehole gml:id="bh.ns94se5">
    <gml:identifier codeSpace="http://data.bgs.ac.uk/id/Borehole">NS94SE5</gml:identifier>
    <sam:sampledFeature xlink:href="#PEAT"/>
    <sam:sampledFeature xlink:href="#INV-MDST"/>
    <sams:shape>
      <gml:LineString gml:id="bh.ns94se5.shape"
        srsName="urn:ogc:def:crs:EPSG:6.15:7405">
        <gml:posList srsDimension="3" count="7">-30.7111 134.2059 321. -30.7112
          134.2058 315. -30.7113 134.2057 303. -30.7114 134.2056 296. -30.7115
          134.2055 272. -30.7116 134.2054 271. -30.7117 134.2053
          270.</gml:posList>
      </gml:LineString>
    </sams:shape>
    <gsmlbh:referenceLocation>
      <gsmlbh:OriginPosition gml:id="op1">
        <gsmlbh:location>
          <gml:Point gml:id="pt1" srsName="urn:ogc:def:crs:EPSG:6.15:27700"
            srsDimension="2">
            <gml:pos>-30.7 134.2</gml:pos>
          </gml:Point>
        </gsmlbh:location>
        <gsmlbh:elevation srsName="urn:ogc:def:crs:EPSG:6.15:5701"

```

```

    srsDimension="1">321.0</gsmlbh:elevation>
</gsmlbh:OriginPosition>
</gsmlbh:referenceLocation>
<gsmlbh:indexData>
<gsmlbh:BoreholeDetails>
<gsmlbh:purpose
  xlink:href="http://inspire.ec.europa.eu/codelist/BoreholePurposeValue/geologicalSurvey"
  xlink:title="geological Survey"/>
<gsmlbh:boreholeLength>
<swe:Quantity>
  <swe:uom code="m"
    xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
    xlink:title="metre"/>
  <swe:value>51.0</swe:value>
</swe:Quantity>
</gsmlbh:boreholeLength>
</gsmlbh:BoreholeDetails>
</gsmlbh:indexData>
<!-- -->
<!-- The borehole log is given as a series of logElements (MappedIntervals) -->
<!-- -->
<gsmlbh:logElement>
<gsmlbh:BoreholeInterval gml:id="mi1">
<!-- -->
<!-- The MappedInterval is specified by a GeologicUnit -->
<!-- -->
<gsmlbh:specification>
<gsmlb:GeologicUnit gml:id="PEAT">
  <gml:identifier codeSpace="http://data.bgs.ac.uk/id/Lexicon/NamedRockUnit">PEAT</gml:identifier>
  <gml:name>PEAT</gml:name>
  <gsmlb:geologicHistory>
  <gsmlb:GeologicEvent gml:id="EVENT_10">
  <gml:name>UNNAMED EVENT</gml:name>
  <gsmlb:eventProcess
    xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/inSituOrganismicGrowth"
    xlink:title="in-situ organismic growth"/>

```

```

<gsmlb:olderNamedAge
  xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/holocene"
  xlink:title="Holocene"/>
<gsmlb:youngerNamedAge
  xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/holocene"
  xlink:title="Holocene"/>
<gsmlb:eventEnvironment>
  <swe:Category
    definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
    <swe:extension>
      <swe:Category
        definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
          <swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
          <swe:label>always</swe:label>
          <swe:codeSpace
            xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"
            />
          </swe:Category>
        </swe:extension>
        <swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/bogSetting</swe:identifier>
        <swe:label>bog setting</swe:label>
        <swe:codeSpace
          xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"
          />
        </swe:Category>
      </gsmlb:eventEnvironment>
    </gsmlb:GeologicEvent>
  </gsmlb:geologicHistory>
  <gsmlb:geologicUnitType
    xlink:href="http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue/lithodemicUnit"
    xlink:title="lithodemic unit"/>
  <gsmlb:composition>
    <gsmlb:CompositionPart>
      <gsmlb:role xlink:title="unspecified part role"
        xlink:href="http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/unspecifiedPartRole"/>
    </gsmlb:material>
  </gsmlb:composition>
</gsmlb:geologicHistory>

```

```

<gsmlb:RockMaterial gml:id="LOCAL_ID_30">
  <gsmlb:lithology
    xlink:href="http://inspire.ec.europa.eu/codelist/LithologyValue/peat"
    xlink:title="peat"/>
  </gsmlb:RockMaterial>
</gsmlb:material>
<gsmlb:proportion>
  <gsmlb:GSML_QuantityRange
    xmlns="http://xmlns.geosciml.org/Utilities/3.2">
    <swe:uom code="%"
      xlink:href="http://unitsofmeasure/ucum.html#para-29"
      xlink:title="percent"/>
    <swe:value>100.0 100.0</swe:value>
    <gsmlb:lowerValue>100.0</gsmlb:lowerValue>
    <gsmlb:upperValue>100.0</gsmlb:upperValue>
  </gsmlb:GSML_QuantityRange>
</gsmlb:proportion>
</gsmlb:CompositionPart>
</gsmlb:composition>
</gsmlb:GeologicUnit>
</gsmlbh:specification>
<gsmlbh:mappedIntervalBegin>
  <swe:Quantity>
    <swe:uom code="m"
      xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>0.0</swe:value>
  </swe:Quantity>
</gsmlbh:mappedIntervalBegin>
<gsmlbh:mappedIntervalEnd>
  <swe:Quantity>
    <swe:uom code="m"
      xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>2.0</swe:value>
  </swe:Quantity>

```

```

</gsmlbh:mappedIntervalEnd>
<gsmlbh:shape>
  <gml:LineString gml:id="ls1" srsName="#bh.ns94se5.shape">
    <gml:posList srsDimension="1" count="2">0.0 2.0</gml:posList>
  </gml:LineString>
</gsmlbh:shape>
</gsmlbh:BoreholeInterval>
</gsmlbh:logElement>
<gsmlbh:logElement>
  <gsmlbh:BoreholeInterval gml:id="mi2">
    <gsmlbh:specification>
      <gsmlb:GeologicUnit gml:id="INV-MDST">
        <gml:identifier codeSpace="http://data.bgs.ac.uk/id/Lexicon/NamedRockUnit">INV</gml:identifier>
        <gml:name>INVERCLYDE GROUP</gml:name>
        <gsmlb:geologicHistory>
          <gsmlb:GeologicEvent gml:id="EVENT_11">
            <gml:name>UNNAMED EVENT</gml:name>
            <gsmlb:eventProcess>
              xlink:href="http://inspire.ec.europa.eu/codelist/EventProcessValue/mechanicalDeposition"
              xlink:title="mechanical deposition"/>
            <gsmlb:olderNamedAge>
              xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/tournaisian"
              xlink:title="Tournaisian"/>
            <gsmlb:youngerNamedAge>
              xlink:href="http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/visean"
              xlink:title="Visean"/>
            <gsmlb:eventEnvironment>
              <swe:Category>
                definition="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue">
              <swe:extension>
                <swe:Category>
                  definition="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier">
                <swe:identifier>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:identifier>
                <swe:label>always</swe:label>
                <swe:codeSpace>
                  xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201211/valuequalifier"

```

```

/>
</swe:Category>
</swe:extension>
<swe:identifier>http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/riverPlainSystemSetting</swe:identifier>
<swe:label>river plain system setting</swe:label>
<swe:codeSpace
  xlink:href="http://inspire.ec.europa.eu/codelist/EventEnvironmentValue"
/>
</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<gsmlb:geologicUnitType
  xlink:href="http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue/lithostratigraphicUnit"
  xlink:title="lithostratigraphic Unit"/>
<gsmlb:composition>
<gsmlb:CompositionPart>
<gsmlb:role xlink:title="unspecified part role"
  xlink:href="http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/unspecifiedPartRole"/>
<gsmlb:material>
<gsmlb:RockMaterial gml:id="LOCAL_ID_31">
<gsmlb:lithology
  xlink:href="http://inspire.ec.europa.eu/codelist/LithologyValue/mudstone"
  xlink:title="mudstone"/>
</gsmlb:RockMaterial>
</gsmlb:material>
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange
  xmlns="http://xmlns.geosciml.org/Utilities/3.2">
<swe:uom code="%"
  xlink:href="http://unitsofmeasure/ucum.html#para-29"
  xlink:title="percent"/>
<swe:value>100.0 100.0</swe:value>
<gsmlb:lowerValue>100.0</gsmlb:lowerValue>
<gsmlb:upperValue>100.0</gsmlb:upperValue>
</gsmlb:GSML_QuantityRange>

```



```

    </gsmlb:proportion>
  </gsmlb:CompositionPart>
</gsmlb:composition>
</gsmlb:GeologicUnit>
</gsmlbh:specification>
<gsmlbh:mappedIntervalBegin>
  <swe:Quantity>
    <swe:uom code="m"
      xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>2.0</swe:value>
  </swe:Quantity>
</gsmlbh:mappedIntervalBegin>
<gsmlbh:mappedIntervalEnd>
  <swe:Quantity>
    <swe:uom code="m"
      xlink:href="http://www.opengis.net/def/uom/OGC/1.0/metre"
      xlink:title="metre"/>
    <swe:value>51.0</swe:value>
  </swe:Quantity>
</gsmlbh:mappedIntervalEnd>
<gsmlbh:shape>
  <gml:LineString gml:id="ls2" srsName="#bh.ns94se5.shape"
    srsDimension="1">
    <gml:pos>2.0</gml:pos>
    <gml:pos>51.0</gml:pos>
  </gml:LineString>
</gsmlbh:shape>
</gsmlbh:BoreholeInterval>
</gsmlbh:logElement>
</gsmlbh:Borehole>
</gsmlb:member>
</gsmlb:GSML>
</wfs:member>
</wfs:FeatureCollection>

```

Annex 3: Example MappedFeature from a 5* OneGeology WFS

Note that this example includes the encoding of attributes which are not mandatory for OneGeology, such as eventProcess in GeologicEvent. Extending the basic information required for OneGeology in this way makes the service more useful. Where appropriate such extensions should use the CGI vocabularies provided at <http://resource.geosciml.org/> or, if the service is also functioning as an INSPIRE download service and the property is covered by INSPIRE vocabularies, one from <http://inspire.ec.europa.eu/codelist/>.

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:FeatureCollection xmlns:wfs="http://www.opengis.net/wfs/2.0"
  xmlns:swe="http://www.opengis.net/swe/2.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:gsmblb="http://xmlns.geosciml.org/GeoSciML-Basic/4.0"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" numberMatched="unknown" numberReturned="1"
  timeStamp="2015-11-23T10:11:10.726Z"
  xsi:schemaLocation="http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd http://xmlns.geosciml.org/GeoSciML-Basic/4.0 http://schemas.geosciml.org/geosciml-
  basic/4.0/geoSciMLBasic.xsd http://www.opengis.net/gml/3.2 http://schemas.opengis.net/gml/3.2.1/gml.xsd">
  <wfs:member>
    <gsmblb:MappedFeature gml:id="bgsn_digmap20111213000012743_625k">
      <gsmblb:mappingFrame
        xlink:href="http://inspire.ec.europa.eu/codelist/MappingFrameValue/topOfBedrock"
        xlink:title="top of bedrock"/>
      <gsmblb:specification>
        <gsmblb:GeologicUnit gml:id="UISD-MFIR">
          <gml:description>UNNAMED IGNEOUS INTRUSION, LATE SILURIAN TO EARLY DEVONIAN - MAFIC
            IGNEOUS-ROCK</gml:description>
          <gsmblb:geologicHistory>
            <gsmblb:GeologicEvent gml:id="gsmblga.ge-UISD-MFIR">
              <gsmblb:eventProcess
                xlink:href="http://resource.geosciml.org/classifier/cgi/eventprocess/intrusion"
                xlink:title="intrusion"/>
              <gsmblb:olderNamedAge xlink:href="http://resource.geosciml.org/classifier/ics/ischart/Ludlow"
                xlink:title="Ludlow"/>
              <gsmblb:youngerNamedAge
```

```

xlink:href="http://resource.geosciml.org/classifier/ics/ischart/LowerDevonian"
xlink:title="Early/Lower Devonian"/>
<gsmlb:eventEnvironment>
<swe:Category
definition="http://resource.geosciml.org/classifierscheme/cgi/201012/eventenvironment">
<swe:extension>
<swe:Category
definition="http://dummy.resource.geosciml.org/classifier/cgi/2012/propertytypes/valuequalifier">
<swe:label>always</swe:label>
<swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201202/valuequalifier"/>
<swe:value>http://resource.geosciml.org/classifier/cgi/valuequalifier/always</swe:value>
</swe:Category>
</swe:extension>
<swe:label>tectonically defined setting</swe:label>
<swe:codeSpace
xlink:href="http://resource.geosciml.org/classifierscheme/cgi/201012/eventenvironment"/>
<swe:value>http://resource.geosciml.org/classifier/cgi/eventenvironment/tectonic_setting</swe:value>
</swe:Category>
</gsmlb:eventEnvironment>
</gsmlb:GeologicEvent>
</gsmlb:geologicHistory>
<gsmlb:geologicUnitType
xlink:href="http://resource.geosciml.org/classifier/cgi/geologicunittype/lithodemic_unit"
xlink:title="lithodemic unit"/>
<gsmlb:composition>
<gsmlb:CompositionPart>
<gsmlb:role
xlink:href="http://resource.geosciml.org/classifier/cgi/geologicunitpartrole/only_part"
xlink:title="only part"/>
<gsmlb:material>
<gsmlb:RockMaterial gml:id="gsmlb.rockmaterial-164">
<gsmlb:lithology
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</gsmlb:RockMaterial>

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</gsmlb:material>
<gsmlb:proportion>
<gsmlb:GSML_QuantityRange>
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  xlink:title="percent"/>
  <swe:value>95.0 100.0</swe:value>
  <gsmlb:lowerValue>95.0</gsmlb:lowerValue>
  <gsmlb:upperValue>100.0</gsmlb:upperValue>
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</gsmlb:proportion>
</gsmlb:CompositionPart>
</gsmlb:composition>
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</gsmlb:specification>
<gsmlb:shape>
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  <gml:LinearRing>
  <gml:posList>274375.24800000055 555042.4010000002 274315.42099999994 555042.4010000002
  274175.82299999996 555092.27799999991 274175.82299999996 555152.13099999995 274140.92399999996
  555202.00800000006 274140.92399999996 555236.92100000001 274320.40599999995 555177.06900000007
  274375.24800000055 555042.4010000002</gml:posList>
  </gml:LinearRing>
  </gml:exterior>
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