INSPIRE Infrastructure for Spatial Information in Europe

D2.8.II.4 Data Specification on *Geology* – Technical Guidelines

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Foreword

How to read the document?

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

The data specification is based on a common template[1] used for all data specifications, which has been harmonised using the experience from the development of the Annex I, II and III data specifications.

This document provides guidelines for the implementation of the provisions laid down in the Implementing Rule for spatial data sets and services of the INSPIRE Directive. It also includes additional requirements and recommendations that, although not included in the Implementing Rule, are relevant to guarantee or to increase data interoperability.

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

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

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

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

The document will be publicly available as a 'non-paper'. It does not represent an official position of the European Commission, and as such cannot be invoked in the context of legal procedures.

Interoperability of Spatial Data Sets and Services – General Executive Summary

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

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

INSPIRE does not require collection of new data. However, after the period specified in the Directive[2] Member States have to make their data available according to the Implementing Rules.

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

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

To facilitate the implementation of INSPIRE, it is important that all stakeholders have the opportunity to participate in specification and development. For this reason, the Commission has put in place a consensus building process involving data users, and providers together with representatives of industry, research and government. These stakeholders, organised through Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO)[3], have provided reference materials, participated in the user requirement and technical[4] surveys, proposed experts for the Data Specification Drafting Team[5], the Thematic Working Groups[6] and other ad-hoc cross-thematic technical groups and participated in the public stakeholder consultations on draft versions of the data specifications. These consultations covered expert reviews as well as feasibility and fitness-for-purpose testing of the data specifications[7].

This open and participatory approach was successfully used during the development of the data specifications on Annex I, II and III data themes as well as during the preparation of the

Implementing Rule on Interoperability of Spatial Data Sets and Services[8] for Annex I spatial data themes and of its amendment regarding the themes of Annex II and III.

The development framework elaborated by the Data Specification Drafting Team aims at keeping the data specifications of the different themes coherent. It summarises the methodology to be used for the development of the data specifications, providing a coherent set of requirements and recommendations to achieve interoperability. The pillars of the framework are the following technical documents[9]:

- The *Definition of Annex Themes and Scope* describes in greater detail the spatial data themes defined in the Directive, and thus provides a sound starting point for the thematic aspects of the data specification development.
- The *Generic Conceptual Model* defines the elements necessary for interoperability and data harmonisation including cross-theme issues. It specifies requirements and recommendations with regard to data specification elements of common use, like the spatial and temporal schema, unique identifier management, object referencing, some common code lists, etc. Those requirements of the Generic Conceptual Model that are directly implementable are included in the Implementing Rule on Interoperability of Spatial Data Sets and Services.
- The *Methodology for the Development of Data Specifications* defines a repeatable methodology. It describes how to arrive from user requirements to a data specification through a number of steps including use-case development, initial specification development and analysis of analogies and gaps for further specification refinement.
- The *Guidelines for the Encoding of Spatial Data* defines how geographic information can be encoded to enable transfer processes between the systems of the data providers in the Member States. Even though it does not specify a mandatory encoding rule it sets GML (ISO 19136) as the default encoding for INSPIRE.
- The *Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development* provides guidelines on how the "Observations and Measurements" standard (ISO 19156) is to be used within INSPIRE.
- The *Common data models* are a set of documents that specify data models that are referenced by a number of different data specifications. These documents include generic data models for networks, coverages and activity complexes.

The structure of the data specifications is based on the "ISO 19131 Geographic information - Data product specifications" standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language[10].

A consolidated model repository, feature concept dictionary, and glossary are being maintained to support the consistent specification development and potential further reuse of specification elements. The consolidated model consists of the harmonised models of the relevant standards from the ISO 19100 series, the INSPIRE Generic Conceptual Model, and the application schemas[11] developed for each spatial data theme. The multilingual INSPIRE Feature Concept Dictionary contains the definition and description of the INSPIRE themes together with the definition of the spatial object types present in the specification. The INSPIRE Glossary defines all the terms (beyond the spatial object types) necessary for understanding the INSPIRE documentation including the terminology of other components (metadata, network services, data sharing, and monitoring).

By listing a number of requirements and making the necessary recommendations, the data specifications enable full system interoperability across the Member States, within the scope of the application areas targeted by the Directive. The data specifications (in their version 3.0) are published as technical guidelines and provide the basis for the content of the Implementing Rule on Interoperability of Spatial Data Sets and Services[12]. The content of the Implementing Rule is extracted from the data specifications, considering short- and medium-term feasibility as well as cost-benefit considerations. The requirements included in the Implementing Rule are legally binding for the Member States according to the timeline specified in the INSPIRE Directive.

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

Geology – Executive Summary

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

The use of geological data

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

How geoscientists could provide this useful information?

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

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

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

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

Hydrogeological information

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

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

Geophysical information

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

Which geological data to provide through INSPIRE?

Based on the analysis of the potential types of users and identification of use cases the TWG developed a core data model. It is based on the complex GeoSciML data model, developed by the international geosciences community, in particular Geological Survey Organisations (*http://www.geosciml.org/*).

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

Basic geological knowledge and applied maps

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

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

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The Thematic Working Group Geology and Mineral Resources (TWG-GE-MR) included:

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Also contributed:

Invited external experts for hydrogeology: Bernhard Wagner, Janusz Michalak,

Invited external expert for geoscience interoperability: Francois Robida.

For the final version of the document: Chris Schubert

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

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Table of Contents

1. Scope

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

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

2. Overview

2.1. Name

INSPIRE data specification for the theme *Geology*.

2.2. Informal description

Definition:

Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology [Directive 2007/2/EC].

Description

From the definition, we detail each word. **Geology** is the study of the past and present aspects of the Earth, including its history and life on Earth.

The **composition** of an earth material describes what it consists of (its components), both the weight percentage of elements or molecules (chemical composition), and the species and number of particles, e.g. minerals (mineralogical composition), clasts and fossils.

The **structure** of an earth material describes the physical arrangements of its components. A geologic structure is a configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an earth material.

The composition and structure of earth materials

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

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

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

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

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

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

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

This data specification defines three application schemas: Geology, Hydrogeology, and Geophysics to provide the basic geological, hydrogeological and geophysical knowledge on an area, with agreed sets of attributes. To demonstrate the extensibility and also to cover more specific geological and geophysical requirements two extension application schemas for *Geology* and Geophysics where defined (see Annex D).

The Geological data model contains:

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

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

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

The Hydrogeological data model contains:

- The Aquifer System comprising HydrogeologicUnits, Aquifers, Aquitards, Aquicludes and the AquiferSystem,
- The Groundwater System comprising GroundWaterBody, and its relationships to the Aquifer

System, Hydrogeology Objects, and WFD_GroundWaterBody

- Hydrogeology Objects, both natural and man-made, including Wells

Extensibility of the INSPIRE geology models:

- For geology: the possibility of using GeoSciML v 3.2 for a wide range of geoscientific information is discussed in the Annex D,
- For geophysics: guidance and examples are included to demonstrate the usage of the Observations & Measurements schema in delivering measurement and processing results.

Definition:

Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology [Directive 2007/2/EC].

Description:

In the INSPIRE context the *Geology* data theme can be seen as a "reference data theme" as it provides information for several other INSPIRE data themes e.g. Mineral resources; Area Management, Restriction and Regulation Zones; Natural Risk Zones; Soil; Energy resources. In *Geology* there is a specific relationship with one of the most important natural resources, water, through groundwater bodies contained in aquifers. The theme also covers geomorphology that describes the Earth's present-day surface, and the location of the geophysical campaigns and measurements that provide valuable information on the physical properties of rocks (like density, porosity, magnetic susceptibility, etc.) regardless of their organization as geologic units.

The INSPIRE *Geology* Theme is split into the following sub-themes:

- Geology: provides basic knowledge about the physical properties and composition of geologic materials (rocks and sediments), their structure and their age as depicted in geological maps, as well as landforms (geomorphological features). The model also covers boreholes - another important source of information for interpreting the subsurface geology.
- Hydrogeology: describes the flow, occurrence, and behaviour of water in the subsurface environment. The two basic elements are the rock system (including aquifers) and the groundwater system (including groundwater bodies). Man-made or natural hydrogeological objects/features (such as groundwater wells and natural springs) are also included.
- Geophysics: focuses on the availability and location of key geophysical features. It includes metadata on high rank gravity, magnetic and seismological stations that are part of international and national observation networks as well as metadata on 2D and 3D seismic measurements that are most often requested by third party users. It also provides collective metadata on gravity, magnetic and airborne geophysical campaigns that cover large areas and provide basic geological information for scientific research and more detailed applied studies e.g. exploring earth resources (hydrocarbons, mineral deposits, ground water, geothermal energy…).

Entry in the INSPIRE registry: *http://inspire.ec.europa.eu/theme/ge/*

2.3. Normative References

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

[ISO 19105] EN ISO 19105:2000, Geographic information — Conformance and testing

[ISO 19105] EN ISO 19105:2000, Geographic information — Conformance and testing

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

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

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

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

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

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

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

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

[ISO 19125-1] EN ISO 19125-1:2004, Geographic Information – Simple feature access – Part 1: Common architecture

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

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

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

[ISO 19157] ISO/DIS 19157, Geographic information – Data quality

[OGC 06-103r4] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.1

NOTE This is an updated version of "EN ISO 19125-1:2004, Geographic information – Simple feature access – Part 1: Common architecture".

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

[Regulation 976/2009/EC] Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the

Network Services

[Regulation 1089/2010/EC] Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services

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

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

2.4. Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[13].

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

(1) GeologicFeature

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

(2) MappedFeature

A spatial representation of a GeologicFeature. A MappedFeature is part of a geological interpretation.

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

(3) Geologic Unit

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

(4) Geologic Structure

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

(5) Hydrogeologic Unit

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

(6) Aquifer

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

(7) Groundwater Body

A distinct volume of groundwater within an aquifer or system of aquifers, which is hydraulically isolated from nearby groundwater bodies.

(8) Geophysical Station

Geophysical measurement spatially referenced to a single point location.

(9) Geophysical Profile

Geophysical measurement spatially referenced to a curve.

(10) Geophysical Swath

Geophysical measurement spatially referenced to a surface.

(11) Campaign

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

2.5. Symbols and abbreviations

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2.6. How the Technical Guidelines map to the Implementing Rules

The schematic diagram in Figure 1 gives an overview of the relationships between the INSPIRE legal acts (the INSPIRE Directive and Implementing Rules) and the INSPIRE Technical Guidelines. The INSPIRE Directive and Implementing Rules include legally binding requirements that describe, usually on an abstract level, *what* Member States must implement.

In contrast, the Technical Guidelines define *how* Member States might implement the requirements included in the INSPIRE Implementing Rules. As such, they may include non-binding technical requirements that must be satisfied if a Member State data provider chooses to conform to the Technical Guidelines. Implementing these Technical Guidelines will maximise the interoperability of INSPIRE spatial data sets.

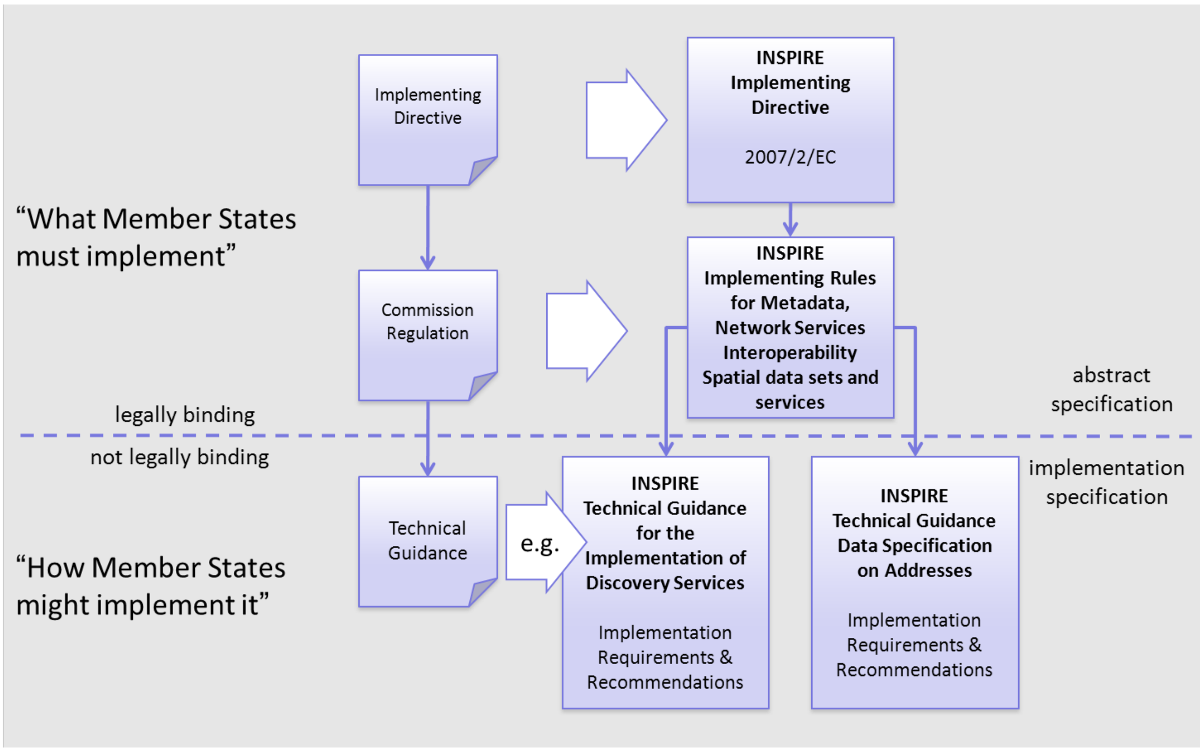


Figure 1 - Relationship between INSPIRE Implementing Rules and Technical Guidelines

2.6.1. Requirements

The purpose of these Technical Guidelines (Data specifications on *Geology*) is to provide practical guidance for implementation that is guided by, and satisfies, the (legally binding) requirements included for the spatial data theme *Geology* in the Regulation (Implementing Rules) on interoperability of spatial data sets and services. These requirements are highlighted in this document as follows:

IR Requirement
Article / Annex / Section no.
Title / Heading

This style is used for requirements contained in the Implementing Rules on interoperability of spatial data sets and services (Commission Regulation (EU) No 1089/2010).

For each of these IR requirements, these Technical Guidelines contain additional explanations and examples.

NOTE The Abstract Test Suite (ATS) in Annex A contains conformance tests that directly check conformance with these IR requirements.

Furthermore, these Technical Guidelines may propose a specific technical implementation for satisfying an IR requirement. In such cases, these Technical Guidelines may contain additional technical requirements that need to be met in order to be conformant with the corresponding IR requirement *when using this proposed implementation*. These technical requirements are highlighted as follows:

TG Requirement X

This style is used for requirements for a specific technical solution proposed in these Technical Guidelines for an IR requirement.

NOTE 1 Conformance of a data set with the TG requirement(s) included in the ATS implies conformance with the corresponding IR requirement(s).

NOTE 2 In addition to the requirements included in the Implementing Rules on interoperability of spatial data sets and services, the INSPIRE Directive includes further legally binding obligations that put additional requirements on data providers. For example, Art. 10(2) requires that Member States shall, where appropriate, decide by mutual consent on the depiction and position of geographical features whose location spans the frontier between two or more Member States. General guidance for how to meet these obligations is provided in the INSPIRE framework documents.

2.6.2. Recommendations

In addition to IR and TG requirements, these Technical Guidelines may also include a number of recommendations for facilitating implementation or for further and coherent development of an interoperable infrastructure.

Recommendation X

Recommendations are shown using this style.

NOTE The implementation of recommendations is not mandatory. Compliance with these Technical Guidelines or the legal obligation does not depend on the fulfilment of the recommendations.

2.6.3. Conformance

Annex A includes the abstract test suite for checking conformance with the requirements included in these Technical Guidelines and the corresponding parts of the Implementing Rules (Commission Regulation (EU) No 1089/2010).

3. Specification scopes

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

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

4. Identification information

These Technical Guidelines are identified by the following URI:

http://inspire.ec.europa.eu/tg/ge/3.0

NOTE ISO 19131 suggests further identification information to be included in this section, e.g. the title, abstract or spatial representation type. The proposed items are already described in the document metadata, executive summary, overview description (section 2) and descriptions of the application schemas (section 5). In order to avoid redundancy, they are not repeated here.

5. Data content and structure

5.1. Application schemas – Overview

5.1.1. Application schemas included in the IRs

Articles 3, 4 and 5 of the Implementing Rules lay down the requirements for the content and structure of the data sets related to the INSPIRE Annex themes.

IR Requirement
Article 4
Types for the Exchange and Classification of Spatial Objects

1. For the exchange and classification of spatial objects from data sets meeting the conditions laid down in Article 4 of Directive 2007/2/EC, Member States shall use the spatial object types and associated data types and code lists that are defined in Annexes II, III and IV for the themes the data sets relate to.
2. When exchanging spatial objects, Member States shall comply with the definitions and constraints set out in the Annexes and provide values for all attributes and association roles set out for the relevant spatial object types and data types in the Annexes. For voidable attributes and association roles for which no value exists, Member States may omit the value.

The types to be used for the exchange and classification of spatial objects from data sets related to the spatial data theme Geology are defined in the following application schemas (see sections 5.3, 5.4, 5.5):

- Geology application schema
- Hydrogeology application schema
- Geophysics application schema

All 3 application schemas provide basic geological, hydrogeological and geophysical knowledge on an area, with an agreed set of attributes.

The application schemas specify requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc.

NOTE The application schemas presented in this section contain some additional information that is not included in the Implementing Rules, in particular multiplicities of attributes and association roles.

TG Requirement 1

Spatial object types and data types shall comply with the multiplicities defined for the attributes and association roles in this section.

An application schema may include references (e.g. in attributes or inheritance relationships) to common types or types defined in other spatial data themes. These types can be found in a sub-section called "Imported Types" at the end of each application schema section. The common types referred to from application schemas included in the IRs are addressed in Article 3.

IR Requirement
Article 3
Common Types

Types that are common to several of the themes listed in Annexes I, II and III to Directive 2007/2/EC shall conform to the definitions and constraints and include the attributes and association roles set out in Annex I.

NOTE Since the IRs contain the types for all INSPIRE spatial data themes in one document, Article 3 does not explicitly refer to types defined in other spatial data themes, but only to types defined in external data models.

Common types are described in detail in the Generic Conceptual Model [DS-D2.7], in the relevant international standards (e.g. of the ISO 19100 series) or in the documents on the common INSPIRE models [DS-D2.10.x]. For detailed descriptions of types defined in other spatial data themes, see the corresponding Data Specification TG document [DS-D2.8.x].

5.1.2. Additional recommended application schemas

In addition to the application schemas listed above, the following additional application schema have been defined for the theme *Geology* (see Annex D):

- Geophysics extension application schema to share e.g. geophysical observation results in a harmonised way using ISO 19156 (O&M) Standard.

These additional application schemas are not included in the IRs. They typically address requirements from specific (groups of) use cases and/or may be used to provide additional information. They are included in this specification in order to improve interoperability also for these additional aspects and to illustrate the extensibility of the application schemas included in the IRs.

Recomendation 1

Additional and/or use case-specific information related to the theme *Geology* should be made available using the spatial object types and data types specified in the following application schema: - **Geophysics extension**

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

The code lists used in attributes or association roles of spatial object types or data types should comply with the definitions and include the values defined in the Annex D.

5.2. Basic notions

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

5.2.1. Notation

5.2.1.1. Unified Modeling Language (UML)

The application schemas included in this section are specified in UML, version 2.1. The spatial object types, their properties and associated types are shown in UML class diagrams.

NOTE For an overview of the UML notation, see Annex D in [ISO 19103].

The use of a common conceptual schema language (i.e. UML) allows for an automated processing of application schemas and the encoding, querying and updating of data based on the application schema – across different themes and different levels of detail.

The following important rules related to class inheritance and abstract classes are included in the IRs.

IR Requirement
Article 5
Types

(…)

2. Types that are a sub-type of another type shall also include all this type's attributes and association roles.
3. Abstract types shall not be instantiated.

The use of UML conforms to ISO 19109 8.3 and ISO/TS 19103 with the exception that UML 2.1 instead of ISO/IEC 19501 is being used. The use of UML also conforms to ISO 19136 E.2.1.1.1-E.2.1.1.4.

NOTE ISO/TS 19103 and ISO 19109 specify a profile of UML to be used in conjunction with the ISO 19100 series. This includes in particular a list of stereotypes and basic types to be used in application schemas. ISO 19136 specifies a more restricted UML profile that allows for a direct encoding in XML Schema for data transfer purposes.

To model constraints on the spatial object types and their properties, in particular to express data/data set consistency rules, OCL (Object Constraint Language) is used as described in ISO/TS 19103, whenever possible. In addition, all constraints are described in the feature catalogue in English, too.

NOTE Since "void" is not a concept supported by OCL, OCL constraints cannot include expressions to test whether a value is a *void* value. Such constraints may only be expressed in natural language.

5.2.1.2. Stereotypes

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

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

Stereotype	Model element	Description
applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
leaf	Package	A package that is not an application schema and contains no packages.
featureType	Class	A spatial object type.
type	Class	A type that is not directly instantiable, but is used as an abstract collection of operation, attribute and relation signatures. This stereotype should usually not be used in INSPIRE application schemas as these are on a different conceptual level than classifiers with this stereotype.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
codeList	Class	A code list.
import	Dependency	The model elements of the supplier package are imported.
voidable	Attribute, association role	A voidable attribute or association role (see section 5.2.2).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.

Stereotype	Model element	Description
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.2.2. Voidable characteristics

The «voidable» stereotype is used to characterise those properties of a spatial object that may not be present in some spatial data sets, even though they may be present or applicable in the real world. This does *not* mean that it is optional to provide a value for those properties.

For all properties defined for a spatial object, a value has to be provided – either the corresponding value (if available in the data set maintained by the data provider) or the value of *void.* A *void* value shall imply that no corresponding value is contained in the source spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs.

Recomendation 2

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

The VoidReasonValue type is a code list, which includes the following pre-defined values:

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

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

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

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

In both cases, the «voidable» stereotype can be applied. In cases where the minimum multiplicity is 0, the absence of a value indicates that it is known that no value exists, whereas a value of void indicates that it is not known whether a value exists or not.

EXAMPLE If an address does not have a house number, the corresponding Address object should not have any value for the «voidable» attribute house number. If the house number is simply not known or not populated in the data set, the Address object should receive a value of *void* (with the corresponding void reason) for the house number attribute.

5.2.3. Code lists

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

5.2.3.1. Code list types

The IRs distinguish the following types of code lists.

IR Requirement
Article 6
Code Lists for Spatial Data Sets

1. The code lists included in this Regulation set out the multilingual thesauri to be used for the key attributes, in accordance with Article 8(2), point (c), of Directive 2007/2/EC.
2. The Commission shall establish and operate an INSPIRE code list register at Union level for managing and making publicly available the values that are included in the code lists referred to in paragraph 1.
3. The Commission shall be assisted by the INSPIRE Commission expert group in the maintenance and update of the code list values.
4. Code lists shall be one of the following types:
   a. code lists whose values comprise only the values specified in the INSPIRE code list register;
   b. code lists whose values comprise the values specified in the INSPIRE code list register and narrower values defined by data providers;
   c. code lists whose values comprise the values specified in the INSPIRE code list register and additional values at any level defined by data providers;
   d. code lists, whose values comprise any values defined by data providers.

5. Code lists may be hierarchical. Values of hierarchical code lists may have a more general parent value.
6. Where, for an attribute whose type is a code list as referred to in paragraph 4, points (b), (c) or (d), a data provider provides a value that is not specified in the INSPIRE code list register, that value and its definition and label shall be made available in another register.

The type of code list is represented in the UML model through the tagged value *extensibility*, which can take the following values:

- *none*, representing code lists whose allowed values comprise only the values specified in the IRs (type a);
- *narrower*, representing code lists whose allowed values comprise the values specified in the IRs and narrower values defined by data providers (type b);
- *open*, representing code lists whose allowed values comprise the values specified in the IRs and additional values at any level defined by data providers (type c); and
- *any*, representing code lists, for which the IRs do not specify any allowed values, i.e. whose allowed values comprise any values defined by data providers (type d).

Recomendation 3

Additional values defined by data providers should not replace or redefine any value already specified in the IRs.

NOTE This data specification may specify recommended values for some of the code lists of type (b), (c) and (d) (see section 5.2.4.3). These recommended values are specified in a dedicated Annex.

In addition, code lists can be hierarchical, as explained in Article 6(5) of the IRs.

IR Requirement
Article 6
Code Lists for Spatial Data Sets

(…)

5. Code lists may be hierarchical. Values of hierarchical code lists may have a more general parent value.

The type of code list and whether it is hierarchical or not is also indicated in the feature catalogues.

5.2.3.2. Obligations on data providers

IR Requirement
Article 6
Code Lists for Spatial Data Sets

(….)

6. Where, for an attribute whose type is a code list as referred to in paragraph 4, points (b), (c) or (d), a data provider provides a value that is not specified in the INSPIRE code list register, that value and its definition and label shall be made available in another register.

Article 6(6) obliges data providers to use only values that are allowed according to the specification of the code list. The "allowed values according to the specification of the code list" are the values explicitly defined in the IRs plus (in the case of code lists of type (b), (c) and (d)) additional values defined by data providers.

For attributes whose type is a code list of type (b), (c) or (d) data providers may use additional values that are not defined in the IRs. Article 6(6) requires that such additional values and their definition be made available in a register. This enables users of the data to look up the meaning of the additional values used in a data set, and also facilitates the re-use of additional values by other data providers (potentially across Member States).

NOTE Guidelines for setting up registers for additional values and how to register additional values in these registers is still an open discussion point between Member States and the Commission.

5.2.3.3. Recommended code list values

For code lists of type (b), (c) and (d), this data specification may propose additional values as a recommendation (in a dedicated Annex). These values will be included in the INSPIRE code list register. This will facilitate and encourage the usage of the recommended values by data providers since the obligation to make additional values defined by data providers available in a register (see section 5.2.4.2) is already met.

Recomendation 4

Where these Technical Guidelines recommend values for a code list in addition to those specified in the IRs, these values should be used.

NOTE For some code lists of type (d), no values may be specified in these Technical Guidelines. In these cases, any additional value defined by data providers may be used.

5.2.3.4. Governance

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

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

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

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

  Since the updates of externally governed code lists is outside the control of INSPIRE, the IRs and these Technical Guidelines reference a specific version for such code lists.

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

  - The *Governance* column describes the external organisation that is responsible for maintaining the code list.
  - The *Source* column specifies a citation for the authoritative source for the values of the code list. For code lists, whose values are mandated in the IRs, this citation should include the version of the code list used in INSPIRE. The version can be specified using a version number or the publication date. For code list values recommended in these Technical Guidelines, the citation may refer to the "latest available version".
  - In some cases, for INSPIRE only a subset of an externally governed code list is relevant. The subset is specified using the *Subset* column.
  - The *Availability* column specifies from where (e.g. URL) the values of the externally governed code list are available, and in which formats. Formats can include machine-readable (e.g. SKOS/RDF, XML) or human-readable (e.g. HTML, PDF) ones.

  Code list values are encoded using http URIs and labels. Rules for generating these URIs and labels are specified in a separate table.

> **Recomendation 5**
>
> The http URIs and labels used for encoding code list values should be taken from the INSPIRE code list registry for INSPIRE-governed code lists and generated according to the relevant rules specified for externally governed code lists.

NOTE Where practicable, the INSPIRE code list register could also provide http URIs and labels for externally governed code lists.

5.2.3.5. Vocabulary

For each code list, a tagged value called "vocabulary" is specified to define a URI identifying the values of the code list. For INSPIRE-governed code lists and externally governed code lists that do not have a persistent identifier, the URI is constructed following the pattern <a href="http://inspire.ec.europa.eu/codelist/<UpperCamelCaseName&gt" class="bare">http://inspire.ec.europa.eu/codelist/<UpperCamelCaseName&gt;.

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

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

5.2.4. Identifier management

IR Requirement
Article 9
Identifier Management

1. The data type Identifier defined in Section 2.1 of Annex I shall be used as a type for the external object identifier of a spatial object.
2. The external object identifier for the unique identification of spatial objects shall not be changed during the life-cycle of a spatial object.

NOTE 1 An external object identifier is a unique object identifier which is published by the responsible body, which may be used by external applications to reference the spatial object. [DS-D2.5]

NOTE 2 Article 9(1) is implemented in each application schema by including the attribute *inspireId* of type Identifier.

NOTE 3 Article 9(2) is ensured if the *namespace* and *localId* attributes of the Identifier remains the same for different versions of a spatial object; the *version* attribute can of course change.

5.2.5. Geometry representation

IR Requirement
Article 12
Other Requirements & Rules

1. The value domain of spatial properties defined in this Regulation shall be restricted to the Simple Feature spatial schema as defined in Herring, John R. (ed.), OpenGIS® Implementation Standard for Geographic information – Simple feature access – Part 1: Common architecture, version 1.2.1, Open Geospatial Consortium, 2011, unless specified otherwise for a specific spatial data theme or type.

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

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

5.2.6. Temporality representation

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

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

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

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

IR Requirement
Article 10
Life-cycle of Spatial Objects

(...)

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

NOTE The requirement expressed in the IR Requirement above will be included as constraints in the UML data models of all themes.

Recomendation 6

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

5.2.6.1. Validity of the real-world phenomena

The application schema(s) use(s) the attributes "validFrom" and "validTo" to record the validity of the real-world phenomenon represented by a spatial object.

The attributes "validFrom" specifies the date and time at which the real-world phenomenon became valid in the real world. The attribute "validTo" specifies the date and time at which the real-world phenomenon is no longer valid in the real world.

Specific application schemas may give examples what "being valid" means for a specific real-world phenomenon represented by a spatial object.

IR Requirement
Article 12
Other Requirements & Rules

(...)

3. Where the attributes validFrom and validTo are used, the value of validTo shall not be before the value of validFrom.

NOTE The requirement expressed in the IR Requirement above will be included as constraints in the UML data models of all themes.

5.2.7. Coverages

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

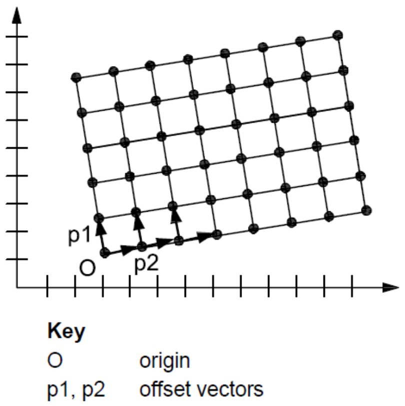
In INSPIRE application schemas, coverage functions are defined as properties of spatial object types where the type of the property value is a realisation of one of the types specified in ISO 19123.

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

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

In addition, some themes make reference to the types TimeValuePair and Timeseries defined in Taylor, Peter (ed.), *OGC® WaterML 2.0: Part 1 – Timeseries, v2.0.0*, Open Geospatial Consortium, 2012. These provide a representation of the time instant/value pairs, i.e. time series (see Figure 3).

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



(Source: ISO 19136:2007)
image::./media/image6.png[image,width=309,height=209, align=center]
(Source: GML 3.3.0)

Figure 2 – Examples of a rectified grid (left) and a referenceable grid (right)

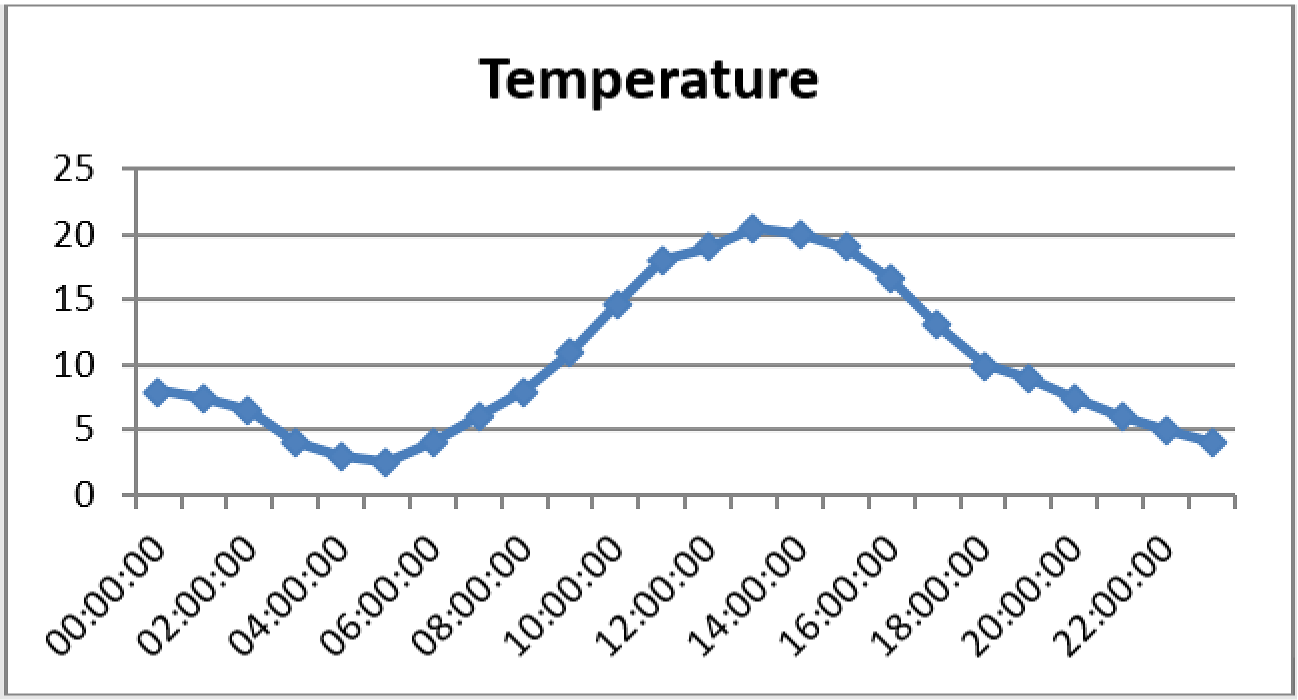


Figure 3 – Example of a time series

5.3. Application schema Geology

5.3.1. Description

5.3.1.1. Narrative description and UML Overview

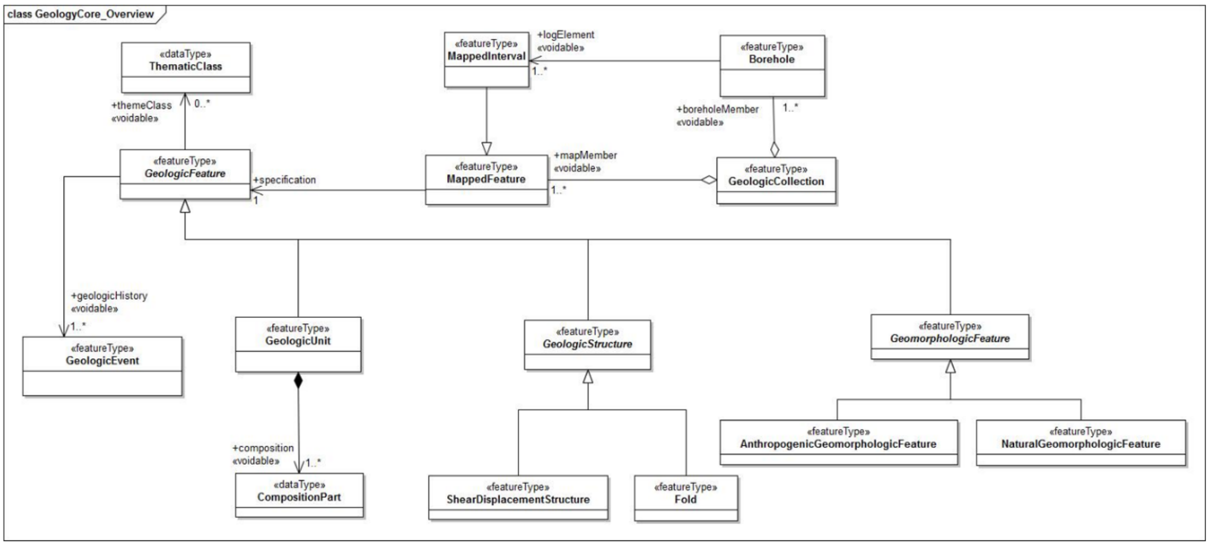


Figure 4 – UML class diagram: Overview of the Geology application schema

Figure 4 shows only the spatial object types and their relationships. It does not include data types and code-lists. The properties are not visible but are shown in the following figures, which describe the main parts of the Geology data model.

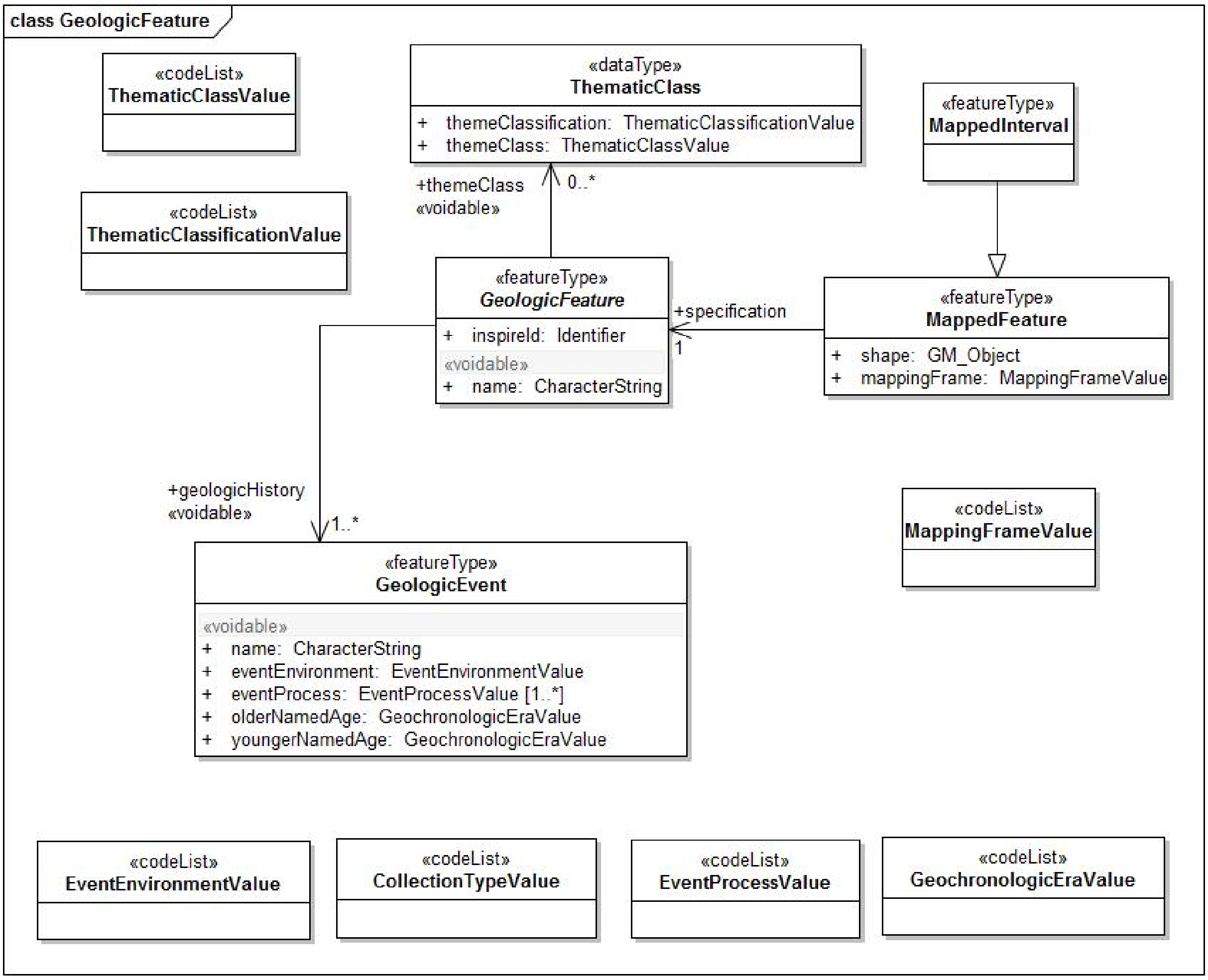


Figure 5 – UML class diagram: GeologicFeature, MappedFeature, GeologicEvent, ThematicClass

MappedFeature and *GeologicFeature* are central classes (spatial object types) in the model.

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

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

The abstract *GeologicFeature* class represents a conceptual geological feature that is hypothesized to exist coherently in the world, and includes as sub-types the main information classes in the model. The implemented Geologic Feature instance acts as the "description package". There are three sub-types of *GeologicFeature* in the data model: *GeologicUnit, GeologicStructure and GeomorphologicFeature.*

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

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

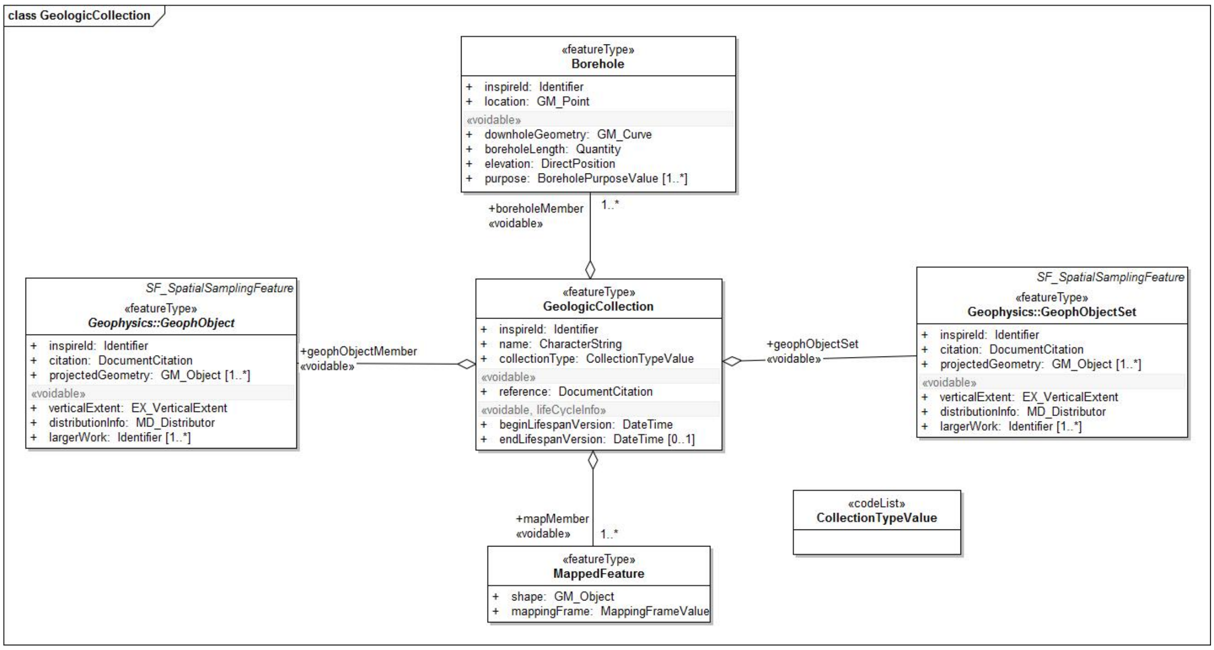


Figure 6 – UML class diagram: GeologicCollection

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

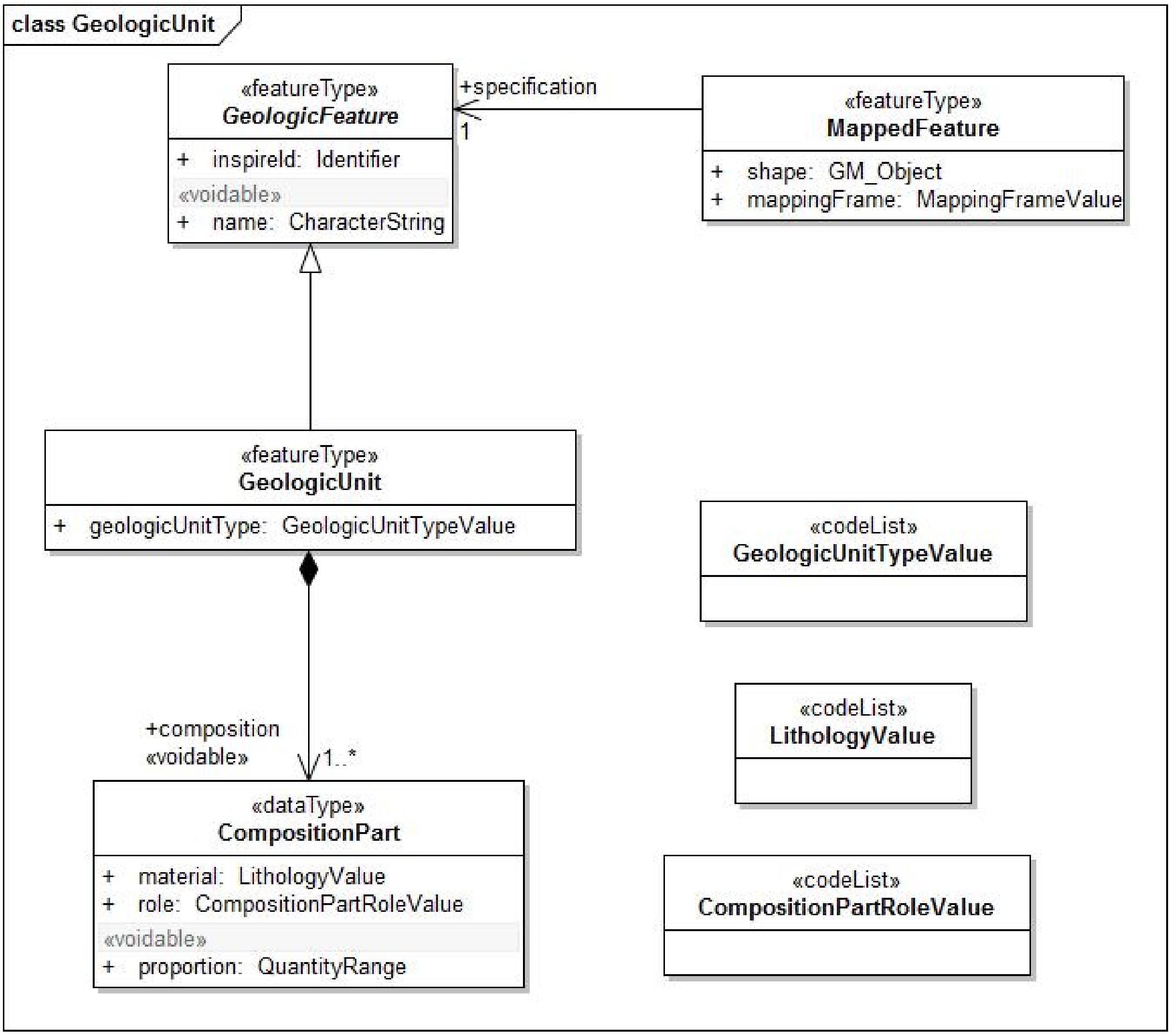


Figure 7 – UML class diagram: GeologicUnit

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

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

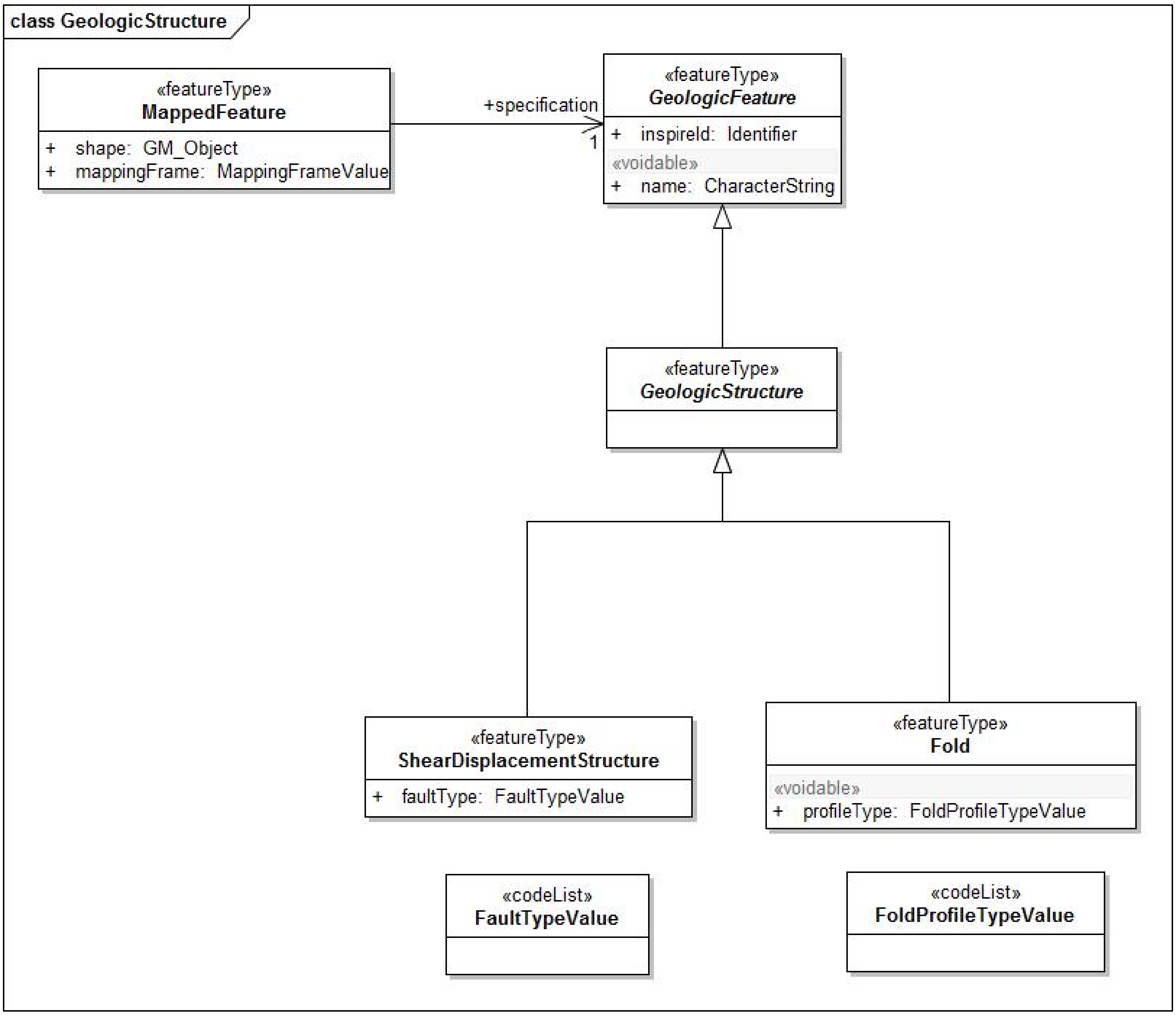


Figure 8 – UML class diagram: GeologicStructure

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

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

- *ShearDisplacementStructure* includes all brittle to ductile style structures along which displacement has occurred, from a simple, single 'planar' brittle (fault) or ductile surface to a fault system comprised of tens of strands of both brittle and ductile nature.
- *Fold* describes one or more systematically curved layers, surfaces, or lines in a rock body. A fold denotes a structure formed by the deformation of a Geologic Feature to form a structure that may be described by the translation of an abstract line (the fold axis) along some curvilinear path (the fold profile).

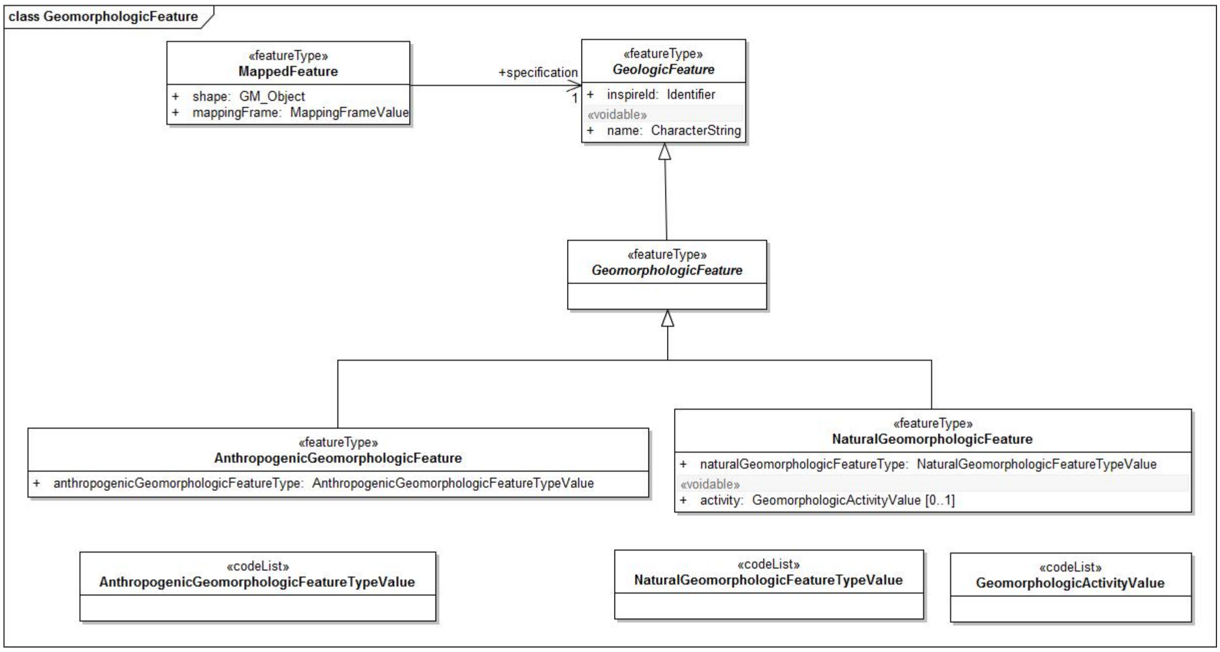


Figure 9 – UML class diagram: GeomorphologicFeature

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

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

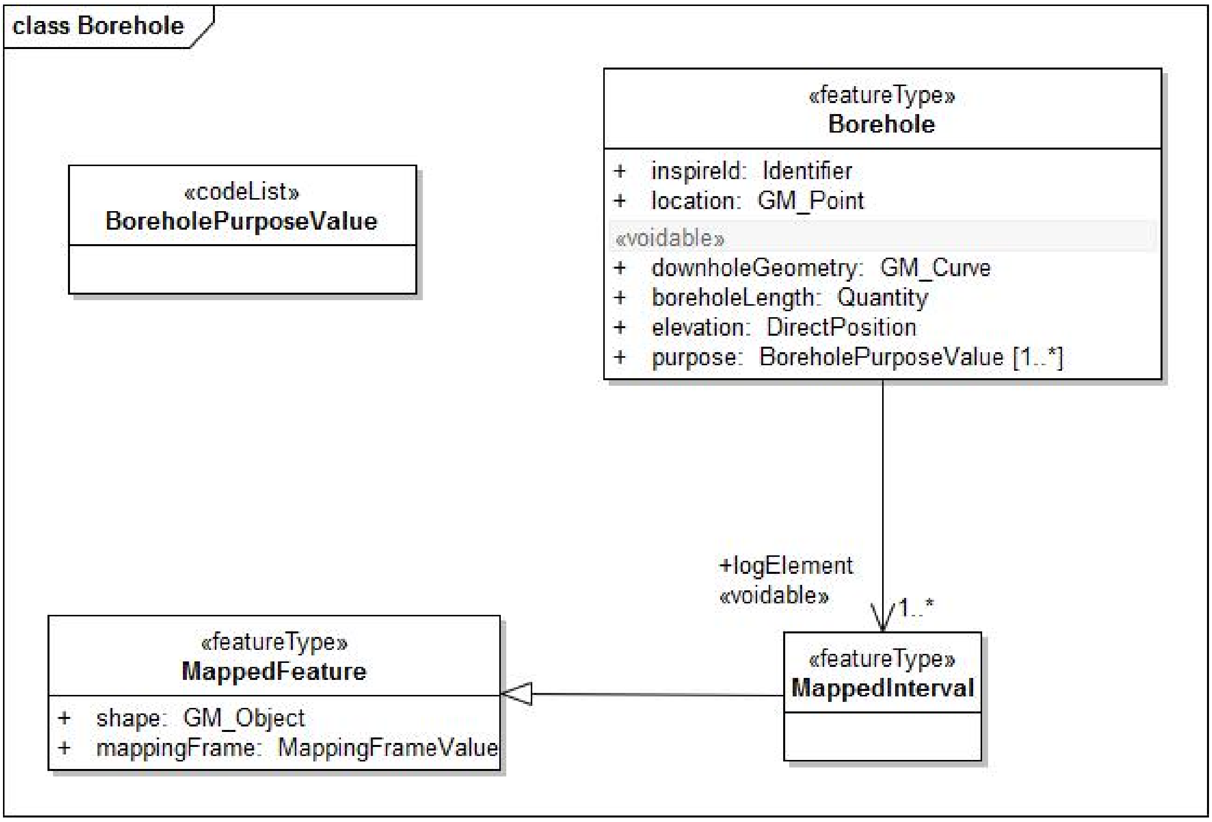


Figure 10 – UML class diagram: Borehole

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

A MappedInterval is therefore an interpretation of the observations (lithological, geophysical etc) made in the original log, and it is only such interpreted borehole logs which are in scope of the data specification. These interpretations can be in terms of lithostratigraphic units described in a stratigraphic lexicon and shown on a geological map, but they can be in terms of other types of unit such as a recognisable lithological unit correlated between boreholes. The data specification does not cover the original observations upon which the interpretation was made, but these can be delivered using the GeoSciML and the ISO 19156 Observations & Measurements standard.

5.3.1.2. Consistency between spatial data sets

The observation location is specified by its coordinates.

5.3.1.3. Modelling of object references

MappedFeature can be seen as a container for geometry whereas GeologicFeature is a container for properties. This enables a single 'real world' GeologicFeature to have multiple 'map' representations, for example at different scales or resolutions of map or as an element in a 3D model

5.3.2. Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema Geology
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
AnthropogenicGeomorphologicFeature	Geology	«featureType»
AnthropogenicGeomorphologicFeatureTypeValue	Geology	«codeList»
Borehole	Geology	«featureType»
BoreholePurposeValue	Geology	«codeList»
CollectionTypeValue	Geology	«codeList»
CompositionPart	Geology	«dataType»
CompositionPartRoleValue	Geology	«codeList»
EventEnvironmentValue	Geology	«codeList»
EventProcessValue	Geology	«codeList»
FaultTypeValue	Geology	«codeList»
Fold	Geology	«featureType»
FoldProfileTypeValue	Geology	«codeList»
GeochronologicEraValue	Geology	«codeList»
GeologicCollection	Geology	«featureType»
GeologicEvent	Geology	«featureType»
GeologicFeature	Geology	«featureType»
GeologicStructure	Geology	«featureType»
GeologicUnit	Geology	«featureType»
GeologicUnitTypeValue	Geology	«codeList»
GeomorphologicActivityValue	Geology	«codeList»
GeomorphologicFeature	Geology	«featureType»
LithologyValue	Geology	«codeList»
MappedFeature	Geology	«featureType»
MappedInterval	Geology	«featureType»
MappingFrameValue	Geology	«codeList»

Type	Package	Stereotypes
NaturalGeomorphologicFeature	Geology	«featureType»
NaturalGeomorphologicFeature TypeValue	Geology	«codeList»
ShearDisplacementStructure	Geology	«featureType»
ThematicClass	Geology	«dataType»
ThematicClassValue	Geology	«codeList»
ThematicClassificationValue	Geology	«codeList»

5.3.2.1. Spatial object types

5.3.2.1.1. AnthropogenicGeomorphologicFeature

AnthropogenicGeomorphologicFeature

Subtype of:	GeomorphologicFeature
Definition:	A geomorphologic feature (ie, landform) which has been created by human activity.
Description:	EXAMPLE: dredged channel, midden, open pit, reclaimed land.
Stereotypes:	«featureType»

Attribute: anthropogenicGeomorphologicFeatureType

Value type:	AnthropogenicGeomorphologicFeatureTypeVal ue
Definition:	Terms describing the type of a geomorphologic feature.
Multiplicity:	1

5.3.2.1.2. Borehole

Borehole

Definition:	A borehole is the generalized term for any narrow shaft drilled in the ground.
Stereotypes:	«featureType»

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the spatial object.
Multiplicity:	1

Borehole	

Attribute: downholeGeometry

Name:	The downhole geometry of the borehole
Value type:	GM_Curve
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: boreholeLength

Value type:	Quantity
Definition:	The distance along a borehole.
Description:	This will be determined by the data provider (ie, "length" can have different sources, like drillers measurement, loggers measurement, survey).
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: elevation

Value type:	DirectPosition
Definition:	The vertical height above datum of the borehole collar.
Description:	This is a compromise approach to supply elevation explictly for location; this is to allow for software that cannot process 3-D GM_Point. Use null if elevation is unknown. Direct position shall have a dimension of 1, and CRS will be a "vertical" CRS (e.g. EPSG CRSs in the range 5600-5799).
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: location

Value type:	GM_Point
Definition:	The location of the borehole collar.
Multiplicity:	1

Borehole	
Attribute: purpose	
Value type:	BoreholePurposeValue
Definition:	The purpose for which the borehole was drilled.
Description:	EXAMPLE: site investigation, mineral exploration, hydrocarbon exploration, water resources.
Multiplicity:	1..*
Stereotypes:	«voidable»
Association role: logElement	
Value type:	MappedInterval
Definition:	1-D MappedFeature instances that are logged (interpreted) intervals within a borehole.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.3. Fold

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

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

5.3.2.1.4. GeologicCollection

GeologicCollection	
Definition:	A collection of geological or geophysical objects.
Description:	Geologic objects are commonly grouped into collections such as geological maps, thematic maps, or the required input to a geological model.
Stereotypes:	«featureType»
Attribute: inspireId	
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Multiplicity:	1
Attribute: name	
Value type:	CharacterString
Definition:	The name of the collection.
Multiplicity:	1

GeologicCollection	
Attribute: collectionType	
Value type:	CollectionTypeValue
Definition:	The type of the collection.
Description:	Refers to a vocabulary of types. EXAMPLE: geological map, thematic map etc.
Multiplicity:	1
Attribute: reference	
Value type:	DocumentCitation
Definition:	A reference for the collection.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: beginLifespanVersion	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: endLifespanVersion	
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»
Association role: geophObjectSet	
Value type:	GeophObjectSet
Definition:	A GeophObjectSet member of a Geologic Collection.
Multiplicity:	0..*
Stereotypes:	«voidable»

GeologicCollection	
Association role: geophObjectMember	
Value type:	GeophObject
Definition:	A GeophObject member of a Geologic Collection.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: boreholeMember	
Value type:	Borehole
Definition:	A Borehole member of a Geologic Collection.
Description:	Association that allows Borehole objects to be included as members in a GML Collection, through the use of the GeologicCollection class.
Multiplicity:	1..*
Stereotypes:	«voidable»
Association role: mapMember	
Value type:	MappedFeature
Definition:	A Mapped Feature member of a Geologic Collection.
Description:	Association that allows MappedFeature objects to be included as members in a GML Collection, through the use of the GeologicCollection class.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.5. GeologicEvent

GeologicEvent

Definition:	An identifiable event during which one or more geological processes act to modify geological entities.
Description:	A GeologicEvent should have a specified geologic age and process, and may have a specified environment. An example might be a cratonic uplift event during which erosion, sedimentation, and volcanism all take place. A GeologicEvent age can represent an instant in time or an interval of time.
Stereotypes:	«featureType»

Attribute: name

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

Attribute: eventEnvironment

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

GeologicEvent	
Attribute: eventProcess	
Value type:	EventProcessValue
Definition:	The process or processes that occurred during the geologic event.
Description:	EXAMPLE: deposition, extrusion, intrusion, cooling.
Multiplicity:	1..*
Stereotypes:	«voidable»
Attribute: olderNamedAge	
Value type:	GeochronologicEraValue
Definition:	Older boundary of the age of the event.
Description:	This is expressed using a geochronologic era defined in a vocabulary of recognised units, such as those of the International Commission on Stratigraphy (ICS) Stratigraphic Chart.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: youngerNamedAge	
Value type:	GeochronologicEraValue
Definition:	Younger boundary of the age of the event.
Description:	This is expressed using a geochronologic era defined in a vocabulary of recognised units, such as those of the International Commission on Stratigraphy (ICS) Stratigraphic Chart.
Multiplicity:	1
Stereotypes:	«voidable»

5.3.2.1.6. GeologicFeature

GeologicFeature (abstract)

Definition:	A conceptual geological feature that is hypothesized to exist coherently in the world.
Description:	This corresponds with a "legend item" from a traditional geologic map. While the bounding coordinates of a Geologic Feature may be described, its shape is not. The implemented Geologic Feature instance acts as the "description package"
Stereotypes:	«featureType»

Attribute: inspireId

Value type:	Identifier
Definition:	External object identifier of the spatial object.
Multiplicity:	1

Attribute: name

Value type:	CharacterString
Definition:	The name of the geologic feature.
Description:	EXAMPLE: a lithostratigraphic unit, mineral occurrence, or major fault. Not all GeologicFeatures will have names, for example minor faults.
Multiplicity:	1
Stereotypes:	«voidable»

Association role: themeClass

Value type:	ThematicClass
Definition:	A thematic classification of the geologic feature.
Description:	A GeologicFeature may be classified according to one or more thematic schema, for example ground stability or mineral resource potential.
Multiplicity:	0..*
Stereotypes:	«voidable»

GeologicFeature (abstract)	
Association role: geologicHistory	
Value type:	GeologicEvent
Definition:	An association that relates one or more geologic events to a geologic feature to describe their age or geologic history.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.7. GeologicStructure

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

5.3.2.1.8. GeologicUnit

GeologicUnit	
Subtype of:	GeologicFeature
Definition:	A volume of rock with distinct characteristics.
Description:	Includes both formal units (i.e. formally adopted and named in an official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised). Spatial properties are only available through association with a MappedFeature.
Stereotypes:	«featureType»

GeologicUnit	
Attribute: geologicUnitType	
Value type:	GeologicUnitTypeValue
Definition:	The type of geological the unit.
Description:	Logical constraints of definition of unit and valid property cardinalities should be contained in the definition.
Multiplicity:	1
Association role: composition	
Value type:	CompositionPart
Definition:	Describes the composition of the geologic unit.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.3.2.1.9. GeomorphologicFeature

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

5.3.2.1.10. MappedFeature

MappedFeature	
Definition:	A spatial representation of a GeologicFeature.
Description:	A MappedFeature is part of a geological interpretation. It provides a link between a notional feature (description package) and one spatial representation of it, or part of it (exposures, surface traces and intercepts, etc) which forms the specific bounded occurrence, such as an outcrop or map polygon.
Stereotypes:	«featureType»
Attribute: shape	
Value type:	GM_Object
Definition:	The geometry of the mapped feature.
Multiplicity:	1
Attribute: mappingFrame	
Value type:	MappingFrameValue
Definition:	The surface on which the mapped feature is projected.
Description:	EXAMPLE: Topographic surface, Bedrock surface, Base of Permian
Multiplicity:	1
Association role: specification	
Value type:	GeologicFeature
Definition:	A description association that links a mapped feature to a notional geologic feature.
Description:	A geologic feature, such as a geologic unit may be linked to mapped features from a number of different maps. A mapped feature, however is always associated with only a single description (geologic feature).
Multiplicity:	1

5.3.2.1.11. MappedInterval

MappedInterval	
Subtype of:	MappedFeature
Definition:	A special kind of mapped feature whose shape is a 1-D interval and which uses the SRS of the containing borehole.
Stereotypes:	«featureType»

5.3.2.1.12. NaturalGeomorphologicFeature

NaturalGeomorphologicFeature	
Subtype of:	GeomorphologicFeature
Definition:	A geomorphologic feature (ie, landform) that has been created by natural Earth processes.
Description:	EXAMPLE: river channel, beach ridge, caldera, canyon, moraine, mud flat.
Stereotypes:	«featureType»
Attribute: naturalGeomorphologicFeatureType	
Value type:	NaturalGeomorphologicFeatureTypeValue
Definition:	The type of the natural geomorphologic feature.
Multiplicity:	1
Attribute: activity	
Value type:	GeomorphologicActivityValue
Definition:	The level of activity of the natural geomorphologic feature.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.3.2.1.13. ShearDisplacementStructure

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

5.3.2.2. Data types

5.3.2.2.1. CompositionPart

CompositionPart	
Definition:	The composition of a geologic unit in terms of lithological constituents.
Stereotypes:	«dataType»
Attribute: material	
Value type:	LithologyValue
Definition:	The material that comprises part or all of the geologic unit.
Description:	This refers to a vocabulary of lithological terms.
Multiplicity:	1

CompositionPart	
Attribute: proportion	
Value type:	QuantityRange
Definition:	Quantity that specifies the fraction of the geologic unit composed of the material.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: role	
Value type:	CompositionPartRoleValue
Definition:	The relationship of the composition part to the geologic unit composition as a whole.
Description:	EXAMPLE: vein, interbedded constituent, layers, dominant constituent.
Multiplicity:	1

5.3.2.2.2. ThematicClass

ThematicClass	
Definition:	A generic thematic classifier to enable the reclassification of Geologic Features with user defined classes appropriate to thematic maps.
Description:	This datatype allows Geologic Features to be classified against thematic classes. This provides a generic means of delivering geological thematic map data.
Stereotypes:	«dataType»
Attribute: themeClassification	
Value type:	ThematicClassificationValue
Definition:	The used classification.
Multiplicity:	1

ThematicClass	
Attribute: themeClass	
Value type:	ThematicClassValue
Definition:	The value of the thematic class.
Description:	The thematic class value should be constrained by a codelist of defined terms, but these will commonly be specific to a particular thematic map.
Multiplicity:	1

5.3.2.3. Code lists

5.3.2.3.1. AnthropogenicGeomorphologicFeatureTypeValue

AnthropogenicGeomorphologicFeatureTypeValue	
Definition:	The types of anthropogenic geomorphologic feature.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/AnthropogenicGeomorphologicFeatureTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.2. BoreholePurposeValue

BoreholePurposeValue	
Definition:	Purposes for which a borehole was drilled.
Description:	EXAMPLE: mineral exploration, water pumping, site evaluation, stratigraphic research, etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/BoreholePurposeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.3. CollectionTypeValue

CollectionTypeValue	
Definition:	Types of collections of geological and geophysical objects.
Description:	EXAMPLE: geological map, thematic map etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CollectionTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.4. CompositionPartRoleValue

CompositionPartRoleValue	
Definition:	Roles that a compositional part plays in a geologic unit.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.5. EventEnvironmentValue

EventEnvironmentValue	
Definition:	Terms for the geologic environments within which geologic events take place.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. INSPIRE Registry includes recommended values that may be used by data providers.

5.3.2.3.6. EventProcessValue

EventProcessValue	
Definition:	Terms specifying the process or processes that occurred during an event.
Description:	EXAMPLE: deposition, extrusion, intrusion, cooling.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/EventProcessValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. INSPIRE Registry includes recommended values that may be used by data providers.

5.3.2.3.7. FaultTypeValue

FaultTypeValue	
Definition:	Terms describing the type of shear displacement structure.
Description:	EXAMPLE: thrust fault, normal fault, wrench fault.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/FaultTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. INSPIRE Registry includes recommended values that may be used by data providers.

5.3.2.3.8. FoldProfileTypeValue

FoldProfileTypeValue	
Definition:	Terms specifying the type of fold.
Description:	Folds are typed according to the concave/convex geometry of the fold relative to the earth surface, and the relationship to younging direction in folded strata if known. EXAMPLE: antiform, synform, anticline, syncline, etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/FoldProfileTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.9. GeochronologicEraValue

GeochronologicEraValue	
Definition:	Terms specifying recognised geological time units.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue
Values:	The allowed values for this code list comprise the values specified in "Cohen, K.M., Finney, S. & Gibbard, P.L., International Chronostratigraphic Chart, August 2012, International Commission on Stratigraphy of the International Union of Geological Sciences, 2012" and additional values at any level defined by data providers. INSPIRE Registry includes recommended values that may be used by data providers.

5.3.2.3.10. GeologicUnitTypeValue

GeologicUnitTypeValue	
Definition:	Terms describing the type of geologic unit.
Description:	EXAMPLE: GeologicUnit, AllostratigraphicUnit etc
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.11. GeomorphologicActivityValue

GeomorphologicActivityValue	
Definition:	Terms indicating the level of activity of a geomorphologic feature.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeomorphologicActivityValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.12. LithologyValue

LithologyValue	
Definition:	Terms describing the lithology.
Description:	EXAMPLE: granite, sandstone, schist.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/LithologyValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. INSPIRE Registry includes recommended values that may be used by data providers.

5.3.2.3.13. MappingFrameValue

MappingFrameValue	
Definition:	Terms indicating the surface on which the MappedFeature is projected.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/MappingFrameValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.14. NaturalGeomorphologicFeatureTypeValue

NaturalGeomorphologicFeatureTypeValue	
Definition:	Terms describing the type of natural geomorphologic feature.
Extensibility:	open
Identifier:	
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.3.2.3.15. ThematicClassificationValue

ThematicClassificationValue	
Definition:	List of thematic classifications for geologic features.
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codelist/ThematicClassificationValue
Values:	The allowed values for this code list comprise any values defined by data providers.

5.3.2.3.16. ThematicClassValue

ThematicClassValue	
Definition:	Values for thematic classification of geologic features.
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codelist/ThematicClassValue
Values:	The allowed values for this code list comprise any values defined by data providers.

5.3.2.4. Imported types (informative)

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

5.3.2.4.1. CharacterString

CharacterString	
Package:	Text
Reference:	Geographic information — Conceptual schema language [ISO/TS 19103:2005]

5.3.2.4.2. DateTime

DateTime	
Package:	Date and Time
Reference:	Geographic information — Conceptual schema language [ISO/TS 19103:2005]

5.3.2.4.3. DirectPosition

DirectPosition	
Package:	Coordinate geometry
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.3.2.4.4. DocumentCitation

DocumentCitation	
Package:	Base Types 2
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	Citation for the purposes of unambiguously referencing a document.

5.3.2.4.5. GM_Curve

GM_Curve	
Package:	Geometric primitive
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.3.2.4.6. GM_Object

GM_Object (abstract)	
Package:	Geometry root
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.3.2.4.7. GM_Point

GM_Point	
Package:	Geometric primitive
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.3.2.4.8. GeophObject

GeophObject (abstract)	
Package:	Geophysics
Reference:	INSPIRE Data specification on Geology [DS-D2.8.II.4]
Definition:	A generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.

5.3.2.4.9. GeophObjectSet

GeophObjectSet	
Package:	Geophysics
Reference:	INSPIRE Data specification on Geology [DS-D2.8.II.4]
Definition:	Generic class for collections of geophysical objects
Description:	It is a set of geophysical objects that are grouped by some common property. p.e: created in the same measuring campaign. GeophObjectSets are used for spatial sampling either by means of data acquisition or data processing. The produced result of a geophObjectSet is always collective, e.g. a map constructed from the results of the individual member objects.

5.3.2.4.10. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.3.2.4.11. Quantity

Quantity	
Package:	valueObjects
Reference:	Geographic information — Geography Markup Language (GML) [ISO 19136:2007]

5.3.2.4.12. QuantityRange

QuantityRange	
Package:	Simple Components
Reference:	Robin, Alexandre (ed.), OGC®SWE Common Data Model Encoding Standard, version 2.0.0, Open Geospatial Consortium, 2011 [OGC 08-094r1]

5.3.3. Externally governed code lists

The externally governed code lists included in this application schema are specified in the tables in this section and in Annex C.

5.3.3.1. Governance and authoritative source

Code list	Governance	Authoritative Source(incl. version*[14] and relevant subset, where applicable)
GeochronologicEraValue	International Commission on Stratigraphy of the International Union of Geological Sciences	Cohen, K.M., Finney, S. & Gibbard, P.L., *International Chronostratigraphic Chart, August 2012*, International Commission on Stratigraphy of the International Union of Geological Sciences, 2012

5.3.3.2. Availability

Code list	Availability	Format
GeochronologicEraValue	http://www.stratigraphy.org/column.php?id=Chart/Time Scale	PDF or JPG

NOTE This externally managed code list and its values extended for Pre-Cambrian rocks and Quaternary units are presented in the Annex C of this document.

5.4. Application schema Hydrogeology

5.4.1. Description

5.4.1.1. Narrative description and UML Overview

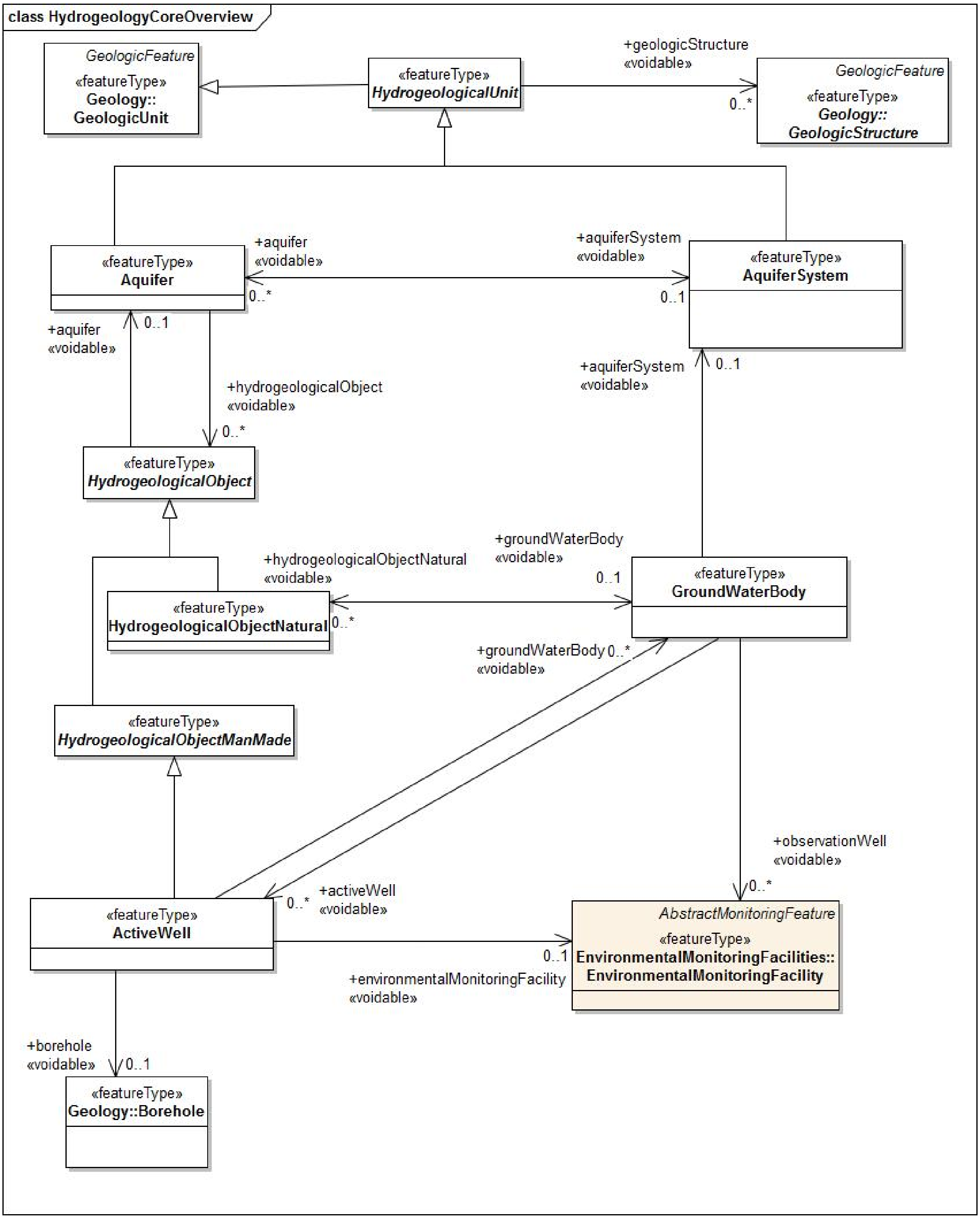


Figure 11 – UML class diagram: Overview of the Hydrogeology application schema

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

The model provides the classes of the 'rock' system and the 'groundwater' system and the links between them and also the interaction of these systems with man-made facilities and natural features. Like the INSPIRE Geological model the Hydrogeological model represents a more static approach aimed at providing mainly information depicted onhydrogeological maps at a regional or national scale (1 : 50.000 or smaller).

NOTE 1 For provision of detailed measurements on the quality and chemical composition of groundwater and time series measurements of groundwater level within groundwater wells the use of the WaterML 2.0 specification is recommended.

The Hydrogeology - 'Rock' system

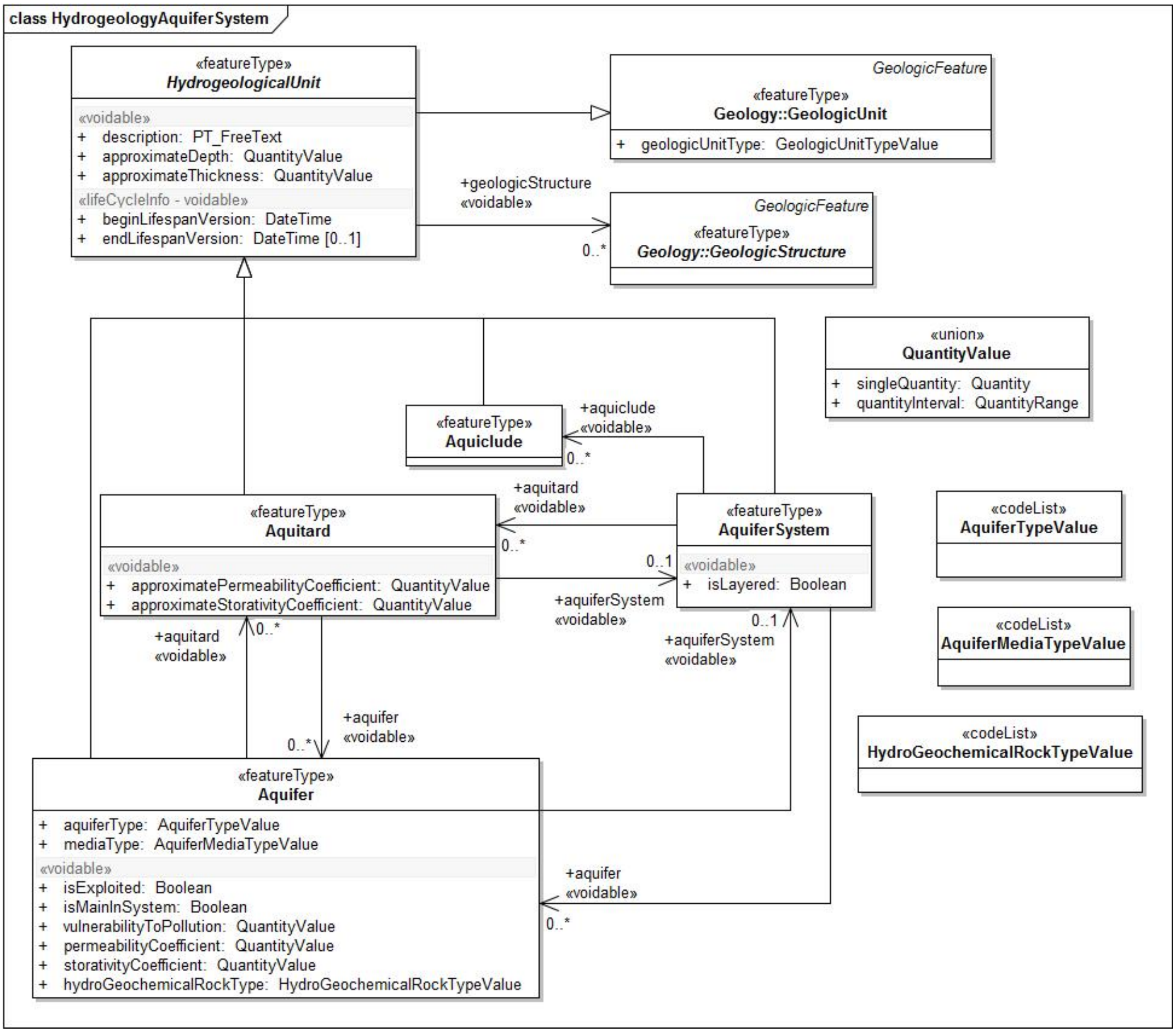


Figure 12 – UML class diagram: HydrogeologicalUnit, AquiferSystem, Aquifer, Aquitard,

Aquiclude

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

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

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

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

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

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

The hydrogeology – "Groundwater system"

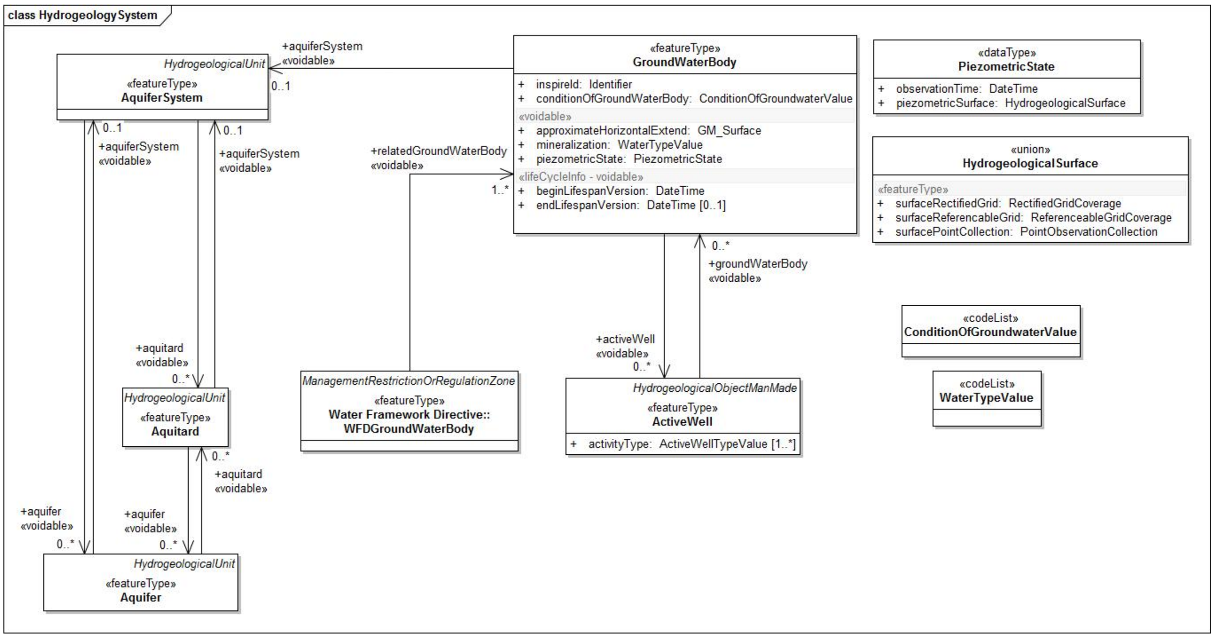


Figure 13 – UML class diagram: GroundWaterBody, AquiferSystem, ActiveWell, WFDGroundWaterBody - from the application schema Water Framework Directive of Area management/restriction/regulation zones and reporting units INSPIRE theme

The hydrogeological system is formed by the interaction of the groundwater system and the rock system.

The main class of the the groundwater system is *GroundWaterBody.*

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

WFDGroundWaterBody is a distinct volume of groundwater within a groundwater flow system, which is used as a reporting or management unit within the Water Framework Directive (WFD). This class is a special type of *ManagementOrRegulationZon*e class, which is imported from the application schema Water Framework Directive of Area management/restriction/regulation zones and reporting units INSPIRE theme. The relationship to the GroundWaterBody is modeled through the association relatedGroundWaterBody (i.e. every *WFDGroundWaterBody* is linked to 1 or many natural *GroundWaterBodies*).

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

Hydrogeological objects

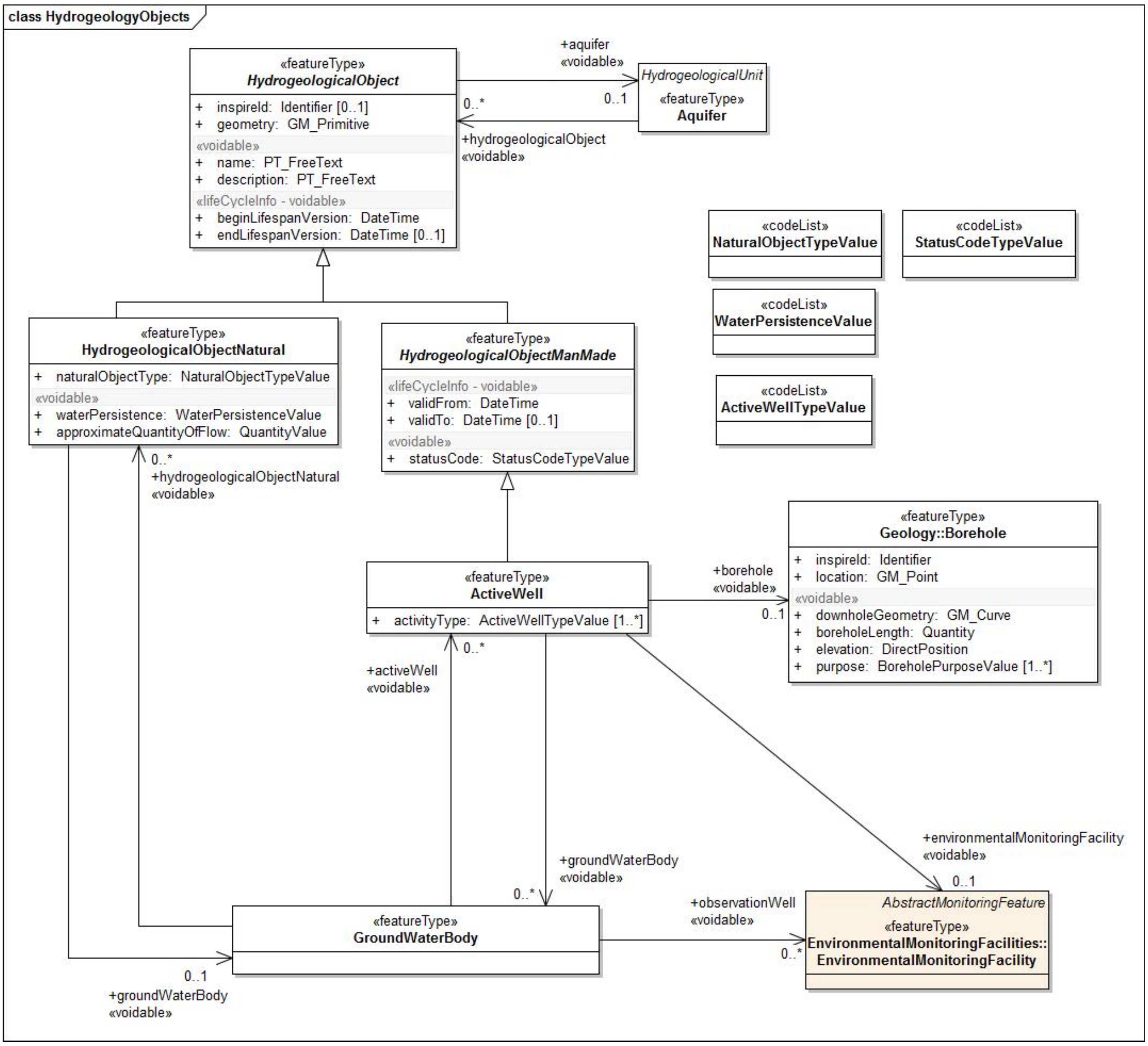


Figure 14 – UML class diagram: HydrogeologicalObject, HydrogeologicalObjectNatural, HydrogeologicalObjectManMade, ActiveWell, GroundWaterBody, Borehole (from Geology), EnvironmentalMonitoringFacilities (from EF Theme)

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

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

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

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

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

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

5.4.1.2. Consistency between spatial data sets

The observation location is specified by its coordinates.

5.4.1.3. Modelling of object references

MappedFeature can be seen as a container for geometry whereas GeologicUnit (and thus HydrogeologicalUnit) is a container for properties. This enables a single 'real world' GeologicUnit to have multiple 'map' representations, for example at different scales or resolutions of map or as an element in a 3D model.

A GroundWaterBody may be monitored by an EnvironmentalMonitoringFacility comprising one or more ActiveWells acting as groundwater observation wells.

Based on the different assumptions established in Member States the delineation of a WFDGroundWaterBody, used for reporting under the Water Framework Directive, boundary can differ from the natural GroundWaterBody extent.The WFDGroundWaterBody is associated with one or more natural groundwater bodies.

5.4.2. Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema Hydrogeology
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
ActiveWell	Hydrogeology	«featureType»
ActiveWellTypeValue	Hydrogeology	«codeList»
Aquiclude	Hydrogeology	«featureType»
Aquifer	Hydrogeology	«featureType»
AquiferMediaTypeValue	Hydrogeology	«codeList»
AquiferSystem	Hydrogeology	«featureType»
AquiferTypeValue	Hydrogeology	«codeList»
Aquitard	Hydrogeology	«featureType»
ConditionOfGroundwaterValue	Hydrogeology	«codeList»
GroundWaterBody	Hydrogeology	«featureType»
HydroGeochemicalRockTypeValue	Hydrogeology	«codeList»
HydrogeologicalObject	Hydrogeology	«featureType»
HydrogeologicalObjectManMade	Hydrogeology	«featureType»
HydrogeologicalObjectNatural	Hydrogeology	«featureType»
HydrogeologicalSurface	Hydrogeology	«union»
HydrogeologicalUnit	Hydrogeology	«featureType»
NaturalObjectTypeValue	Hydrogeology	«codeList»
PiezometricState	Hydrogeology	«dataType»
QuantityValue	Hydrogeology	«union»
StatusCodeTypeValue	Hydrogeology	«codeList»
WaterPersistenceValue	Hydrogeology	«codeList»
WaterSalinityValue	Hydrogeology	«codeList»

5.4.2.1. Spatial object types

5.4.2.1.1. ActiveWell

ActiveWell

Name:	Active Well
Subtype of:	HydrogeologicalObjectManMade
Definition:	A well influencing the groundwater resources of the aquifer.
Description:	The most common examples of Active Well are: extracting, artificial recharging, or dewatering wells. NOTE ActiveWell by extracting, recharging or dewatering influences and changes the state of groundwater resources.
Stereotypes:	«featureType»

Attribute: activityType

Name:	Active Well Type
Value type:	ActiveWellTypeValue
Definition:	The type of activity carried out by the well.
Description:	Indicates if the well is used for extracting, recharging, dewatering etc of the groundwater resources.
Multiplicity:	1..*

Association role: environmentalMonitoringFacility

Name:	Environmental Monitoring Facility
Value type:	EnvironmentalMonitoringFacility
Definition:	The related EnvironmentalMonitoringFacility.
Description:	The Environmental Monitoring Facility commonly comprises one or more Active Wells acting as groundwater observation wells.
Multiplicity:	0..1
Stereotypes:	«voidable»

ActiveWell	
Association role: borehole	
Name:	Borehole
Value type:	Borehole
Definition:	The Borehole upon which the ActiveWell is based.
Multiplicity:	0..1
Stereotypes:	«voidable»
Association role: groundWaterBody	
Name:	Groundwater Body
Value type:	GroundWaterBody
Definition:	The GroundWaterBody from which the ActiveWell extracts groundwater resources.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.1.2. Aquiclude

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

5.4.2.1.3. Aquifer

Aquifer

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

Attribute: aquiferType

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

Attribute: mediaType

Name:	Type of Media
Value type:	AquiferMediaTypeValue
Definition:	The classification of the medium in which the groundwater flow occurs.
Multiplicity:	1

Attribute: isExploited

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

Aquifer

Attribute: isMainInSystem

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

Attribute: vulnerabilityToPollution

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

Aquifer

Attribute: permeabilityCoefficient

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

Attribute: storativityCoefficient

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

Attribute: hydroGeochemicalRockType

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

Aquifer	
Association role: aquitard	
Name:	Aquitard
Value type:	Aquitard
Definition:	The Aquitard(s) that separates the Aquifer.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: hydrogeologicalObject	
Name:	Hydrogeological Object
Value type:	HydrogeologicalObject
Definition:	The HydrogeologicalObject(s) related to the aquifer.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: aquiferSystem	
Name:	Aquifer System
Value type:	AquiferSystem
Definition:	The specific AquiferSystem where the Aquitard occurs.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.4. AquiferSystem

AquiferSystem

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

Attribute: isLayered

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

Association role: aquitard

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

AquiferSystem	
Association role: aquiclude	
Name:	Aquiclude
Value type:	Aquiclude
Definition:	An Aquiclude enclosing the AquiferSystem.
Description:	This acts as a barrier for groundwater flow.
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: aquifer	
Name:	Aquifer
Value type:	Aquifer
Definition:	The Aquifer(s) contained in the AquiferSystem.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.1.5. Aquitard

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

Aquitard

Attribute: approximatePermeabilityCoefficient

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

Attribute: approximateStorativityCoefficient

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

Association role: aquiferSystem

Name:	Aquifer System
Value type:	AquiferSystem
Definition:	The AquiferSystem of which the Aquitard is a part.
Multiplicity:	0..1
Stereotypes:	«voidable»

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

5.4.2.1.6. GroundWaterBody

GroundWaterBody	
Name:	Groundwater Body
Definition:	A distinct volume of groundwater within an aquifer or system of aquifers, which is hydraulically isolated from nearby groundwater bodies.
Description:	Groundwater bodies form the principal management units under the European Water Framework Directive (2000/60/CE, 2000). They should be hydraulically continuous entities, and must be defined on the basis of flow or abstraction, and are inextricably linked to surface water bodies.
Stereotypes:	«featureType»
Attribute: inspireId	
Name:	INSPIRE Identifier
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

GroundWaterBody

Attribute: approximateHorizontalExtend

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

Attribute: conditionOfGroundWaterBody

Name:	Condition of Groundwater Body
Value type:	ConditionOfGroundwaterValue
Definition:	The approximate degree of change to groundwater as a result of human activity.
Multiplicity:	1

Attribute: mineralization

Name:	Water Type
Value type:	WaterSalinityValue
Definition:	One of the main chemical characteristics of water. A value is a sum of all water chemical concentration components.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: piezometricState

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

GroundWaterBody

Attribute: beginLifespanVersion

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

Attribute: endLifespanVersion

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

Association role: activeWell

Name:	Active Well
Value type:	ActiveWell
Definition:	The ActiveWell which changes the state of the GroundwaterBody through the extraction of groundwater resources.
Description:	ActiveWell by extracting groundwater resources influences the state of GroundWaterBody resources it is installed in.
Multiplicity:	0..*
Stereotypes:	«voidable»

Association role: aquiferSystem

Name:	Aquifer System
Value type:	AquiferSystem
Definition:	The AquiferSystem which includes the GroundWaterBody.
Multiplicity:	0..1
Stereotypes:	«voidable»

GroundWaterBody	
Association role: observationWell	
Value type:	EnvironmentalMonitoringFacility
Definition:	The observation wells which monitor the GroundWaterBody
Multiplicity:	0..*
Stereotypes:	«voidable»
Association role: hydrogeologicalObjectNatural	
Name:	Hydrogeological Object Natural
Value type:	HydrogeologicalObjectNatural
Definition:	A HydrogeologicalObjectNatural interacting with the GroundwaterBody.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.1.7. HydrogeologicalObject

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

HydrogeologicalObject (abstract)

Attribute: inspireId

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

Attribute: geometry

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

Attribute: name

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

Attribute: description

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

HydrogeologicalObject (abstract)	
Attribute: beginLifespanVersion	
Name:	Begin Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: endLifespanVersion	
Name:	End Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»
Association role: aquifer	
Name:	Aquifer
Value type:	Aquifer
Definition:	The Aquifer within which the HydrogeologicalObject occurs.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.8. HydrogeologicalObjectManMade

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

HydrogeologicalObjectManMade (abstract)	
Attribute: validFrom	
Name:	Valid From
Value type:	DateTime
Definition:	Official date and time the hydrogeological object was/will be legally established.
Description:	NOTE This is the date and time the register reference can be used in legal acts.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: validTo	
Name:	Valid To
Value type:	DateTime
Definition:	Date and time at which the hydrogeological object legally ceased/will cease to be used.
Description:	NOTE This is the date and time the register reference can no longer be used in legal acts.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: statusCode	
Name:	Status Code
Value type:	StatusCodeTypeValue
Definition:	A code defining the formal status of a man-made hydrogeological object.
Multiplicity:	1
Stereotypes:	«voidable»

5.4.2.1.9. HydrogeologicalObjectNatural

HydrogeologicalObjectNatural

Name:	Hydrogeological Object Natural
Subtype of:	HydrogeologicalObject
Definition:	HydrogeologicalObject which was created by natural processes.
Description:	Examples of natural hydrogeological objects are: a source, vanishing point and geyser.
Stereotypes:	«featureType»

Attribute: naturalObjectType

Name:	Natural Object Type
Value type:	NaturalObjectTypeValue
Definition:	The type of natural hydrogeological object.
Multiplicity:	1

Attribute: waterPersistence

Name:	Water Persistence
Value type:	WaterPersistenceValue
Definition:	The degree of persistence of water flow.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: approximateQuantityOfFlow

Name:	Approximate Quantity of Flow
Value type:	QuantityValue
Definition:	An approximate value defining the water yield in a natural hydrogeological object.
Description:	The discharge of water flow for a certain cross-section per time unit.
Multiplicity:	1
Stereotypes:	«voidable»

HydrogeologicalObjectNatural	
Association role: groundWaterBody	
Name:	Groundwater Body
Value type:	GroundWaterBody
Definition:	The GroundWateBody with which the natural hydrogeological object interacts.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.4.2.1.10. HydrogeologicalUnit

HydrogeologicalUnit (abstract)	
Name:	Hydrogeological Unit
Subtype of:	GeologicUnit
Definition:	A part of the lithosphere with distinctive parameters for water storage and conduction.
Stereotypes:	«featureType»
Attribute: description	
Value type:	PT_FreeText
Definition:	The description of the HydrogeologicalUnit
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: approximateDepth	
Name:	Approximate Depth
Value type:	QuantityValue
Definition:	The approximate depth of the HydrogeologicalUnit occurrence.
Multiplicity:	1
Stereotypes:	«voidable»

HydrogeologicalUnit (abstract)	
Attribute: approximateThickness	
Name:	Approximate Thickness
Value type:	QuantityValue
Definition:	The approximate thickness of the HydrogeologicalUnit.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: beginLifespanVersion	
Name:	Begin Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«lifeCycleInfo - voidable»
Attribute: endLifespanVersion	
Name:	End Life Span Version
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«lifeCycleInfo - voidable»
Association role: geologicStructure	
Name:	Geologic Structure
Value type:	GeologicStructure
Definition:	Relates one or many HydrogeologicalUnit(s) to a GeologicStructure.
Description:	Allows the description of groundwater occurrence in geological structures.
Multiplicity:	0..*
Stereotypes:	«voidable»

5.4.2.2. Data types

5.4.2.2.1. HydrogeologicalSurface

HydrogeologicalSurface

Name:	Hydrogeological Surface
Definition:	A surface that represents the interpolated groundwater table, or other surface, for a local or regional area.
Description:	This is the 2.5D geometry for hydrogeological surfaces and is based on hydrogeological measurements in a group of wells or other sources of data.
Stereotypes:	«union»

Attribute: surfaceRectifiedGrid

Name:	Surface as Rectified Grid
Value type:	RectifiedGridCoverage
Definition:	A surface whose domain is a rectified grid.
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate system. It can be used for both discrete and continuous coverages.
Multiplicity:	1
Stereotypes:	«featureType»

Attribute: surfaceReferencableGrid

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

HydrogeologicalSurface	
Attribute: surfacePointCollection	
Name:	Surface Point Collection
Value type:	PointObservationCollection
Definition:	Hydrogeological surface represented by collection of observations in points.
Multiplicity:	1
Stereotypes:	«featureType»

5.4.2.2.2. PiezometricState

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

5.4.2.2.3. QuantityValue

QuantityValue	
Name:	QuantityValue
Definition:	Data container with a single quantity value or a range of quantity values .
Stereotypes:	«union»
Attribute: singleQuantity	
Name:	Single Quantity
Value type:	Quantity
Definition:	Scalar component with decimal representation and a unit of measure used to store value of a continuous quantity.
Multiplicity:	1
Attribute: quantityInterval	
Name:	Quantity Interval
Value type:	QuantityRange
Definition:	Decimal pair for specifying a quantity range with a unit of measure.
Multiplicity:	1

5.4.2.3. Code lists

5.4.2.3.1. ActiveWellTypeValue

ActiveWellTypeValue	
Name:	Active Well Type
Definition:	Types of active wells.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ActiveWellTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.2. AquiferMediaTypeValue

AquiferMediaTypeValue	
Name:	Aquifer Media Type
Definition:	Values describing the characteristics of the aquifer medium.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/AquiferMediaTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.3. AquiferTypeValue

AquiferTypeValue	
Name:	Aquifer Type
Definition:	Types of aquifers.
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codelist/AquiferTypeValue
Values:	The allowed values for this code list comprise only the values specified in the INSPIRE Registry.

5.4.2.3.4. ConditionOfGroundwaterValue

ConditionOfGroundwaterValue	
Name:	Condition Of Groundwater
Definition:	Values indicating the approximate degree of change which has taken place on the natural state of groundwater.
Description:	The groundwater in a GroundWaterFlowSystem is in a variable condition, dependent on external factors, among which are diverse human activities.
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codelist/ConditionOfGroundwaterValue
Values:	The allowed values for this code list comprise only the values specified in the INSPIRE Registry.

5.4.2.3.5. HydroGeochemicalRockTypeValue

HydroGeochemicalRockTypeValue	
Name:	Hydrogeochemical Rock Value
Definition:	Values describing the hydrogeochemical condition of the groundwater environment.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/HydroGeochemicalRockTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.6. NaturalObjectTypeValue

NaturalObjectTypeValue	
Name:	Natural Object Type
Definition:	Types of natural hydrogeological objects.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/NaturalObjectTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.7. StatusCodeTypeValue

StatusCodeTypeValue	
Name:	Status Code Type
Definition:	Values describing the statuses of man-made hydrogeological objects.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StatusCodeTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.8. WaterPersistenceValue

WaterPersistenceValue	
Name:	Water Persistence Value
Definition:	Types of hydrological persistence of water.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/WaterPersistenceValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.3.9. WaterSalinityValue

WaterSalinityValue	
Name:	Water Salinity
Definition:	A code list indicating salinity classes in water.
Description:	Salinity is the saltiness or dissolved salt content of a body of water. Generally, it is the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater salinity often refers to the concentration of chlorides in the water. See also total dissolved solids.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/WaterSalinityValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.4.2.4. Imported types (informative)

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

5.4.2.4.1. Boolean

Boolean	
Package:	Truth
Reference:	Geographic information — Conceptual schema language [ISO/TS 19103:2005]

5.4.2.4.2. Borehole

Borehole	
Package:	Geology
Reference:	INSPIRE Data specification on Geology [DS-D2.8.II.4]
Definition:	A borehole is the generalized term for any narrow shaft drilled in the ground.

5.4.2.4.3. DateTime

DateTime	
Package:	Date and Time
Reference:	Geographic information — Conceptual schema language [ISO/TS 19103:2005]

5.4.2.4.4. EnvironmentalMonitoringFacility

EnvironmentalMonitoringFacility	
Package:	EnvironmentalMonitoringFacilities
Reference:	INSPIRE Data specification on Environmental Monitoring Facilities [DS-D2.8.III.7]
Definition:	A georeferenced object directly collecting or processing data about objects whose properties (e.g. physical, chemical, biological or other aspects of environmental conditions) are repeatedly observed or measured. An environmental monitoring facility can also host other environmental monitoring facilities.
Description:	NOTE 1: An EnvironmentalMonitoringFacility is not a facility in the common INSPIRE sense realised by the Generic Conceptual Model class ActivtiyComplex. NOTE 2: Laboratories are not EnvironmentalMonitoringFacilities from an INSPIRE perspective as the exact location of the laboratory does not add further information to the measurement. The methodology used in the laboratory should be provided with observational data.

5.4.2.4.5. GM_Primitive

GM_Primitive (abstract)	
Package:	Geometric primitive
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.4.2.4.6. GM_Surface

GM_Surface	
Package:	Geometric primitive
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.4.2.4.7. GeologicStructure

GeologicStructure (abstract)	
Package:	Geology
Reference:	INSPIRE Data specification on Geology [DS-D2.8.II.4]
Definition:	A configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in an earth material.
Description:	The identity of a GeologicStructure is independent of the material that is the substrate for the structure.

5.4.2.4.8. GeologicUnit

GeologicUnit	
Package:	Geology
Reference:	INSPIRE Data specification on Geology [DS-D2.8.II.4]
Definition:	A volume of rock with distinct characteristics.
Description:	Includes both formal units (i.e. formally adopted and named in an official lexicon) and informal units (i.e. named but not promoted to the lexicon) and unnamed units (i.e. recognisable and described and delineable in the field but not otherwise formalised). Spatial properties are only available through association with a MappedFeature.

5.4.2.4.9. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.4.2.4.10. PT_FreeText

PT_FreeText	
Package:	Cultural and linguistic adapdability
Reference:	Geographic information — Metadata — XML schema implementation [ISO/TS 19139:2007]

5.4.2.4.11. PointObservationCollection

PointObservationCollection	
Package:	Point Observations
Reference:	Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE [DS-D2.9]
Definition:	A collection of Point Observations.
Description:	The PointObservationCollection is a collection of separate PointObservations. In the case where it is useful to group together a set of otherwise independent PointObservations the PointObservationCollection should be used to make this grouping. The grouping may be made on any basis e.g. it may be useful to group together PointObservations made by the same instrument or Environmental Facility, or in a particular measurement campaign. Each member of the PointObservationCollection must be a single PointObservation.

5.4.2.4.12. Quantity

Quantity	
Package:	valueObjects
Reference:	Geographic information — Geography Markup Language (GML) [ISO 19136:2007]

5.4.2.4.13. QuantityRange

QuantityRange	
Package:	Simple Components
Reference:	Robin, Alexandre (ed.), OGC®SWE Common Data Model Encoding Standard, version 2.0.0, Open Geospatial Consortium, 2011 [OGC 08-094r1]

5.4.2.4.14. RectifiedGridCoverage

RectifiedGridCoverage	
Package:	Coverages (Domain and Range)
Reference:	INSPIRE Data Specifications – Base Models – Coverage Types, version 1.0 [DS-D2.10.2]
Definition:	Coverage whose domain consists of a rectified grid
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.4.2.4.15. ReferenceableGridCoverage

ReferenceableGridCoverage	
Package:	Coverages (Domain and Range)
Reference:	INSPIRE Data Specifications – Base Models – Coverage Types, version 1.0 [DS-D2.10.2]
Definition:	Coverage whose domain consists of a referenceable grid
Description:	A referencable grid is a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.4.3. Externally governed code lists

The Hydrogeology application schema does not contain externally governed code lists.

5.5. Application schema Geophysics

5.5.1. Description

5.5.1.1. Narrative description and UML overview

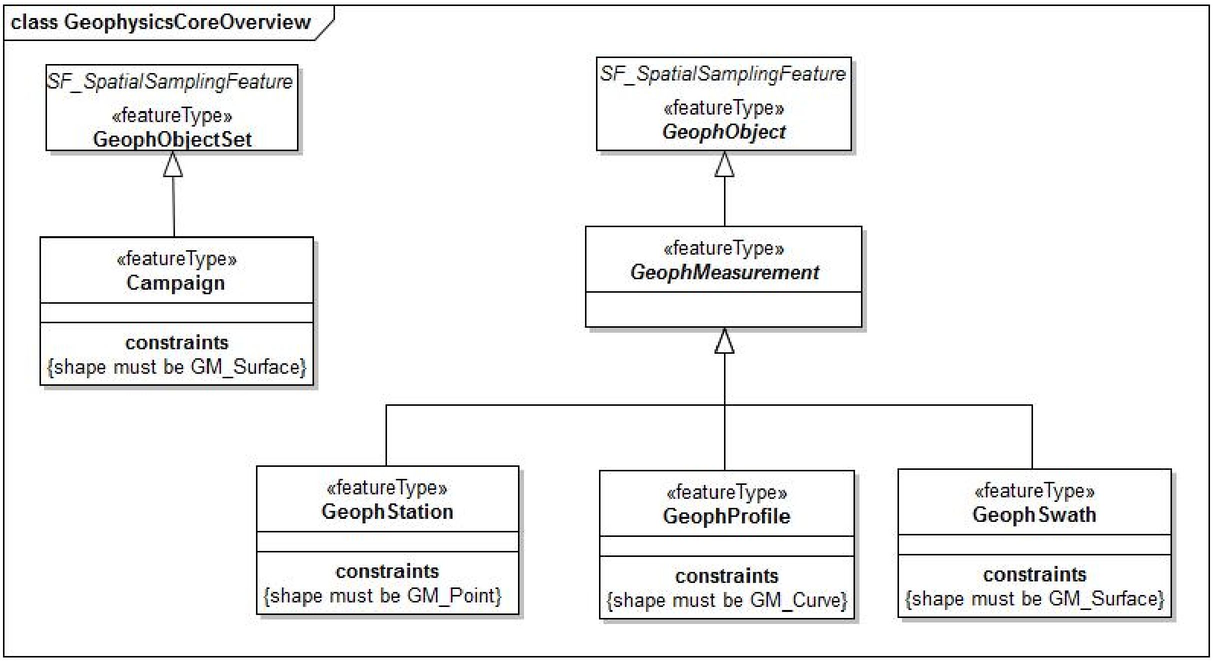


Figure 15 – UML class diagram: Overview of the Geophysics application schema

The Geophysical data model is designed to fulfill identified common requirements mainly related to spatial locations and essential metadata of geophysical measurements. The extended model (see Annex D) is to demonstrate the extensibility of the core model to address some more specific geophysical information and delivery of observation results.

Fundamental classes that are defined in this model are related to the well-known geophysical concepts measurement and survey:

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

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

Geophysics - Campaign

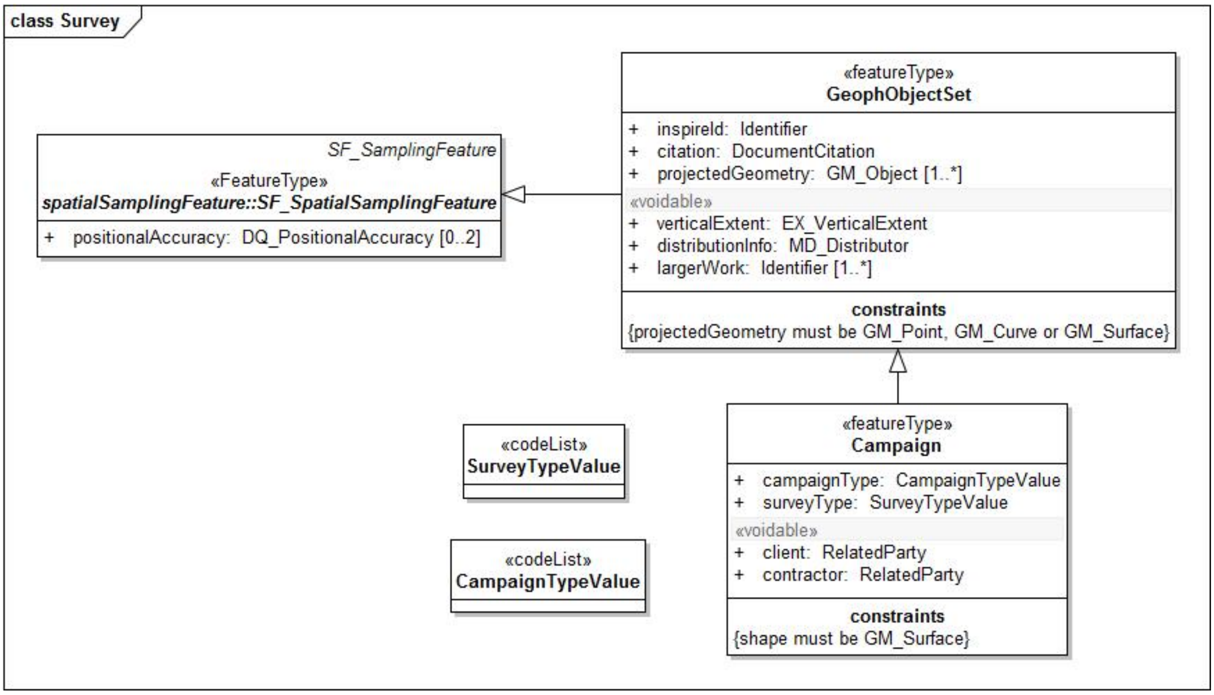


Figure 16 – UML class diagram: GeophObjectSet, Campaign

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

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

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

Geophysics - Measurement

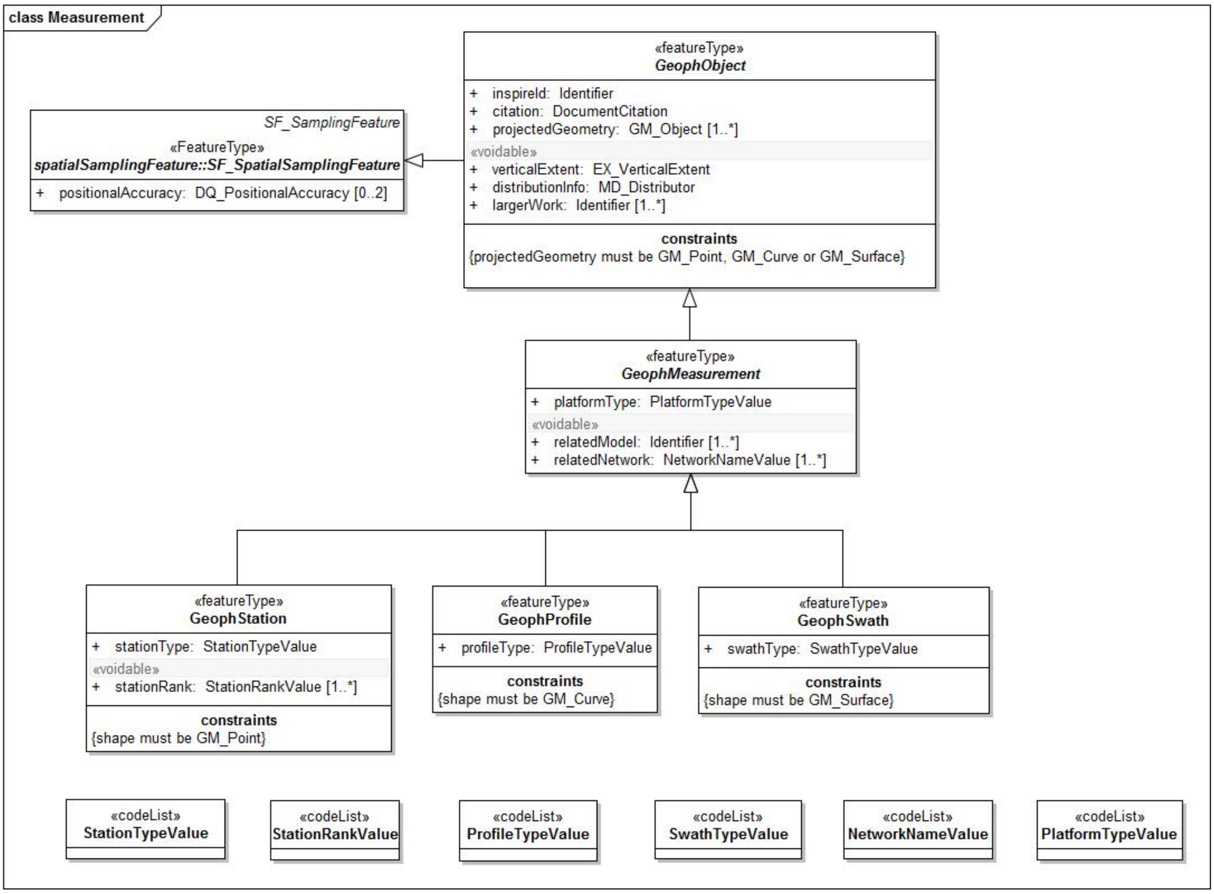


Figure 17 – UML class diagram: GeophObject, GeophMeasurment, GeophStation, GeophProfile, GeophSwath

GeophObject is a generic spatial object type that models single geophysical entities. It has two subtypes: *GeophMeasurement* and *GeophModel.* The later is only available in the Geopysics extension application schema (see Annex D).

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

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

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

Note: Exclusion of ordinary (non base) gravity and magnetic survey stations prevents data providers from the obligation of reporting millions of ordinary stations. These should be reported in a collective manner by using the *Campaign* class.

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

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

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

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

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

5.5.1.2. Consistency between spatial data sets

5.5.1.3. Identifier management

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

5.5.1.4. Modelling of object references

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

5.5.2. Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema Geophysics
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
Campaign	Geophysics	«featureType»
CampaignTypeValue	Geophysics	«codeList»
GeophMeasurement	Geophysics	«featureType»
GeophObject	Geophysics	«featureType»
GeophObjectSet	Geophysics	«featureType»
GeophProfile	Geophysics	«featureType»
GeophStation	Geophysics	«featureType»
GeophSwath	Geophysics	«featureType»
NetworkNameValue	Geophysics	«codeList»
PlatformTypeValue	Geophysics	«codeList»
ProfileTypeValue	Geophysics	«codeList»
StationRankValue	Geophysics	«codeList»
StationTypeValue	Geophysics	«codeList»
SurveyTypeValue	Geophysics	«codeList»
SwathTypeValue	Geophysics	«codeList»

5.5.2.1. Spatial object types

5.5.2.1.1. Campaign

Campaign	
Subtype of:	GeophObjectSet
Definition:	Geophysical activity extending over a limited time range and limited area for producing similar geophysical measurements, processing results or models.
Description:	Campaigns can be considered as parents of geophysical measurements or models. Children may refer to parent campaigns through the largerWork identifier.
Stereotypes:	«featureType»

Campaign	
Attribute: campaignType	
Value type:	CampaignTypeValue
Definition:	Type of activity to produce data
Description:	Value shall be one of the items defined in codelist CampaignTypeValue
Multiplicity:	1
Attribute: surveyType	
Value type:	SurveyTypeValue
Definition:	Type of geophysical survey
Description:	The geophysical method is specified by this attribute. Value shall be one of the items defined in codelist SurveyTypeValue.
Multiplicity:	1
Attribute: client	
Value type:	RelatedParty
Definition:	Party for which data was created.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: contractor	
Value type:	RelatedParty
Definition:	Party by which data was created
Description:	Party responsible for creating the data related to the campaign
Multiplicity:	1
Stereotypes:	«voidable»
Constraint: shape must be GM_Surface	
Natural language:	The shape attribute shall be of type GM_Surface
OCL:	inv: shape.oclIsKindOf(GM_Surface)

5.5.2.1.2. GeophMeasurement

GeophMeasurement (abstract)

Subtype of:	GeophObject
Definition:	Generic spatial object type for geophysical measurements.
Description:	Geophysical measurements collect data outside or on the boundary of the observed spatial domain.
Stereotypes:	«featureType»

Attribute: relatedModel

Value type:	Identifier
Definition:	Identifier of the geophysical model that was created from the measurement
Description:	Results of the measurement can be referenced by these identifiers.
Multiplicity:	1..*
Stereotypes:	«voidable»

Attribute: platformType

Value type:	PlatformTypeValue
Definition:	Platform from which the measurement was carried out
Description:	Values to be used are defined in codelist PlatformTypeValue.
Multiplicity:	1

Attribute: relatedNetwork

Value type:	NetworkNameValue
Definition:	Name of a national or international observation network to which the facility belongs, or to which measured data is reported.
Description:	Permanent measuring installations maz be part of larger observation networks. It means that observation data is regularly sent to the archives of the related network in an official way.
Multiplicity:	1..*
Stereotypes:	«voidable»

5.5.2.1.3. GeophObject

GeophObject (abstract)

Subtype of:	SF_SpatialSamplingFeature
Definition:	A generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.
Stereotypes:	«featureType»

Attribute: inspireId

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

Attribute: citation

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

GeophObject (abstract)	
Attribute: projectedGeometry	
Value type:	GM_Object
Definition:	2D projection of the feature to the ground surface (as a representative point, curve or bounding polygon) to be used by an INSPIRE view service to display the spatial object location on a map.
Description:	When measurement setup is 3 dimensional, it is necessary to define a 2D geometry for displaying purposes. It shall be the 2D projection of the spatial object on the ground surface. Allowed types: point, track and outline. Examples: projected geometry of a borehole logging measurement is a point coincident with the borehole collar location. Projected geometry of a 3D multielectrode DC measurement is a polygon
Multiplicity:	1..*
Attribute: verticalExtent	
Value type:	EX_VerticalExtent
Definition:	Vertical extent of the range of interest.
Description:	This parameter serves discovery purposes. It may refer both to the vertical extent of the measurement setup (p.e. borehole logging) or the extent of the range where processed data is spatially referenced to (Vertical Electric Sounding). The aim is to give an idea to the user about the estimated depth of investigation.
Multiplicity:	1
Stereotypes:	«voidable»

GeophObject (abstract)	
Attribute: distributionInfo	
Value type:	MD_Distributor
Definition:	Distribution metadata
Description:	Data providers may use external services to provide information on a geophysical measurement. Links to the access points, description of ordering procedures or external services can be added in distributionInfo, that is an ISO MD_Distributor record.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: largerWork	
Value type:	Identifier
Definition:	Identifier of a larger work dataset, typically a campaign or project
Description:	Measurements are usually made in campaigns. The largerWork identifier points to the parent Campaign or Project
Multiplicity:	1..*
Stereotypes:	«voidable»
Constraint: projectedGeometry must be GM_Point, GM_Curve or GM_Surface	
Natural language:	The projectedGeometry shall be of type GM_Point, GM_Curve or GM_Surface
OCL:	inv: projectedGeometry.oclIsKindOf(GM_Point) or projectedGeometry.oclIsKindOf(GM_Curve) or projectedGeometry.oclIsKindOf(GM_Surface)

5.5.2.1.4. GeophObjectSet

GeophObjectSet

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

Attribute: inspireId

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

Attribute: citation

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

GeophObjectSet

Attribute: verticalExtent

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

Attribute: distributionInfo

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

Attribute: projectedGeometry

Value type:	GM_Object
Definition:	2D projection of the feature to the ground surface (as a representative point, curve or bounding polygon) to be used by an INSPIRE view service to display the spatial object on a map..
Description:	Projected geometry of the object set (survey), that is usually the bounding polygon of the working area.
Multiplicity:	1..*

GeophObjectSet	
Attribute: largerWork	
Value type:	Identifier
Definition:	Identifier of a larger work dataset
Description:	The largerWork identifier points to the parent Campaign or Project
Multiplicity:	1..*
Stereotypes:	«voidable»
Constraint: projectedGeometry must be GM_Point, GM_Curve or GM_Surface	
Natural language:	The projectedGeometry shall be of type GM_Point, GM_Curve or GM_Surface
OCL:	inv: projectedGeometry.oclIsKindOf(GM_Point) or projectedGeometry.oclIsKindOf(GM_Curve) or projectedGeometry.oclIsKindOf(GM_Surface)

5.5.2.1.5. GeophProfile

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

5.5.2.1.6. GeophSwath

GeophSwath	
Subtype of:	GeophMeasurement
Definition:	Geophysical measurement spatially referenced to a surface
Description:	Used to collect data over a surface. Example: 3D seismic swath NOTE1. Processing results of geophSwaths can be both surface and solid coverages
Stereotypes:	«featureType»
Attribute: swathType	
Value type:	SwathTypeValue
Definition:	Type of geophysical swath
Multiplicity:	1
Constraint: shape must be GM_Surface	
Natural language:	The shape attribute shall be of type GM_Surface
OCL:	inv: shape.oclIsKindOf(GM_Surface)

5.5.2.1.7. GeophStation

GeophStation	
Subtype of:	GeophMeasurement
Definition:	Geophysical measurement spatially referenced to a single point location
Description:	Used to collect data at a single location. The source-sensor setup may be elongated or two dimensional, but the collected data is spatially referenced to a single point. Example: Gravity station, Magnetic station NOTE 1. Processing results of geophStations are often vertical curve coverages
Stereotypes:	«featureType»

GeophStation	
Attribute: stationType	
Value type:	StationTypeValue
Definition:	Type of geophysical station
Multiplicity:	1
Attribute: stationRank	
Value type:	StationRankValue
Definition:	Geophysical stations may be part of a hierarchical system. Rank is proportional to the importance of a station
Description:	Significance of stations can be very different even for the same geophysical method. Rank maz take the following values: 1stOrderBase, 2ndOrderBase, secularStation, observatory. Base stations are used to tie local measurements to higher level networks. Secular stations are visited from time to time to detect long term temporal changes of physical parameters. Observatories are important facilities that collect data continuously, or on a regular basis.
Multiplicity:	1..*
Stereotypes:	«voidable»
Constraint: shape must be GM_Point	
Natural language:	The shape attribute shall be of type GM_Point
OCL:	inv: shape.oclIsKindOf(GM_Point)

5.5.2.2. Code lists

5.5.2.2.1. CampaignTypeValue

CampaignTypeValue	
Definition:	Type of geophysical campaign
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CampaignTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.2. NetworkNameValue

NetworkNameValue	
Definition:	Name of geophysical network
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/NetworkNameValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.3. PlatformTypeValue

PlatformTypeValue	
Definition:	Platform on which data acquisition was carried out
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/PlatformTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.4. ProfileTypeValue

ProfileTypeValue	
Definition:	Type of geophysical profile
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ProfileTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.5. StationRankValue

StationRankValue	
Definition:	Rank of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StationRankValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.6. StationTypeValue

StationTypeValue	
Definition:	Type of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StationTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.7. SurveyTypeValue

SurveyTypeValue	
Definition:	Type of geophysical survey or dataset
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SurveyTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.2.8. SwathTypeValue

SwathTypeValue	
Definition:	Type of geophysical swath
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SwathTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

5.5.2.3. Imported types (informative)

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

5.5.2.3.1. DocumentCitation

DocumentCitation	
Package:	Base Types 2
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	Citation for the purposes of unambiguously referencing a document.

5.5.2.3.2. EX_VerticalExtent

EX_VerticalExtent	
Package:	Extent information
Reference:	Geographic information — Metadata [ISO 19115:2003/Cor 1:2006]

5.5.2.3.3. GM_Object

GM_Object (abstract)	
Package:	Geometry root
Reference:	Geographic information — Spatial schema [ISO 19107:2003]

5.5.2.3.4. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.5.2.3.5. MD_Distributor

MD_Distributor	
Package:	Distribution information
Reference:	Geographic information — Metadata [ISO 19115:2003/Cor 1:2006]

5.5.2.3.6. RelatedParty

RelatedParty	
Package:	Base Types 2
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	An organisation or a person with a role related to a resource.
Description:	NOTE 1 A party, typically an individual person, acting as a general point of contact for a resource can be specified without providing any particular role.

5.5.2.3.7. SF_SpatialSamplingFeature

SF_SpatialSamplingFeature (abstract)	
Package:	spatialSamplingFeature
Reference:	Geographic information — Observations and measurements [ISO/TS 19156:2011]

5.5.3. Externally governed code lists

The Geophysics application schema does not contain externally governed code lists.

6. Reference systems, units of measure and grids

6.1. Default reference systems, units of measure and grid

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

6.1.1. Coordinate reference systems

6.1.1.1. Datum

IR Requirement
Annex II, Section 1.2
Datum for three-dimensional and two-dimensional coordinate reference systems

For the three-dimensional and two-dimensional coordinate reference systems and the horizontal component of compound coordinate reference systems used for making spatial data sets available, the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, or the datum of the International Terrestrial Reference System (ITRS) or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well documented relationship between both systems, according to EN ISO 19111.

6.1.1.2. Coordinate reference systems

IR Requirement
Annex II, Section 1.3
Coordinate Reference Systems

Spatial data sets shall be made available using at least one of the coordinate reference systems specified in sections 1.3.1, 1.3.2 and 1.3.3, unless one of the conditions specified in section 1.3.4 holds.

1.3.1. Three-dimensional Coordinate Reference Systems

- Three-dimensional Cartesian coordinates based on a datum specified in 1.2 and using the parameters of the Geodetic Reference System 1980 (GRS80) ellipsoid.
- Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height) based on a datum specified in 1.2 and using the parameters of the GRS80 ellipsoid.

1.3.2. Two-dimensional Coordinate Reference Systems

- Two-dimensional geodetic coordinates (latitude and longitude) based on a datum specified in 1.2 and using the parameters of the GRS80 ellipsoid.
- Plane coordinates using the ETRS89 Lambert Azimuthal Equal Area coordinate reference system.
- Plane coordinates using the ETRS89 Lambert Conformal Conic coordinate reference system.
- Plane coordinates using the ETRS89 Transverse Mercator coordinate reference system.

1.3.3. Compound Coordinate Reference Systems

1. For the horizontal component of the compound coordinate reference system, one of the coordinate reference systems specified in section 1.3.2 shall be used.
2. For the vertical component, one of the following coordinate reference systems shall be used:

- For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope. Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS.
- For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere, or other linear or parametric reference systems shall be used. Where other parametric reference systems are used, these shall be described in an accessible reference using EN ISO 19111-2:2012.
- For the vertical component in marine areas where there is an appreciable tidal range (tidal waters), the Lowest Astronomical Tide (LAT) shall be used as the reference surface.
- For the vertical component in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200 meters, the Mean Sea Level (MSL) or a well-defined reference level close to the MSL shall be used as the reference surface.

1.3.4. Other Coordinate Reference Systems

Exceptions, where other coordinate reference systems than those listed in 1.3.1, 1.3.2 or 1.3.3 may be used, are:
. Other coordinate reference systems may be specified for specific spatial data themes.

1. For regions outside of continental Europe, Member States may define suitable coordinate reference systems.

The geodetic codes and parameters needed to describe these other coordinate reference systems and to allow conversion and transformation operations shall be documented and an identifier shall be created in a coordinate systems register established and operated by the Commission, according to EN ISO 19111 and ISO 19127.
The Commission shall be assisted by the INSPIRE Commission expert group in the maintenance and update of the coordinate systems register.

6.1.1.3. Display

IR Requirement
Annex II, Section 1.4

Coordinate Reference Systems used in the View Network Service

For the display of spatial data sets with the view network service as specified in Regulation No 976/2009, at least the coordinate reference systems for two-dimensional geodetic coordinates (latitude, longitude) shall be available.

6.1.1.4. Identifiers for coordinate reference systems

IR Requirement
Annex II, Section 1.5
Coordinate Reference System Identifiers

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

These Technical Guidelines propose to use the http URIs provided by the Open Geospatial Consortium as coordinate reference system identifiers (see identifiers for the default CRSs in the INSPIRE coordinate reference systems register). These are based on and redirect to the definition in the EPSG Geodetic Parameter Registry (*http://www.epsg-registry.org/*).

TG Requirement 2

The identifiers listed in the INSPIRE coordinate reference systems register (https://inspire.ec.europa.eu/crs) shall be used for referring to the coordinate reference systems used in a data set.

NOTE CRS identifiers may be used e.g. in:

- data encoding,
- data set and service metadata, and
- requests to INSPIRE network services.

6.1.2. Temporal reference system

IR Requirement
Article 11
Temporal Reference Systems

1. The default temporal reference system referred to in point 5 of part B of the Annex to Commission Regulation (EC) No 1205/2008 ([15]) shall be used, unless other temporal reference systems are specified for a specific spatial data theme in Annex II.

NOTE 1 Point 5 of part B of the Annex to Commission Regulation (EC) No 1205/2008 (the INSPIRE Metadata IRs) states that the default reference system shall be the Gregorian calendar, with dates expressed in accordance with ISO 8601.

NOTE 2 ISO 8601 *Data elements and interchange formats – Information interchange – Representation of dates and times* is an international standard covering the exchange of date and time-related data. The purpose of this standard is to provide an unambiguous and well-defined method of representing dates and times, so as to avoid misinterpretation of numeric representations of dates and times, particularly when data is transferred between countries with different conventions for writing numeric dates and times. The standard organizes the data so the largest temporal term (the year) appears first in the data string and progresses to the smallest term (the second). It also provides for a standardized method of communicating time-based information across time zones by attaching an offset to Coordinated Universal Time (UTC).

EXAMPLE 1997 (the year 1997), 1997-07-16 (16th July 1997), 1997-07-16T19:20:3001:00 (16th July 1997, 19h 20' 30'', time zone: UTC1)

6.1.3. Units of measure

IR Requirement
Article 12
Other Requirements & Rules

(…)

2. All measurement values shall be expressed using SI units or non-SI units accepted for use with the International System of Units, unless specified otherwise for a specific spatial data theme or type.

6.1.4. Grids

IR Requirement
Annex II, Section 2.2
Grids

Either of the grids with fixed and unambiguously defined locations defined in Sections 2.2.1 and 2.2.2 shall be used as a geo-referencing framework to make gridded data available in INSPIRE, unless one of the following conditions holds:

1. Other grids may be specified for specific spatial data themes in Annexes II-IV. In this case, data exchanged using such a theme-specific grid shall use standards in which the grid definition is either included with the data, or linked by reference.
2. For grid referencing in regions outside of continental Europe Member States may define their own grid based on a geodetic coordinate reference system compliant with ITRS and a Lambert Azimuthal Equal Area projection, following the same principles as laid down for the grid specified in Section 2.2.1. In this case, an identifier for the coordinate reference system shall be created.

2.2 Equal Area Grid

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

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

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

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

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

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

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

6.2. Theme-specific requirements and recommendations

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

7. Data quality

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

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

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

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

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

7.1. Data quality elements

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

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

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

Section	Data quality element	Data quality sub-element	Definition	Evaluation Scope
7.1.1	Logical consistency	Conceptual consistency	adherence to rules of the conceptual schema	spatial object type; spatial object
7.1.2	Logical consistency	Domain consistency	adherence of values to the value domains	spatial object type; spatial object

Recomendation 7

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

7.1.1. Logical consistency – Conceptual consistency

The Application Schema conformance class of the Abstract Test Suite in Annex I defines a number of tests to evaluate the conceptual consistency (tests A.1.1-A.1.7) of a data set.

Recomendation 8

For the tests on conceptual consistency, it is recommended to use the *Logical consistency – Conceptual consistency* data quality sub-element and the measure *Number of items not compliant with the rules of the conceptual schema* as specified in the table below.

Name	
Alternative name	-
Data quality element	logical consistency
Data quality sub-element	conceptual consistency
Data quality basic measure	error count
Definition	count of all items in the dataset that are not compliant with the rules of the conceptual schema
Description	If the conceptual schema explicitly or implicitly describes rules, these rules shall be followed. Violations against such rules can be, for example, invalid placement of features within a defined tolerance, duplication of features and invalid overlap of features.
Evaluation scope	spatial object / spatial object type
Reporting scope	data set
Parameter	-
Data quality value type	integer
Data quality value structure	-
Source reference	ISO/DIS 19157 Geographic information – Data quality
Example	
Measure identifier	10

7.1.2. Logical consistency – Domain consistency

The Application Schema conformance class of the Abstract Test Suite in Annex I defines a number of tests to evaluate the domain consistency (tests A1.1 - A.1.7) of a data set.

Recomendation 9

For the tests on domain consistency, it is recommended to use the *Logical consistency – Domain consistency* data quality sub-element and the measure *Number of items not in conformance with their value domain* as specified in the table below.

Name	**Number of items not in conformance with their value domain**
Alternative name	-
Data quality element	logical consistency
Data quality sub-element	domain consistency
Data quality basic measure	error count
Definition	count of all items in the dataset that are not in conformance with their value domain
Description	
Evaluation scope	spatial object / spatial object type
Reporting scope	data set
Parameter	-
Data quality value type	integer

7.2. Minimum data quality requirements

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

8. Dataset-level metadata

This section specifies dataset-level metadata elements, which should be used for documenting metadata for a complete dataset or dataset series.

NOTE Metadata can also be reported for each individual spatial object (spatial object-level metadata). Spatial object-level metadata is fully described in the application schema(s) (section 5).

For some dataset-level metadata elements, in particular those for reporting data quality and maintenance, a more specific scope can be specified. This allows the definition of metadata at sub-dataset level, e.g. separately for each spatial object type (see instructions for the relevant metadata element).

8.1. Metadata elements defined in INSPIRE Metadata Regulation

Table 4 gives an overview of the metadata elements specified in Regulation 1205/2008/EC (implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata).

The table contains the following information:

- The first column provides a reference to the relevant section in the Metadata Regulation, which contains a more detailed description.
- The second column specifies the name of the metadata element.
- The third column specifies the multiplicity.
- The fourth column specifies the condition, under which the given element becomes mandatory.

Table 4 – Metadata for spatial datasets and spatial dataset series specified in Regulation 1205/2008/EC

Metadata Regulation Section	Metadata element	Multiplicity	Condition
1.1	Resource title	1	
1.2	Resource abstract	1	
1.3	Resource type	1	
1.4	Resource locator	0..*	Mandatory if a URL is available to obtain more information on the resource, and/or access related services.
1.5	Unique resource identifier	1..*	

1.7	Resource language	0..*	Mandatory if the resource includes textual information.
2.1	Topic category	1..*	
3	Keyword	1..*	
4.1	Geographic bounding box	1..*	
5	Temporal reference	1..*	
6.1	Lineage	1	
6.2	Spatial resolution	0..*	Mandatory for data sets and data set series if an equivalent scale or a resolution distance can be specified.
7	Conformity	1..*	
8.1	Conditions for access and use	1..*	
8.2	Limitations on public access	1..*	
9	Responsible organisation	1..*	
10.1	Metadata point of contact	1..*	
10.2	Metadata date	1	
10.3	Metadata language	1	

Generic guidelines for implementing these elements using ISO 19115 and 19119 are available at *http://inspire.jrc.ec.europa.eu/index.cfm/pageid/101*. The following sections describe additional theme-specific recommendations and requirements for implementing these elements.

8.1.1. Conformity

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

Recomendation 10

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

Recomendation 11

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

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

Recomendation 12

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

Recomendation 13

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

Recomendation 14

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

NOTE Currently no minimum data quality requirements are included in the IRs. The recommendation above should be included as a requirement in the IRs if minimum data quality requirements are defined at some point in the future.

Recomendation 15

When documenting conformance with this data specification or one of the conformance classes defined in the Abstract Test Suite, the *Specification* sub-element should be given using the http URI identifier of the conformance class or using a citation including the following elements:

- title: "INSPIRE Data Specification on *Geology* – Draft Guidelines – <name of the conformance class>"
- date:
  - dateType: publication
  - date: 2013-02-04

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

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

or (using a citation):

```
<gmd:DQ_ConformanceResult>
    <gmd:specification>
        <gmd:CI_Citation>
            <gmd:title>
                <gco:CharacterString>INSPIRE Data Specification on Geology  Draft
Guidelines</gco:CharacterString>
            </gmd:title>
            <gmd:date>
                <gmd:date>
                    <gco:Date>2013-02-04</gco:Date>
                </gmd:date>
                <gmd:dateType>
                    <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/r
esou
rces/Codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">publication</gmd:CI_DateTypeCode>
                </gmd:dateType>
            </gmd:date>
        </gmd:CI_Citation>
    </gmd:specification>
    <gmd:explanation> (...) </gmd:explanation>
    <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

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

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

or (using a citation):

```
<gmd:DQ_ConformanceResult>
    <gmd:specification>
        <gmd:CI_Citation>
            <gmd:title>
                <gco:CharacterString>INSPIRE Data Specification on Geology  Draft
Guidelines  CRS</gco:CharacterString>
            </gmd:title>
            <gmd:date>
                <gmd:date>
                    <gco:Date>2013-02-04</gco:Date>
                </gmd:date>
                <gmd:dateType>
                    <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/r
esou
rces/Codelist/ML_gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">publication</gmd:CI_DateTypeCode>
                </gmd:dateType>
            </gmd:date>
        </gmd:CI_Citation>
    </gmd:specification>
    <gmd:explanation> (...) </gmd:explanation>
    <gmd:pass> (...) </gmd:pass>
</gmd:DQ_ConformanceResult>
```

8.1.2. Lineage

Recomendation 16

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

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

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

Recomendation 17

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

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

TWG Recommendations on the use of the Lineage MD element (based on the results of the OneGeology-Europe project):

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

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

Metadata elements to describe the dataset

- Digitizing method
- Internal thematic harmonization
- Internal geometric harmonization

Metadata elements to describe Geological and Topographic Sources:

- Title
- Description
- Date
- Mapping method (only for geological source)
- Temporal extent
- Scale
- Reference system

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

Digitizing method:

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

Internal thematic harmonization

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

Internal geometric harmonization

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

Source title:

ISO Number	360

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

Source description:

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

Source Date:

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

Source Mapping method (only for geological source):

ISO Number	87
Name	description
Definition	description of the event, including related parameters or tolerances

XPath	dataQualityInfo//**lineage**// processStep/*/description
Data type	CharacterString
Domain	Free text
Example	Field survey *(A predefined code list is available for specifying the source mapping method)*

Source Scale:

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

Source Reference system:

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

Suggested list of Digitizing methods:

code	**method**
directGIS	Direct input in GIS software
directGPS	Direct input – GPS measurement
interpolationPoint	Generated data (interpolation from point data)
	Digitized on digitizing tablet:

digitizedTabletLineMap	• from line-map
digitizedTabletPenciledOriginal	• from penciled original
digitizedTabletScribingFolio	• from scribing folio
digitizedTabletFilm	• from transparency film
digitizedTabletPaperCopy	• from paper copy
	Digitized on screen from scanned geological or applied map:
digitizedScannedMapManual	• Interactive manually
digitizedScannedMapSemiAutomated	• semi-automated
digitizedScannedMapAutomated	• automated
	Digitized on screen from other digital raster data:
digitizedScannedOtherManual	• Interactive manually
digitizedScannedOtherSemiAutomated	• semi-automated
digitizedScannedOtherAutomated	• automated
generalized	Generalized
unknown	Unknown digitizing method

Suggested list of Mapping methods:

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

8.1.3. Temporal reference

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

Recomendation 18

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

8.2. Metadata elements for interoperability

IR Requirement
Article 13
Metadata required for Interoperability

The metadata describing a spatial data set shall include the following metadata elements required for interoperability:

1. Coordinate Reference System: Description of the coordinate reference system(s) used in the data set.
2. Temporal Reference System: Description of the temporal reference system(s) used in the data set.

   This element is mandatory only if the spatial data set contains temporal information that does not refer to the default temporal reference system.

3. Encoding: Description of the computer language construct(s) specifying the representation of data objects in a record, file, message, storage device or transmission channel.
4. Topological Consistency: Correctness of the explicitly encoded topological characteristics of the data set as described by the scope.

   This element is mandatory only if the data set includes types from the Generic Network Model and does not assure centreline topology (connectivity of centrelines) for the network.

5. Character Encoding: The character encoding used in the data set.

   This element is mandatory only if an encoding is used that is not based on UTF-8.

6. Spatial Representation Type: The method used to spatially represent geographic information.

These Technical Guidelines propose to implement the required metadata elements based on ISO 19115 and ISO/TS 19139.

The following TG requirements need to be met in order to be conformant with the proposed encoding.

TG Requirement 3

Metadata instance (XML) documents shall validate without error against the used ISO 19139 XML schema.

NOTE Section 2.1.2 of the Metadata Technical Guidelines discusses the different ISO 19139 XML schemas that are currently available.

TG Requirement 4

Metadata instance (XML) documents shall contain the elements and meet the INSPIRE multiplicity specified in the sections below.

TG Requirement 5

The elements specified below shall be available in the specified ISO/TS 19139 path.

Recomendation 19

The metadata elements for interoperability should be made available together with the metadata elements defined in the Metadata Regulation through an INSPIRE discovery service.

NOTE While this not explicitly required by any of the INSPIRE Implementing Rules, making all metadata of a data set available together and through one service simplifies implementation and usability.

8.2.1. Coordinate Reference System

Metadata element name	**Coordinate Reference System**
Definition	Description of the coordinate reference system used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1..*
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem
Domain	To identify the reference system, the referenceSystemIdentifier (RS_Identifier) shall be provided. NOTE More specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	

Metadata element name	Coordinate Reference System
Example	referenceSystemIdentifier: code: ETRS_89 codeSpace: INSPIRE RS registry

Example XML encoding

```
<gmd:referenceSystemInfo>
        <gmd:MD_ReferenceSystem>
            <gmd:referenceSystemIdentifier>
                <gmd:RS_Identifier>
                    <gmd:code>
                        <gco:CharacterString>ETRS89
</gco:CharacterString>
                    </gmd:code>
                    <gmd:codeSpace>
                        <gco:CharacterString>INSPIRE RS
registry</gco:CharacterString>
                    </gmd:codeSpace>
                </gmd:RS_Identifier>
            </gmd:referenceSystemIdentifier>
        </gmd:MD_ReferenceSystem>
</gmd:referenceSystemInfo>
```

Comments	

8.2.2. Temporal Reference System

Metadata element name	Temporal Reference System
Definition	Description of the temporal reference systems used in the dataset.
ISO 19115 number and name	13. referenceSystemInfo
ISO/TS 19139 path	referenceSystemInfo
INSPIRE obligation / condition	Mandatory, if the spatial data set or one of its feature types contains temporal information that does not refer to the Gregorian Calendar or the Coordinated Universal Time.
INSPIRE multiplicity	0..*
Data type(and ISO 19115 no.)	186. MD_ReferenceSystem

Metadata element name	**Temporal Reference System**
Domain	No specific type is defined in ISO 19115 for temporal reference systems. Thus, the generic MD_ReferenceSystem element and its reference SystemIdentifier (RS_Identifier) property shall be provided. NOTE More specific instructions, in particular on pre-defined values for filling the referenceSystemIdentifier attribute should be agreed among Member States during the implementation phase to support interoperability.
Implementing instructions	
Example	referenceSystemIdentifier: code: GregorianCalendar codeSpace: INSPIRE RS registry

Example XML encoding

```
<gmd:referenceSystemInfo>
    <gmd:MD_ReferenceSystem>
        <gmd:referenceSystemIdentifier>
            <gmd:RS_Identifier>
                <gmd:code>
            <gco:CharacterString>GregorianCalendar
</gco:CharacterString>
                </gmd:code>
                <gmd:codeSpace>
                    <gco:CharacterString>INSPIRE RS
registry</gco:CharacterString>
                </gmd:codeSpace>
            </gmd:RS_Identifier>
        </gmd:referenceSystemIdentifier>
    </gmd:MD_ReferenceSystem>
</gmd:referenceSystemInfo>
```

Comments	

8.2.3. Encoding

Metadata element name	**Encoding**
Definition	Description of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel
ISO 19115 number and name	271. distributionFormat

Metadata element name	**Encoding**
ISO/TS 19139 path	distributionInfo/MD_Distribution/distributionFormat
INSPIRE obligation / condition	mandatory
INSPIRE multiplicity	1..*
Data type (and ISO 19115 no.)	284. MD_Format
Domain	See B.2.10.4. The property values (name, version, specification) specified in section 5 shall be used to document the default and alternative encodings.
Implementing instructions	
Example	name: <Application schema name> GML application schema version: version 3.0 specification: D2.8.II.4 Data Specification on *Geology* – Technical Guidelines

Example XML encoding	`<gmd:MD_Format>`
	`    <gmd:name>`
	`        <gco:CharacterString>SomeApplicationSchema GML application schema</gco:CharacterString>`
	`    </gmd:name>`
	`    <gmd:version>`
	`        <gco:CharacterString>3.0</gco:CharacterString>`
	`    </gmd:version>`
	`    <gmd:specification>`
	`        <gco:CharacterString>D2.8.II.4 Data Specification on Geology □ Technical Guidelines</gco:CharacterString>`
	`    </gmd:specification>`
	`</gmd:MD_Format>`

Comments	

8.2.4. Character Encoding

Metadata element name	**Character Encoding**
Definition	The character encoding used in the data set.
ISO 19115 number and name	
ISO/TS 19139 path	

<table>
<tr><th>Metadata element name</th><th>Character Encoding</th></tr>
<tr><td>INSPIRE obligation / condition</td><td>Mandatory, if an encoding is used that is not based on UTF-8.</td></tr>
<tr><td>INSPIRE multiplicity</td><td>0..*</td></tr>
<tr><td>Data type (and ISO 19115 no.)</td><td></td></tr>
<tr><td>Domain</td><td></td></tr>
<tr><td>Implementing instructions</td><td></td></tr>
<tr><td>Example</td><td>-</td></tr>
<tr><td>Example XML encoding</td><td>

```
<gmd:characterSet>
    <gmd:MD_CharacterSetCode codeListValue="8859part2"
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/Codelist/ML_gmxCodelists.xml#CharacterSetCode">8859-2</gmd:MD_CharacterSetCode>
</gmd:characterSet>
```

</td></tr>
<tr><td>Comments</td><td></td></tr>
</table>

8.2.5. Spatial representation type

Metadata element name	**Spatial representation type**
Definition	The method used to spatially represent geographic information.
ISO 19115 number and name	37. spatialRepresentationType
ISO/TS 19139 path	
INSPIRE obligation / condition	Mandatory
INSPIRE multiplicity	1..*
Data type (and ISO 19115 no.)	B.5.26 MD_SpatialRepresentationTypeCode
Domain	
Implementing instructions	Of the values included in the code list in ISO 19115 (vector, grid, textTable, tin, stereoModel, video), only vector, grid and tin should be used. NOTE Additional code list values may be defined based on feedback from implementation.
Example	-

Metadata element name	Spatial representation type
Example XML encoding	
Comments	

8.2.6. Data Quality – Logical Consistency – Topological Consistency

See section 8.3.2 for instructions on how to implement metadata elements for reporting data quality.

8.3. Recommended theme-specific metadata elements

Recomendation 20

The metadata describing a spatial data set or a spatial data set series related to the theme *Geology* should comprise the theme-specific metadata elements specified in **Table 5**.

The table contains the following information:

- The first column provides a reference to a more detailed description.
- The second column specifies the name of the metadata element.
- The third column specifies the multiplicity.

Table 5 – Optional theme-specific metadata elements for the theme *Geology*

Section	Metadata element	Multiplicity
8.3.1	Maintenance Information	0..1
8.3.2	Logical Consistency – Conceptual Consistency	0..*
8.3.2	Logical Consistency – Domain Consistency	0..*

Recomendation 21

For implementing the metadata elements included in this section using ISO 19115, ISO/DIS 19157 and ISO/TS 19139, the instructions included in the relevant sub-sections should be followed.

8.3.1. Maintenance Information

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

8.3.2. Metadata elements for reporting data quality

Recomendation 22

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

Recomendation 23

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

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

Recomendation 24

If a dataset does not pass the tests of the Application schema conformance class (defined in Annex A), the results of each test should be reported using one of the options described in sections 8.3.2.1 and 8.3.2.2.

NOTE 1 If using non-quantitative description, the results of several tests do not have to be reported separately, but may be combined into one descriptive statement.

NOTE 2 The sections 8.3.2.1 and 8.3.2.2 may need to be updated once the XML schemas for ISO 19157 have been finalised.

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

Recomendation 25

The scope element (of type DQ_Scope) of the DQ_DataQuality subtype should be used to encode the reporting scope.

Only the following values should be used for the level element of DQ_Scope: Series, Dataset, featureType.

If the level is featureType the levelDescription/MDScopeDescription/features element (of type Set< GF_FeatureType>) shall be used to list the feature type names.

NOTE In the level element of DQ_Scope, the value featureType is used to denote spatial object type.

8.3.2.1. Guidelines for reporting quantitative results of the data quality evaluation

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission

Metadata element name	**See chapter 7**
Domain	Lines 7-9 from ISO/DIS 19157 7. DQ_MeasureReference (C.2.1.3) 8. DQ_EvaluationMethod (C.2.1.4.) 9. DQ_Result (C2.1.5.)
Implementing instructions	39. nameOfMeasure NOTE This should be the name as defined in Chapter 7. 42. evaluationMethodType 43. evaluationMethodDescription NOTE If the reported data quality results are derived or aggregated (i.e. the scope levels for evaluation and reporting are different), the derivation or aggregation should also be specified using this property. 46. dateTime NOTE This should be data or range of dates on which the data quality measure was applied. 63. DQ_QuantitativeResult / 64. value NOTE The DQ_Result type should be DQ_QuantitativeResult and the value(s) represent(s) the application of the data quality measure (39.) using the specified evaluation method (42-43.)
Example	See Table E.12 — Reporting commission as metadata (ISO/DIS 19157)
Example XML encoding	

8.3.2.2. Guidelines for reporting descriptive results of the Data Quality evaluation

Metadata element name	**See chapter 7**
Definition	See chapter 7
ISO/DIS 19157 number and name	3. report
ISO/TS 19139 path	dataQualityInfo/*/report
INSPIRE obligation / condition	optional
INSPIRE multiplicity	0..*
Data type (and ISO/DIS 19157 no.)	Corresponding DQ_xxx subelement from ISO/DIS 19157, e.g. 12. DQ_CompletenessCommission

Metadata element name	**See chapter 7**
Domain	Line 9 from ISO/DIS 19157 9. DQ_Result (C2.1.5.)
Implementing instructions	67. DQ_DescripitveResult / 68. statement NOTE The DQ_Result type should be DQ_DescriptiveResult and in the statement (68.) the evaluation of the selected DQ sub-element should be expressed in a narrative way.
Example	See Table E.15 — Reporting descriptive result as metadata (ISO/DIS 19157)
Example XML encoding	

9. Delivery

9.1. Updates

IR Requirement
Article 8
Updates

1. Member States shall make available updates of data on a regular basis.
2. All updates shall be made available at the latest 6 months after the change was applied in the source data set, unless a different period is specified for a specific spatial data theme in Annex II.

NOTE In this data specification, no exception is specified, so all updates shall be made available at the latest 6 months after the change was applied in the source data set.

9.2. Delivery medium

According to Article 11(1) of the INSPIRE Directive, Member States shall establish and operate a network of services for INSPIRE spatial data sets and services. The relevant network service types for making spatial data available are:

- *view services* making it possible, as a minimum, to display, navigate, zoom in/out, pan, or overlay viewable spatial data sets and to display legend information and any relevant content of metadata;
- *download services*, enabling copies of spatial data sets, or parts of such sets, to be downloaded and, where practicable, accessed directly;
- *transformation services*, enabling spatial data sets to be transformed with a view to achieving interoperability.

NOTE For the relevant requirements and recommendations for network services, see the relevant Implementing Rules and Technical Guidelines[16].

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

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

through the Describe Spatial Object Types operation).

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

Input data (mandatory). The data set to be transformed.

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

9.3. Encodings

The IRs contain the following two requirements for the encoding to be used to make data available.

IR Requirement
Article 7
Encoding

1. Every encoding rule used to encode spatial data shall conform to EN ISO 19118. In particular, it shall specify schema conversion rules for all spatial object types and all attributes and association roles and the output data structure used.

2. Every encoding rule used to encode spatial data shall be made available.

2a. Every encoding rule used to encode spatial data shall also specify whether and how to represent attributes and association roles for which a corresponding value exists but is not contained in the spatial data sets maintained by a Member State, or cannot be derived from existing values at reasonable costs.

NOTE ISO 19118:2011 specifies the requirements for defining encoding rules used for interchange of geographic data within the set of International Standards known as the "ISO 19100 series". An encoding rule allows geographic information defined by application schemas and standardized schemas to be coded into a system-independent data structure suitable for transport and storage. The encoding rule specifies the types of data being coded and the syntax, structure and coding schemes used in the resulting data structure. Specifically, ISO 19118:2011 includes

- requirements for creating encoding rules based on UML schemas,
- requirements for creating encoding services, and
- requirements for XML-based encoding rules for neutral interchange of data.

While the IRs do not oblige the usage of a specific encoding, these Technical Guidelines propose to make data related to the spatial data theme *Geology* available at least in the default encoding(s) specified in section 0. In this section, a number of TG requirements are listed that need to be met in order to be conformant with the default encoding(s).

The proposed default encoding(s) meet the requirements in Article 7 of the IRs, i.e. they are conformant with ISO 19118 and (since they are included in this specification) publicly available.

9.3.1. Default Encoding(s)

9.3.1.1. Specific requirements for GML encoding

This data specification proposes the use of GML as the default encoding, as recommended in sections 7.2 and 7.3 of [DS-D2.7]. GML is an XML encoding in compliance with ISO 19118, as required in Article 7(1). For details, see [ISO 19136], and in particular Annex E (UML-to-GML application schema encoding rules).

The following TG requirements need to be met in order to be conformant with GML encodings.

TG Requirement 6

Data instance (XML) documents shall validate without error against the provided XML schema.

NOTE 1 Not all constraints defined in the application schemas can be mapped to XML. Therefore, the following requirement is necessary.

NOTE 2 The obligation to use only the allowed code list values specified for attributes and most of the constraints defined in the application schemas cannot be mapped to the XML sch. They can therefore not be enforced through schema validation. It may be possible to express some of these constraints using other schema or rule languages (e.g. Schematron), in order to enable automatic validation.

9.3.1.2. Default encoding(s) for application schema Geology

Name: Geology GML Application Schema
Version: version 3.0,
Specification: D2.8.II.4 Data Specification on *Geology* – Technical Guidelines
Character set: UTF-8

The xml schema document is available on the INSPIRE website *http://inspire.ec.europa.eu/schemas/ge/3.0/Geology.xsd*

9.3.1.3. Default encoding(s) for application schema Hydrogeology

Name: Hydrogeology GML Application Schema
Version: version 3.0,
Specification: D2.8.II.4 Data Specification on *Geology* – Technical Guidelines
Character set: UTF-8

The xml schema document is available on the INSPIRE website *http://inspire.ec.europa.eu/schemas/ge_hg/3.0/Hydrogeology.xsd*

9.3.1.4. Default encoding(s) for application schema Geophysics

Name: Geology GML Application Schema
Version: version 3.0,
Specification: D2.8.II.4 Data Specification on *Geology* – Technical Guidelines
Character set: UTF-8

The xml schema document is available on the INSPIRE website *http://inspire.ec.europa.eu/schemas/ge_gp/3.0/Geophysics.xsd*

9.3.2. Recommended Encoding(s)

Recomendation 26

It is recommended that also the encodings specified in this section be provided for the relevant application schemas.

9.3.2.1. The use of GeoSciML encoding

Name: GeoSciML
Version: 3.2, GML, version 3.2.1
Specification: http://www.geosciml.org
Character set: UTF-8

GeoSciML v 3.2 is the community developed exchange format for providing detailed geoscientific information. It also served as the basis for the more simplified INSPIRE *Geology* core data model. The detailed guidelines, entitled "GeoSciML 3.2 Encoding Cookbook for INSPIRE WFS services" document how to use GeoSciML for INSPIRE and are available at*:*

http://www.geosciml.org/geosciml/3.2/documentation/cookbook/INSPIRE_GeoSciML_Cookbook%20_1.0.pdf.

NOTE These aim at providing a unique encoding solution (e.g. a transformation tool) to fully address both INSPIRE and GeoSciML requirements. However, this proposed solution still needs to be tested by the wider stakeholder community as part of the INSPIRE Maintenance and Implementation Framework. Based on the results, it should be discussed whether the current default INSPIRE encoding (see Section 9.3.1.) can be replaced by the GeoSciML encoding.

9.4. Options for delivering coverage data

For coverages, different encodings may be used for the domain and the range of the coverage. There are several options for packaging the domain and range encoding when delivering coverage data through a download service, as discussed below[17].].

Multipart representation

For performance reasons, binary file formats are usually preferred to text-based formats such as XML for storing large amounts of coverage data. However, they cannot directly constitute an alternative to pure GML, since their own data structure might often not support all the ISO 19123 elements used to describe coverages in the conceptual model.

The OGC standard GML Application Schema for coverages [OGC 09-146r2] offers a format encoding which combines these two approaches. The first part consists of a GML document representing all coverage components except the range set, which is contained in the second part in some other encoding format such as 'well known' binary formats'. Some information in the second part may be redundant with the GML content of the first part. In this case, consistency must be necessarily ensured, for example by defining a GML mapping of the additional encoding format.

The advantage of this multipart representation is that coverage constituents are not handled individually but as a whole. This is not really the case with GML which also allows the encoding of the value side of the coverage in external binary files, but via references to remote locations.

TG Requirement 7

Coverage data encoded as multipart messages shall comply with the multipart representation conformance class defined in GML Application Schema for Coverages [OGC 09-146r2].

NOTE The GML Application Schema for Coverages establishes a one-to-one relationship between coverages and multipart document instances.

Reference to an external file

The range set can be encoded within the XML structure as an external binary file using the gml:File element. This has the benefit of efficiently storing the range set data within an external file that is of a well-known format type, for example TIFF or GeoTIFF. This method of encoding is of most use for the storage of large files.

Encoding the range inline

This option encodes the range set data within the XML inline. This is encoded as a DataBlock element. This encoding provides much greater visibility for the range set values, however, this comes at the cost of reduced efficiency. This method of encoding would therefore only be suitable for small datasets.

Encoding the domain inside a JPEG 2000 file

This option consists in packaging all the components of one or several coverages, including the domain expressed in GML, in a single JPEG 2000 file. It is based on the OGC standard GML in JPEG 2000 for Geographic Imagery [OGC 05-047r2], also known as GMLJP2, which specifies how to use GML within the XML boxes of JPEG 2000 files.

TG Requirement 8

Coverage data encoded in standalone JPEG 2000 files shall comply with the OGC standard GML in JPEG 2000 for Geographic Imagery [OGC 05-047r2].

TG Requirement 8 implies that all the encoding rules presented in GMLJP2 shall be strictly followed for including GML within JPEG 2000 data files correctly. For the sake of harmonization, the encoding rules adopted for the multipart message encoding should also apply to the GMLJP2 encoding.

The encoding of coverage components in GMLJP2 within a JPEG 2000 file should conform to the rules specified in the Guidelines for the encoding of spatial data [DS-D2.7].

10. Data Capture

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

11. Portrayal

This clause defines the rules for layers and styles to be used for portrayal of the spatial object types defined for this theme. Portrayal is regulated in Article 14 of the IRs.

IR Requirement
Article 14
Portrayal

1. For the portrayal of spatial data sets using a view network service as specified in Commission Regulation No 976/2009 ([18]), the following shall be available:
   a. the layers specified in Annex II for the theme or themes the data set is related to;
   b. for each layer at least a default portrayal style, with as a minimum an associated title and a unique identifier.
2. For each layer, Annex II defines the following:
   a. a human readable title of the layer to be used for display in user interface;
   b. the spatial object type(s), or sub-set thereof, that constitute(s) the content of the layer.

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

NOTE The layer specification in the IRs only contains the name, a human readable title and the (subset(s) of) spatial object type(s), that constitute(s) the content of the layer. In addition, these Technical Guidelines suggest keywords for describing the layer.

Recomendation 27

It is recommended to use the keywords specified in section □ in the *Layers Metadata parameters* of the INSPIRE View service (see Annex III, Part A, section 2.2.4 in Commission Regulation (EC) No 976/2009).

Section 0 specifies one style for each of these layers. It is proposed that INSPIRE view services support this style as the default style required by Article 14(1b).

TG Requirement 9

For each layer specified in this section, the styles defined in section 0 shall be available.

NOTE The default style should be used for portrayal by the view network service if no user-defined style is specified in a portrayal request for a specific layer.

In section 11.3, further styles can be specified that represent examples of styles typically used in a thematic domain. It is recommended that also these styles should be supported by INSPIRE view services, where applicable.

Recomendation 28

In addition, it is recommended that, where applicable, INSPIRE view services also support the styles defined in section 11.3.

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

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

11.1. Layers to be provided by INSPIRE view services

Layer Name	Layer Title	Spatial object type(s)	Keywords
GE.GeologicUnit	Geologic Units	MappedFeature (spatial objects whose specification property is of type GeologicUnit)	Geology, Lithology, Age, Geologic unit
GE.<CodeListValue>[19] Example: GE.ShrinkingAndSwelling Clays	<human readable name> Example: Shrinking and swelling clays	MappedFeature (spatial objects whose specification property is of type GeologicFeature and which are classified (using the themeClass property) according to the same thematic classification) (themeClassification : ThematicClassification Value)	Geology, Thematic map
GE.GeologicFault	Geologic Faults	MappedFeature (spatial objects whose specification property is of type ShearDisplacementStructure)	Geology, Geologic Structure, Fault
GE.GeologicFold	Geologic Folds	MappedFeature (spatial objects whose specification property is of type Fold)	Geology, Geologic Structure, Fold

Layer Name	Layer Title	Spatial object type(s)	Keywords
GE.GeomorphologicFeature	Geomorphologic Features	MappedFeature (spatial objects whose specification property is of type GeomorphologicFeature)	Geomorphology, Land surface, Landform
GE.Borehole	Boreholes	Borehole	Borehole, Shaft
GE.Aquifer	Aquifers	MappedFeature (spatial objects whose specification property is of type Aquifer)	Aquifer, Groundwater, Permeable, Hydrogeology
GE.Aquiclude	Aquicludes	MappedFeature (spatial objects whose specification property is of type Aquiclude)	Impermeable, Aquiclude, Hydrogeology
GE.Aquitard	Aquitards	MappedFeature (spatial objects whose specification property is of type Aquitard)	Poorly permeable, Saturated, Aquitard, Hydrogeology
GE.AquiferSystems	Aquifer Systems	MappedFeature (spatial objects whose specification property is of type AquiferSystem)	Aquifer, Aquitard, Hydrogeology
GE.Groundwaterbody	Groundwater Bodies	Groundwaterbody	Groundwater, Aquifer, Hydrogeology
GE.ActiveWell	Active Wells	ActiveWell	Groundwater, Well, Aquifer, Hydrogeology
GE.<CodeListValue>[20] Example: GE.gravityStation	<human readable name> Example: Gravity Stations	GeophStation (stationType : StationTypeValue)	Geophysics, Measurement, Point, Station
GE.<CodeListValue>[21] Example: GE.seismicLine	<human readable name> Example: Seismic Lines	GeophProfile (profilType : ProfileTypeValue)	Geophysics, Measurement, Curve, Profile

Layer Name	Layer Title	Spatial object type(s)	Keywords
GE.<CodeListValue>[22] Example: GE.groundGravitySurvey	<human readable name> Example: Ground Gravity Surveys	Campaign (surveyType : SurveyTypeValue)	Geophysics, Measurement, Campaign, Survey
GE.<CodeListValue>[23] Example: GE.3DSeismics	<human readable name> Example: 3D Seismics	GeophSwath (swathType: SwathTypeValue)	Geophysics, Measurement, Surface, Swath

NOTE The table above contains several layers for the spatial object type(s), which can be further classified using a code list-valued attribute. Such sets of layers are specified as described in Article 14(3) of the IRs.

IR Requirement
Article 14
Portrayal

(...)

3. For spatial object types whose objects can be further classified using a code list-valued attribute, several layers may be defined. Each of these layers shall include the spatial objects corresponding to one specific code list value. In the definition of such sets of layers in Annexes II-IV,
   a. the placeholder <CodeListValue> shall represent the values of the relevant code list, with the first letter in upper case,
   b. the placeholder <human-readable name> shall represent the human-readable name of the code list values;
   c. the spatial object type shall include the relevant attribute and code list, in parentheses;
   d. one example of a layer shall be given.

11.1.1. Layers organisation

None.

11.2. Styles required to be supported by INSPIRE view services

None

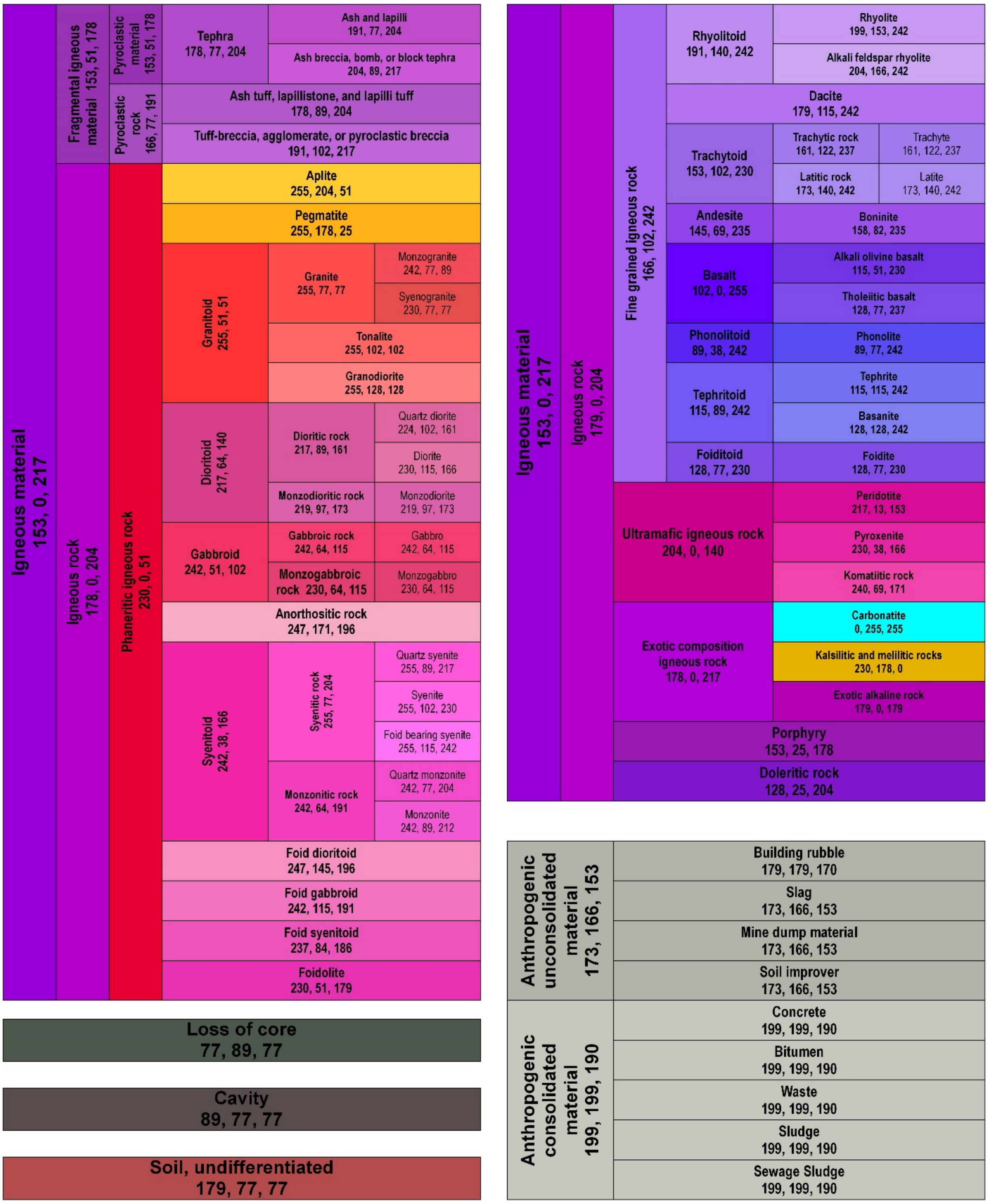
11.3. Styles recommended to be supported by INSPIRE view services

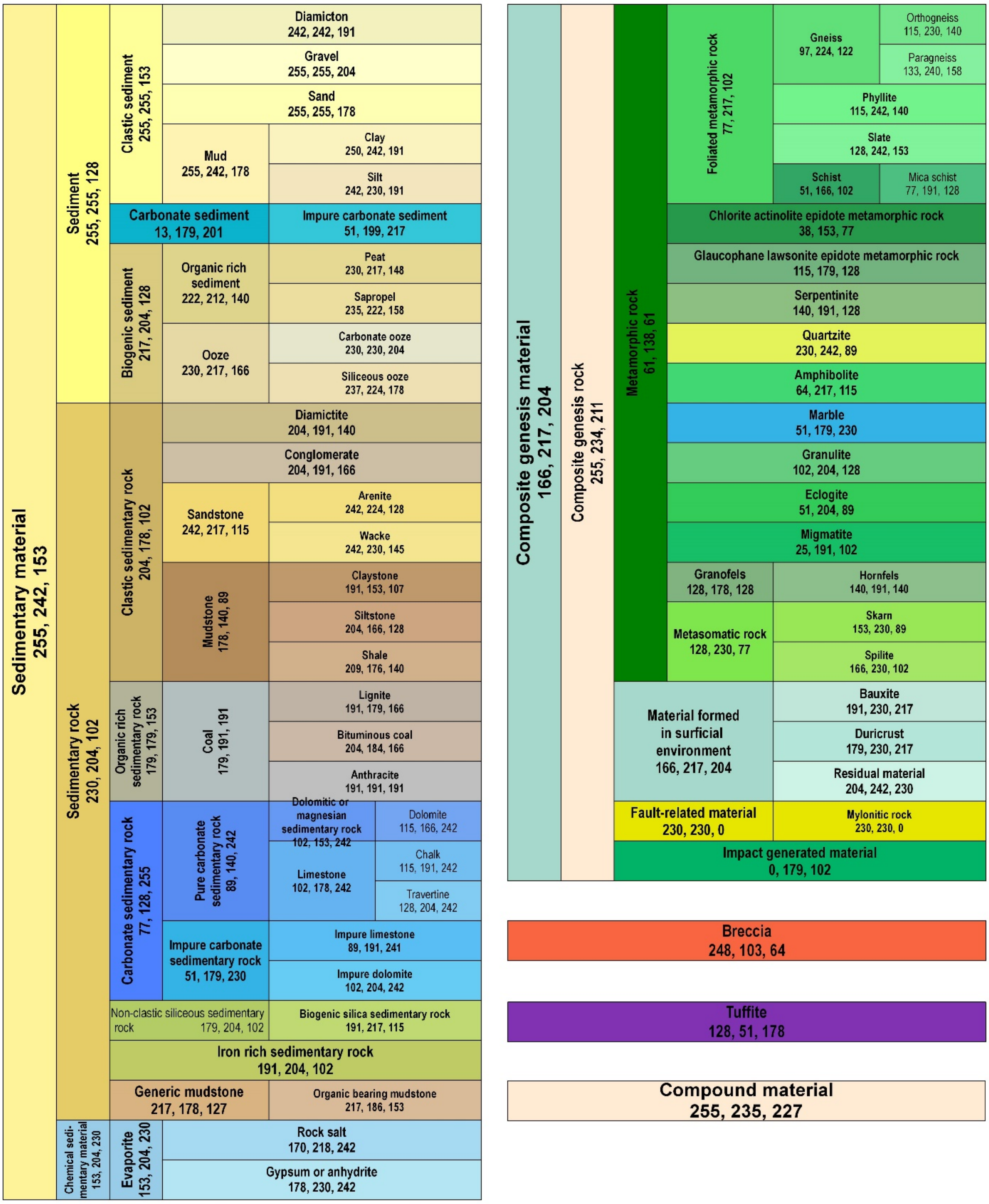
The way rock units are portrayed on maps is an important factor in facilitating the understanding of geological data and can be used to highlight, for example, the different lithologies or ages. For the user it is important to be able to recognise patterns and schemes, so that relevant information can be drawn from the spatial data base immediately.

A portrayal scheme for lithology, age and faults was developed for OneGeology-Europe with special attention paid to the particularities of the different European countries.

11.3.1. Styles for the layer GE.GeologicUnit - Lithology

Style Name	GE.GeologicUnit.Lithology
Style Title	Geologic Units - Lithology
Style Abstract	The colours and RGB codes for lithology, developed for the OneGeology-Europe project, with the addition of styles for anthropogenic consolidated and unconsolidated material, loss of core, cavity and soil, undifferentiated material are includedin the colour tables below.
Symbology	See the colour tables below
Minimum & maximum scales	None


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



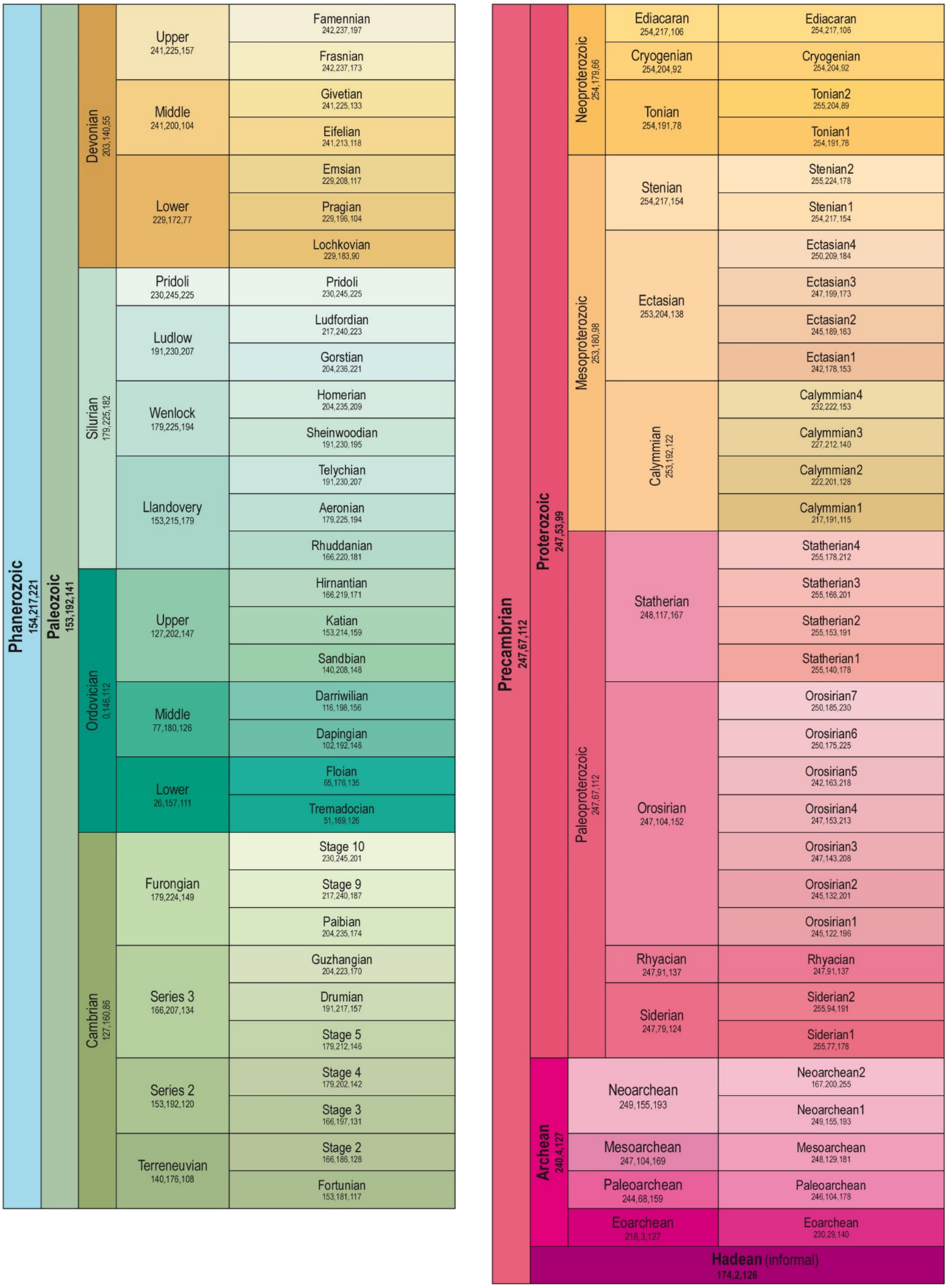
11.3.2. Styles for the layer GE.GeologicUnit – Age of Rocks (olderNamedAge)

Style Name	GE.GeologicUnit.AgeOfRocks
Style Title	Geologic Units – Age of rocks

Style Abstract	The colours and RGB codes according to the Geological Time Scale 2008, International Commission of Stratigraphy, with the addition of 27 newly defined colours for the proposed new European Proterozoic Epochs (by the OneGeology-Europe project). Please note, the defining age for the unit is the older age.
Symbology	See the colour tables below.
Minimum & maximum scales	None

Phanerozoic 154,217,221	Cenozoic 242,249,29	Quaternary 249,249,127	Holocene 254,242,224	Holocene 254,242,224
			Pleistocene 255,255,174	Upper Pleistocene 255,242,211
				Ionian 255,242,199
				Calabrian 255,242,186
				Gelasian 255,255,204
		Neogene 255,230,25	Pliocene 255,255,153	Piacenzian 255,255,191
				Zanclean 255,255,179
			Miocene 255,255,0	Messinian 255,255,115
				Tortonian 255,255,102
				Serravallian 255,255,89
				Langhian 255,255,77
				Burdigalian 255,255,65
				Aquitanian 255,255,51
		Paleogene 253,154,82	Oligocene 253,192,122	Chattian 254,230,170
				Rupelian 254,217,154
			Eocene 253,180,108	Priabonian 253,205,161
				Bartonian 253,192,145
				Lutetian 252,180,130
				Ypresian 252,167,115
			Paleocene 253,167,95	Thanetian 253,191,111
				Selandian 255,191,101
				Danian 253,180,98
	Mesozoic 103,197,202	Cretaceous 127,198,78	Upper 166,216,74	Maastrichtian 242,250,140
				Campanian 230,244,127
				Santonian 217,239,116
				Coniacian 204,233,104
				Turonian 191,227,93
				Cenomanian 179,222,83
			Lower 140,205,87	Albian 204,234,151
				Aptian 191,228,138
				Barremian 179,223,127
				Hauterivian 166,217,117
				Valanginian 153,211,106
				Berriasian 140,205,96

Phanerozoic 154,217,221	Mesozoic 103,197,202	Jurassic 52,197,202		Upper 179,227,238	Tithonian 217,241,247
					Kimmeridgian 204,236,244
					Oxfordian 191,231,241
				Middle 128,207,216	Callovian 191,231,229
					Bathonian 179,226,227
					Bajocian 166,221,224
					Aalenian 154,217,221
				Lower 66,174,208	Toarcian 153,206,227
					Pliensbachian 128,197,221
					Sinemurian 103,188,216
					Hettangian 78,179,211
		Triassic 129,43,146		Upper 189,140,195	Rhaetian 227,185,219
					Norian 214,170,211
					Carnian 201,155,203
				Middle 177,104,177	Ladinian 201,131,191
					Anisian 188,117,183
				Lower 152,57,153	Olenekian 176,81,165
					Induan 164,70,159
	Paleozoic 153,192,141	Permian 240,64,40		Lopingian 251,167,148	Changhsingian 252,192,178
					Wuchiapingian 252,180,162
				Guadalupian 251,116,92	Capitanian 251,154,133
					Wordian 251,141,118
					Roadian 251,128,105
				Cisuralian 239,88,69	Kungurian 227,135,118
					Artinskian 227,123,104
					Sakmarian 227,111,92
					Asselian 227,99,80
		Carboniferous 103,165,153	Pennsylvanian 153,194,181	Upper 191,208,186	Gzhelian 204,212,199
					Kasimovian 191,208,197
				Middle 166,199,183	Moscovian 179,203,185
				Lower 140,190,180	Bashkirian 153,194,181
			Mississippian 103,143,102	Upper 179,190,108	Serpukhovian 191,194,107
				Middle 153,180,108	Visean 166,185,108
				Lower 128,171,108	Tournaisian 140,176,108

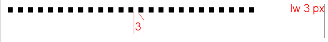
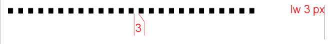
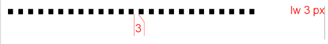
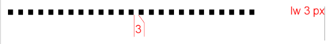
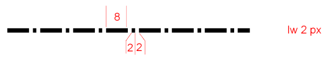
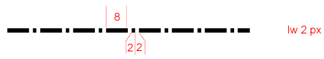
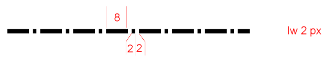


11.3.3. Styles for the layer GE.GeologicFault

Style Name	GE.GeologicFault.
Style Title	Type of Geologic Fault

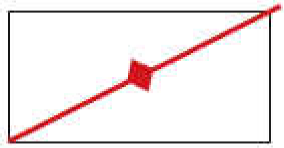
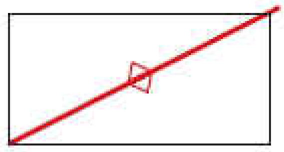
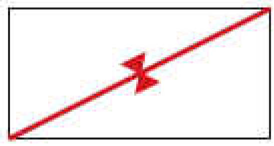
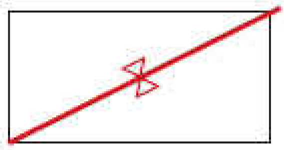
Style Abstract	The lines (MappedFeatures) of **Geologic Structures - faults** are portrayed by their type. A proposal was created for the OneGeology_Europe project.
Symbology	See the colour table below
Minimum & maximum scales	None

Value (FaultTypeValue)	**Draw annotation**	**Colour (RGB)**	**Symbol [lw = line width in pixel]**
fault		0, 0, 0	
strikeSlipFault		0, 0, 0	
dextralStrikeSlipFault		0, 0, 0	
sinistralStrikeSlipFault		0, 0, 0	
wrenchFault		0, 0, 0	
reverseFault	Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)	0, 0, 0	
thrustFault	Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)	0, 0, 0	
highAngleReverse	Symbols in the upthrown block. (For cartographers: The line should be drawn so that the upthrown block is to the right in the drawing direction.)	0, 0, 0	
normalFault		0, 0, 0	

Value (FaultTypeValue)	Draw annotation	Colour (RGB)	Symbol [lw = line width in pixel]
lowAngleNormalFault	Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction	0, 0, 0	
detachmentFault	Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction	0, 0, 0	
highAngleNormalFault	Symbols in the downthrown block. (For cartographers: The line should be drawn so that the downthrown block is to the right in the drawing direction	0, 0, 0	
highAngleFault		0, 0, 0	
lowAngleFault			
horizontalFault			
obliqueSlipFault			
leftNormalFault			
rightNormalFault			
leftReverseFault			
rightReverseFault			
scissorFault		255,51,51	
extractionFault		128,230,77	
mixedExtractionFault		128,230,77	
pureExtractionFault		128,230,77	

11.3.4. Styles for the layer GE.GeologicFold

Style Name	GE.GeologicFold
Style Title	Type of Geologic Fold
Style Abstract	The lines (MappedFeatures) of Geological structures - **Folds** are portrayed by their type.
Symbology	See the colour table below
Minimum & maximum scales	None

Value (FoldProfileTypeValue)	Colour (RGB)	Line width	Symbol
anticline	230, 0, 51	1 px	
antiform	230, 0, 51	1 px	
syncline	230, 0, 51	1 px	
synform	230, 0, 51	1 px	

11.3.5. Styles for the layer GE.GeomorphologicFeature – Natural Geomorphologic Feature

Style Name	**GE.GeomorphologicFeature.Natural**
Style Title	Type of Natural Geomorphologic Features
Style Abstract	Proposal for the portrayal style for types of natural geomorphologic features based on color codes: Some rules consider color codes associated to the landform genesis or geomorphologic environments (References 1 and 2). In other cases (Reference 3) the color code is not directly related to any specific geomorphologic environment.
Symbology	See the colour tables below
Minimum & maximum scales	Depending on the information resolution, the landforms are represented using polygons, lines or points.

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	drainagePattern	L	0,255,255		Stream course	3
naturalGeomorphologicFeature	constructionalFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	destructionalFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			

Feature	**Values (NaturalGeomorphologicFeatureTypeValue)**	**POINT (P) LINE (L) POLYGON (POL)**	**COLOUR (RGB)**	**EXAMPLE**	**EXAMPLE NAME**	**REFERENCE**
naturalGeomorphologicFeature	degradation Feature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			

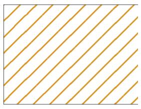
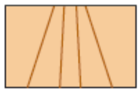
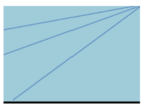
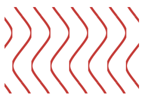
Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	relicFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	exhumedFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial,l acustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	buriedFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			
naturalGeomorphologicFeature	pediment	POL	168,74,10		Pediment	1

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	erosionalFeature	P,L,POL	Same colour as the volcanic, hydrothermal, slopeGravitational, nivalPeriglacialPermafrost, glacial, eolian, marineLittoralCoastalWetland, karstChemicalWeathering, alluvialFluvial, lacustrine or impact NaturalGeomorphologicFeatureTypeValue to which is related (symbol *ad-hoc*)			
naturalGeomorphologicFeature	hill	POL	200,200,200		Hill	—
naturalGeomorphologicFeature	interfluve	POL	235,230,230		Interfluve	—
naturalGeomorphologicFeature	crest	L	0,0,0		Crest	1
naturalGeomorphologicFeature	headSlope	POL	160,160,160		Head slope	—

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature`	sideSlope	POL	215,215,215		Side slope	—
naturalGeomorphologicFeature	noseSlope	POL	240,230,255		Nose slope	—
naturalGeomorphologicFeature	freeFace	POL	227,227,227		Outcrop (i.e. "carbonate rocks")	4
naturalGeomorphologicFeature	baseSlope	POL	250,220,140		Base slope	—
naturalGeomorphologicFeature	mountain	POL	227,227,245		Mountains (i.e."Alpine chain")	4
naturalGeomorphologicFeature	mountaintop	POL	254,254,254		Mountain top	—
naturalGeomorphologicFeature	mountainslope	POL	225,220,200		Mountain slope	—
naturalGeomorphologicFeature	mountainflank	POL	220,225,205		Mountain flank	—
naturalGeomorphologicFeature	mountainbase	POL	245,210,170		Mountain base	—
naturalGeomorphologicFeature	depression	POL	220,235,210		Depression	1
naturalGeomorphologicFeature	plain	POL	235,235,200		Plain	—
naturalGeomorphologicFeature	tectonicStructural	P,L, POL	0,0,0		Hogback	1

Feature	Values (NaturalGeomorphologicFeatureTypeValue)	POINT (P) LINE (L) POLYGON (POL)	COLOUR (RGB)	EXAMPLE	EXAMPLE NAME	REFERENCE
naturalGeomorphologicFeature	volcanic	P,L,POL	209,43,255		Lava field	4
naturalGeomorphologicFeature	hydrothermal	P,L,POL	225,65,110		Geyser	1
naturalGeomorphologicFeature	erosionSurface	POL	168,74,10		Erosion surface	4
naturalGeomorphologicFeature	slopeGravitational	P,L,POL	245,210,170		Scree slope	1
naturalGeomorphologicFeature	nivalPeriglacialPermafrost	P,L,POL	235,150,180		Rock glacier	2
naturalGeomorphologicFeature	glacial	P,L, POL	220,150,225		Till plain	4
naturalGeomorphologicFeature	eolian	P,L, POL	240,240,70		Dune field	4
naturalGeomorphologicFeature	marineLittoralCoastalWetland	P,L, POL	160,255,235		Delta plain complex	4
naturalGeomorphologicFeature	karstChemicalWeathering	P, L, POL	240,160,185		Karst landscape	4
naturalGeomorphologicFeature	alluvialFluvial	P,L, POL	160,215,170		Alluvial plain	—
naturalGeomorphologicFeature	lacustrine	P,L, POL	220,250,250		Playa	4
naturalGeomorphologicFeature	impact	P,L,POL	150,120,100		Impact crater	—

11.3.6. Styles for the layer GE.GeomorphologicFeature – Anthropogenic Geomorphologic Feature

Style Name	GE.GeomorphologicFeature.Anthropogenic
Style Title	Type of Anthropogenic Geomorphologic Features
Style Abstract	Proposal for the portrayal style for types of anthropogenic geomorphologic features based on Color codes: Some rules consider color codes associated to the landform genesis or geomorphologic environments (References 1 and 2). In other cases (Reference 3) the color code is not directly related to any specific geomorphologic environment.
Symbology	See the colour table below
Minimum & maximum scales	Depending on the information resolution, the landforms are represented using polygons, lines or points.

Feature	Values (AnthropogenicGeomorpohologicFeatureTypeValue)	POINT(P), LINE(L), POLYGON (POL)	COLOUR (RGB)	EXAMPLE
AnthropogenicGeomorpohologicFeature	artificialCollapsedDepression	P,L,POL	170,165,45	
AnthropogenicGeomorpohologicFeature	artificialDrainage	L	90,220,225	
AnthropogenicGeomorpohologicFeature	artificialLevee	L,POL	80,60,30	
AnthropogenicGeomorpohologicFeature	dredgedChannel	L	40,100,125	
AnthropogenicGeomorpohologicFeature	dump	P,POL	200,175,100	
AnthropogenicGeomorpohologicFeature	fill	P,POL	250,210,80	
AnthropogenicGeomorpohologicFeature	impactCraterAnthropogenic	P,POL	210,20,5	
AnthropogenicGeomorpohologicFeature	landfillSite	P,POL	255,190,0	

Feature	Values (AnthropogenicGeomorpohologicFeatureTypeValue)	POINT(P), LINE(L), POLYGON (POL)	COLOUR (RGB)	EXAMPLE
AnthropogenicGeomorpohologicFeature	levelledLand	POL	230,200,150	
AnthropogenicGeomorpohologicFeature	openpitMine	P,POL	145,110,45	
AnthropogenicGeomorpohologicFeature	pit	P,POL	105,100,30	
AnthropogenicGeomorpohologicFeature	quarry	P,POL	230,227,162	
AnthropogenicGeomorpohologicFeature	reclaimedLand	POL	250,225,250	
AnthropogenicGeomorpohologicFeature	reservoirLake	POL	90,220,225	
AnthropogenicGeomorpohologicFeature	spoilBank	P,POL	215,105,45	
AnthropogenicGeomorpohologicFeature	subsidenceAreaAnthropogenic	POL	200,200,70	

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- Université de Lausanne. Faculté des Géosciences et de l’Environnement. Institut de Géographie. *http://www.unil.ch/igul/page19238.html* (April 2011)
- Federal Geographic Data Committee [prepared for the Federal Geographic Data Committee by the U.S. Geological Survey], 2006, FGDC Digital Cartographic Standard for Geologic Map Symbolization: Reston, Va., Federal Geographic Data Committee Document Number FGDC-STD-013-2006, 290 p., 2 plates.

11.3.7. Styles for the layer GE.Borehole - Purpose of Boreholes

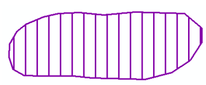
Style Name	GE.Borehole
Style Title	Boreholes – Purpose type
Style Abstract	The Point Symbology to portrayal different boreholes based on their purpose (BoreholePurposeValue code list) using the 'ASCII Windings Font'.
Symbology	See the colour table below
Minimum & maximum scales	None

Value (BoreholePurposeValue)	Portrayal	Portrayal Code
aquaculture	□	170-w2
contingencyWaterSupply	□	165-w2
dewatering	□□ □	163-w2 230-w2
disposal	□	85-w2
drinkingWaterSupply	□□ □	163-w2 174-w2
emergencyWaterSupply	□□ □	163-w2 237-w2
environmentalMonitoring	□	155-w2
explorationExploitationNonmetallicMineralDeposits	□	209-w2
explorationExploitationRawMaterial	□	171-w
explorationNaturalUndergroundStorage	□	193-w2
explorationExploitationEnergyResources	□	191-w2
flowingShot	□	163-w2
geochemicalSurvey	□	178-w
geologicalSurvey	□	202-w2
geophysicalSurvey	□	226-w2
geotechnicalSurvey	□	179w
geothermalEnergy	□	236-w2
groundwaterLevelMonitoring	□□ □	162-w2 178-w
hydrogeologicalSurvey	□	162-w2
industrialWaterSupply	□□ □	163-w2 236-w2
irrigation	□□ □	163-w2 231-w2
mineralExplorationExtraction	□	185-w2
mitigation	□	156-w2

Value (BoreholePurposeValue)	Portrayal	Portrayal Code
pedologicalSurvey		195-w2
pollutionMonitoring		88-w2
recharge		167-w2
remediation		152-w2
Shallow methane production		176-w2
shotHole		224-w2
thermalCleaning		56-w2
waterQualityMonitoring		181w
hydrocarbonAppraisal		175-w2
hydrocarbonExploration		179-w2
hydrocarbonProduction		178-w2
waterSupply		163-w2
Fonts: w = Wingdings w2 = Windings2		

11.3.8. Styles for the layer GE.Aquifer – Aquifer Type

Style Name	GE.Aquifer.Type
Style Title	Type of Aquifers
Style Abstract	The polygons (MappedFeatures) of Types of Aquifers based on the **Aqui**f*erTypeValue* code list.
Symbology	See the colour table below
Minimum & maximum scales	None

Value (AquiferTypeValue)	Colour (RGB)	Line width	Symbol
confinedSubArtesian	132, 0, 168	**1,5 px**	
confinedArtesian	132, 0, 168	**1,5 px**	
unconfined	132, 0, 168	**1,5 px**	

11.3.9. Styles for the layer GE.Aquifer – Media Type

Style Name	GE.Aquifer.MediaType
Style Title	Type of Aquifer Media
Style Abstract	The polygons (MappedFeatures) of Types **of Aquifers based on the media type** (**AquiferMediaTypeValue** code list).
Symbology	See the colour tables below
Minimum & maximum scales	None

	Color (CMYK and RGB)									
AquiferMediaTypeValue	**C**	**M**	**Y**	**K**		**R**	**G**	**B**		**Symbol**
fractured	0	32	30	0		255	173	178		
porous	45	0	0	0		140	255	255		
karstic	89	0	161	122		204	224	188		
compound	0	173	50	0		255	211	127		
karsticAndFractured	25	25	0	0		191	191	255		
porousAndFractured	40	0	40	0		155	255	153		

11.3.10. Styles for the layer GE.Aquiclude – ConstitutionOfAquiclude

Style Name	**GE. Aquiclude.ConstitutionOfAquiclude**
Style Title	Aquiclude – Constitution of Aquiclude
Style Abstract	The polygons (MappedFeatures) of spatial objects whose specification property is of type Aquiclude
Symbology	See the colour table below

Style Name	GE. Aquiclude.ConstitutionOfAquiclude
Minimum & maximum scales	None

	Color (CMYK and RGB)									
Aquiclude	**C**	**M**	**Y**	**K**		**R**	**G**	**B**		**Symbol**
unconsolidated	7	17	40	0		237	212	153		
consolidated (rock)	15	30	45	0		217	178	140		

11.3.11. Styles for the layer GE.Aquitard – ConstitutionOfAquitard

Style Name	GE.Aquitard. ConstitutionOfAquitard
Style Title	Aquiclude – Constitution of Aquiclude
Style Abstract	The polygons (MappedFeatures) of spatial objects whose specification property is of type Aquitard
Symbology	See the colour table below
Minimum & maximum scales	None

	Color (CMYK and RGB)									
	C	**M**	**Y**	**K**		**R**	**G**	**B**		**Symbol**
Aquitard	38	20	0	114		140	180	226		

11.3.12. Styles for the layer GE.AquiferSystem – ConstitutionOfAquifer System

Style Name	GE.AquiferSystem. ConstitutionOfAquiferSystem
Style Title	AquiferSystem – Constitution of AquiferSystem

Style Name	**GE.AquiferSystem. ConstitutionOfAquiferSystem**
Style Abstract	The polygons (MappedFeatures) of spatial objects whose specification property is of type AquiferSystem
Symbology	See the colour table below
Minimum & maximum scales	None

	Color (CMYK and RGB)									
	C	**M**	**Y**	**K**		**R**	**G**	**B**		**Symbol**
AquiferSystem	38	20	0	114		190	215	240		

11.3.13. Styles for the layer GE.GroundWaterBody– Groundwater Body

Style Name	**GE.GroundWaterBody**
Style Title	Groundwater Body
Style Abstract	Normally represented by contour lines of (piezometric) head
Symbology	default
Minimum & maximum scales	None

	Color (CMYK and RGB)									
	C	**M**	**Y**	**K**		**R**	**G**	**B**		**Line**
Groundwater Body	0	0	0	1		0	0	0		

11.3.14. Styles for the layer GE.ActiveWell– Type of Active Well

Style Name	**GE.ActiveWell**
Style Title	Type of Active Wells
Style Abstract	Style for Active Wells based on the activity type (ActiveWellTypeValue)
Symbology	See the colour table below

Style Name	GE.ActiveWell
Minimum & maximum scales	None

Value (ActiveWellTypeValue)	Portrayal	Portrayal Code
exploitation	□	165-w2
recharge	□	167-w2
dewatering	□□ □	163-w2 230-w2
disposal	□	85-w2
waterExploratory	□	162-w2
thermal	□	236-w2

11.3.15. Styles for the layer group GE.GeophStation - (TypeOfGeophStation)

Style Name	GE.TypeOfGeophStation:GE.gravityStation
Style Title	TypeOfGeophStation - Gravity Stations
Style Abstract	The symbols of **GeophStation** are portrayed by type (stationType) and size of symbol by rank (stationRank). Note: One layer shall be made available for each code list value, for example: GE.gravityStation, GE.magneticStation, GE.seismologicalStation, etc..
Symbology	See the colour table below
Minimum & maximum scales	

Value (StationTypeValue)	Value (StationRankValue)	Geometry	Stroke RGB	Fill RGB	Symbol	Size
gravity station	Observatory	point		#FF6600	square	14
gravity station	1stOrderBase	point		#FF6600	circle	14
gravity station	2ndOrderBase	point		#FF6600	circle	12
magnetic station	Observatory	point		#00CCFF	square	14
magnetic station	secularStation	point		#00CCFF	triangle	14

magnetic station	1stOrderBase	point		#00CCFF	circle	14
magnetic station	2ndOrderBase	point		#00CCFF	circle	12
seismologicalStation	Observatory	point		#993366	square	14
seismologicalStation	1stOrderBase	point		#993366	circle	14
seismologicalStation	2ndOrderBase	point		#993366	circle	12
magnetotelluricsounding	-	point		#FFFF00	circle	10
verticalElectricSounding	-	point		#C0C0C0	circle	10

11.3.16. Styles for the layer group GE.GeophProfile - (TypeOfGeophProfile)

Style Name	**GE.TypeOf GeophProfile:GE.seismicLine**
Style Title	TypeOf GeophProfile - Seismic Lines
Style Abstract	The symbols of **GeophProfile** are portrayed by type (ProfileType). Note: One layer shall be made available for each code list value, for example: GE.boreholeLogging, GE.seismicLine, GE.multielectrodeDCProfile, etc.
Symbology	See the colour table below
Minimum & maximum scales	<min scale> - <max scale>

Value (ProfileTypeValue)	**Geometry**	**stroke RGB**	**fll RGB**	**symbol**	**size**
boreholeLogging	point		#00FF00	circle	12
seismicLine	linestring	#FF0000			
multielectrodeDCProfile	linestring	#C0C0C0			
conePenetrationTest	point		#CCFFCC	circle	10
flightLine	linestring	#3366FF			
verticalSeismicProfile	linestring	#FFCC99			

georadarProfile	linestring	#99CC00			

11.3.17. Styles for the layer group GE.Campaign - (TypeOfSurvey)

Style Name	**GE.TypeOfSurvey:GE.groundGravitySurvey**
Style Title	TypeOfSurvey - Ground Gravity Survey
Style Abstract	The symbols of **Campaign** are portrayed by type (surveyType). Note: One layer shall be made available for each code list value, for example: GE.groundGravitySurvey, GE.groundMagneticSurvey, GE.airborneGeophysicalSurvey, etc.
Symbology	See the colour table below
Minimum & maximum scales	

Value (SurveyTypeValue)	**Geometry**	**stroke RGB**	**fll RGB**	**symbol**	**size**
groundGravitySurvey	polygon	#FF6600			
groundMagneticSurvey	polygon	#00CCFF			
airborneGeophysicalSurvey	polygon	#3366FF			
seismologicalSurvey	polygon	#993366			
3DResistivitySurvey	polygon	#C0C0C0			
2D seismic survey	polygon	#FF0000			
3D seismic survey	polygon	#FF0000			
borehole logging survey	polygon	#00FF00			
VES survey	polygon	#C0C0C0			
2D resistivity survey	polygon	#C0C0C0			
TDEM survey	polygon	#FF00FF			
FDEM Survey	polygon	#FF99CC			
MT survey	polygon	#FFFF00			

georadar survey	polygon	#99CC00			
CPT survey	polygon	#CCFFCC			
VSP survey	polygon	#FFCC99			
sonar survey	polygon	#000000			

11.3.18. Styles for the layer group GE. GeophSwath - (TypeOfGeophSwath)

Style Name	**GE.TypeOfGeophSwath: GE.3DSeismics**
Style Title	TypeOfGeophSwath - 3D Seismics
Style Abstract	The symbols of **GeophSwath** are portrayed by type (SwathType).
Symbology	See the colour table below
Minimum & maximum scales	<min scale> - <max scale>

Value (SwathTypeValue)	**Geometry**	**stroke RGB**	**fll RGB**	**symbol**	**size**
radarInterferometry	polygon	#000000	#99CC00		
sonar	polygon	#000000	#FFFFFF		
3D Seismics	polygon	#000000	#FF0000		

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Annex A: Abstract Test Suite - (normative)

Disclaimer

While this Annex refers to the Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, it does not replace the legal act or any part of it.

The objective of the Abstract Test Suite (ATS) included in this Annex is to help the conformance testing process. It includes a set of tests to be applied on a data set to evaluate whether it fulfils the requirements included in this data specification and the corresponding parts of Commission Regulation No 1089/2010 (implementing rule as regards interoperability of spatial datasets and services, further referred to as ISDSS Regulation). This is to help data providers in declaring the conformity of a data set to the "degree of conformity, with implementing rules adopted under Article 7(1) of Directive 2007/2/EC", which is required to be provided in the data set metadata according to Commission Regulation (EC) No 2008/1205 (the Metadata Regulation).

Part 1 of this ATS includes tests that provide **input for assessing conformity with the ISDSS regulation.** In order to make visible which requirements are addressed by a specific test, references to the corresponding articles of the legal act are given. The way how the cited requirements apply to ge specification is described under the testing method.

In addition to the requirements included in ISDSS Regulation this Technical guideline contains TG requirements too. TG requirements are technical provisions that need to be fulfilled in order to be conformant with the corresponding IR requirement when the specific technical implementation proposed in this document is used. Such requirements relate for example to the default encoding described in section 9. **Part 2** of the ATS presents tests necessary for assessing the **conformity with TG requirements**.

NOTE Conformance of a data set with the TG requirement(s) included in this ATS implies conformance with the corresponding IR requirement(s).

The **ATS is applicable to the data sets that have been transformed** to be made available through INSPIRE download services (i.e. the data returned as a response to the mandatory "Get Spatial Dataset" operation) rather than the original "source" data sets.

The requirements to be tested are grouped in several *conformance classes*. Each of these classes covers a specific aspect: one conformance class contains tests reflecting the requirements on the application schema, another on the reference systems, etc. **Each conformance class is identified by a URI** (uniform resource identifier) according to the following pattern:

http://inspire.ec.europa.eu/conformance-class/ir/ge/<conformance class identifier>

EXAMPLE 1 The URI *http://inspire.ec.europa.eu/conformance-class/ir/ef/rs* identifies the Reference Systems ISDSS conformance class of the Environmental Monitoring Facilities (EF) data theme.

The results of the tests should be published referring to the relevant conformance class (using its URI).

When an INSPIRE data specification contains **more than one application schema,** the requirements tested in a conformance class may differ depending on the application schema used as a target for the transformation of the data set. This will always be the case for the application schema conformance class. However, also other conformance classes could have different requirements for different application schemas. In such cases, a separate conformance class is defined for each application schema, and they are distinguished by specific URIs according to the following pattern:

http://inspire.ec.europa.eu/conformance-class/ir/ge/<conformance class identifier>/
<application schema namespace prefix>

EXAMPLE 2 The URI *http://inspire.ec.europa.eu/conformance-class/ir/el/as/el-vec* identifies the conformity with the application schema (*as*) conformance class for the Elevation Vector Elements (*el-vec*) application schema.

An overview of the conformance classes and the associated tests is given in the table below.

Table 6. Overview of the tests within this Abstract Test Suite.

A.1 Application Schema Conformance Class
A.1.1 Schema element denomination test
A.1.2 Value type test
A.1.3 Value test
A.1.4 Attributes/associations completeness test
A.1.5 Abstract spatial object test
A.1.6 Constraints test
A.1.7 Geometry representation test
A.2 Reference Systems Conformance Class
A.2.1 Datum test
A.2.2 Coordinate reference system test
A.2.3 Grid test
A.2.4 View service coordinate reference system test
A.2.5 Temporal reference system test
A.2.6 Units of measurements test
A.3 Data Consistency Conformance Class
A.3.1 Unique identifier persistency test
A.3.2 Version consistency test
A.3.3 Life cycle time sequence test
A.3.4 Validity time sequence test
A.3.5 Update frequency test

A.4 Metadata IR Conformance Class
A.4.1 Metadata for interoperability test
A.5 Information Accessibility Conformance Class
A.5.1 Code list publication test
A.5.2 CRS publication test
A.5.3 CRS identification test
A.5.4 Grid identification test
A.6 Data Delivery Conformance Class
A.6.1 Encoding compliance test
A.7 Portrayal Conformance Class
A.7.1 Layer designation test
A.8 Technical Guidelines Conformance Class
A.8.1 Multiplicity test
A.8.2 CRS http URI test
A.8.3 Metadata encoding schema validation test
A.8.4 Metadata occurrence test
A.8.5 Metadata consistency test
A.8.6 Encoding schema validation test
A.8.7 Coverage multipart representation test
A.8.8 Coverage domain consistency test
A.8.9 Style test

In order to be conformant to a conformance class, a data set has to pass **all** tests defined for that conformance class.

In order to be conformant with the ISDSS regulation the inspected data set needs to be conformant to **all** conformance classes in Part 1. The conformance class for overall conformity with the ISDSS regulation is identified by the URI *http://inspire.ec.europa.eu/conformance-class/ir/ge/*.

In order to be conformant with the Technical Guidelines, the dataset under inspection needs to be conformant to all conformance classes included both in Part 1 and 2. Chapter 8 describes in detail how to publish the result of testing regarding overall conformity and conformity with the conformance classes as metadata. The conformance class for overall conformity with the Technical Guidelines is identified by the URI *http://inspire.ec.europa.eu/conformance-class/tg/ge/3.0*.

It should be noted that data providers are not obliged to integrate / decompose the original structure of the source data sets when they deliver them for INSPIRE. It means that a conformant dataset can contain less or more spatial object / data types than specified in the ISDSS Regulation.

A dataset that contains less spatial object and/or data types can be regarded conformant when the corresponding types of the source datasets after the necessary transformations fulfil the requirements set out in the ISDSS Regulation.

A **dataset that contain more spatial object and/or data types** may be regarded as conformant when

- all the spatial object / data types that have corresponding types in the source dataset after the necessary transformations fulfil the requirements set out in the ISDSS Regulation and
- all additional elements of the source model (spatial object types, data types, attributes, constraints and code lists together with their values) do not conflict with any rule defined in the interoperability target specifications defined for any theme within INSPIRE.

Open issue 1: Even though the last condition can be derived from Art. 8(4) of the Directive, the ISDSS Regulation does not contain requirements concerning the above issue. Therefore, no specific tests have been included in this abstract suite for testing conformity of extended application schemas. Annex F of the Generic Conceptual Model (D2.5) provides an example how to extend INSPIRE application schemas in a compliant way.

The ATS contains a detailed list of abstract tests. It should be noted that some tests in the Application schema conformance class can be automated by utilising xml **schema validation tools.** It should be noted that failing such validation test does not necessary reflect non-compliance to the application schema; it may be the results of erroneous encoding.

Each test in this suite follows the same structure:

- Requirement: citation from the legal texts (ISDSS requirements) or the Technical Guidelines (TG requirements);
- Purpose: definition of the scope of the test;
- Reference: link to any material that may be useful during the test;
- Test method: description of the testing procedure.

According to ISO 19105:2000 all tests in this ATS are basic tests. Therefore, this statement is not repeated each time.

Part 1 - (normative)

Conformity with Commission Regulation No 1089/2010

A.1. Application Schema Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/as/Geology

http://inspire.ec.europa.eu/conformance-class/ir/ge/as/Hydrogeology

http://inspire.ec.europa.eu/conformance-class/ir/ge/as/Geophysics

A.1.1. Schema element denomination test

a) Purpose: Verification whether each element of the dataset under inspection carries a name specified in the target application schema(s).

b) Reference: Art. 3 and Art.4 of Commission Regulation No 1089/2010

c) Test Method: Examine whether the corresponding elements of the source schema (spatial object types, data types, attributes, association roles and code lists) are mapped to the target schema with the correct designation of mnemonic names.

NOTE Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

A.1.2. Value type test

a) Purpose: Verification whether all attributes or association roles use the corresponding value types specified in the application schema(s).

b) Reference: Art. 3, Art.4, Art.6(1), Art.6(4), Art.6(5) and Art.9(1)of Commission Regulation No 1089/2010.

c) Test Method: Examine whether the value type of each provided attribute or association role adheres to the corresponding value type specified in the target specification.

NOTE 1 This test comprises testing the value types of INSPIRE identifiers, the value types of attributes and association roles that should be taken from code lists, and the coverage domains.

NOTE 2 Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

A.1.3. Value test

a) Purpose: Verify whether all attributes or association roles whose value type is a code list take the values set out therein.

b) Reference: Art.4 (3) of Commission Regulation No 1089/2010.

c) Test Method: When an attribute / association role has a code list as its type, compare the values of each instance with those provided in the application schema. To pass this tests any instance of an attribute / association role

- shall take only values explicitly specified in the code list when the code list's extensibility is "none".
- shall take only a value explicitly specified in the code list or shall take a value that is narrower (i.e. more specific) than those explicitly specified in the application schema when the code list's extensibility is "narrower".

NOTE 1 This test is not applicable to code lists with extensibility "open" or "any".

NOTE 2 When a data provider only uses code lists with narrower (more specific values) this test can be fully performed based on internal information.

NOTE 3 All code lists defined in this Data specification on *Geology* are with the extensibility "open" or "any". Before using a new or more detailed term the definitions of all values of a relevant code list should be checked (see Recommendation 4).

A.1.4. Attributes/associations completeness test

a) Purpose: Verification whether each instance of spatial object type and data types include all attributes and association roles as defined in the target application schema.

b) Reference: Art. 3, Art.4(1), Art.4(2), and Art.5(2) of Commission Regulation No 1089/2010.

c) Test Method: Examine whether all attributes and association roles defined for a spatial object type or data type are present for each instance in the dataset.

NOTE 1 Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

NOTE 2 For all properties defined for a spatial object, a value has to be provided if it exists in or applies to the real world entity – either the corresponding value (if available in the data set maintained by the data provider) or the value of *void.* If the characteristic described by the attribute or association role does not exist in or apply to the real world entity, the attribute or association role does not need to be present in the data set.

A.1.5. Abstract spatial object test

a) Purpose: Verification whether the dataset does NOT contain abstract spatial object / data types defined in the target application schema(s).

b) Reference: Art.5(3) of Commission Regulation No 1089/2010

c) Test Method: Examine that there are NO instances of abstract spatial object / data types in the dataset provided.

NOTE Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

A.1.6. Constraints test

a) Purpose: Verification whether the instances of spatial object and/or data types provided in the dataset adhere to the constraints specified in the target application schema(s).

b) Reference: Art. 3, Art.4(1), and Art.4(2) of Commission Regulation No 1089/2010.

c) Test Method: Examine all instances of data for the constraints specified for the corresponding spatial object / data type. Each instance shall adhere to all constraints specified in the target application schema(s).

NOTE Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

A.1.7. Geometry representation test

a) Purpose: Verification whether the value domain of spatial properties is restricted as specified in the Commission Regulation No 1089/2010.

b) Reference: Art.12(1) of Commission Regulation No 1089/2010

c) Test Method: Check whether all spatial properties only use 0, 1 and 2-dimensional geometric objects that exist in the right 2-, 3- or 4-dimensional coordinate space, and where all curve interpolations respect the rules specified in the reference documents.

NOTE Further technical information is in OGC Simple Feature spatial schema v1.2.1 [06-103r4].

A.2. Reference Systems Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/rs

A.2.1. Datum test

a) Purpose: Verify whether each instance of a spatial object type is given with reference to one of the (geodetic) datums specified in the target specification.

b) Reference: Annex II Section 1.2 of Commission Regulation No 1089/2010

c) Test Method: Check whether each instance of a spatial object type specified in the application schema(s) in section 5 has been expressed using:

- the European Terrestrial Reference System 1989 (ETRS89) within its geographical scope; or
- the International Terrestrial Reference System (ITRS) for areas beyond the ETRS89 geographical scope; or

- other geodetic coordinate reference systems compliant with the ITRS. Compliant with the ITRS means that the system definition is based on the definition of ITRS and there is a well-established and described relationship between both systems, according to the EN ISO 19111.

NOTE Further technical information is given in Section 6 of this document.

A.2.2. Coordinate reference system test

a) Purpose: Verify whether the two- and three-dimensional coordinate reference systems are used as defined in section 6.

b) Reference: Section 6 of Commission Regulation 1089/2010.

c) Test Method: Inspect whether the horizontal and vertical components of coordinates one of the corresponding coordinate reference system has been:

- Three-dimensional Cartesian coordinates based on a datum specified in 1.2 and using the parameters of the Geodetic Reference System 1980 (GRS80) ellipsoid.
- Three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height) based on a datum specified in 1.2 and using the parameters of the GRS80 ellipsoid.
- Two-dimensional geodetic coordinates (latitude and longitude) based on a datum specified in 1.2 and using the parameters of the GRS80 ellipsoid.
- Plane coordinates using the ETRS89 Lambert Azimuthal Equal Area coordinate reference system.
- Plane coordinates using the ETRS89 Lambert Conformal Conic coordinate reference system.
- Plane coordinates using the ETRS89 Transverse Mercator coordinate reference system.
- For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights within its geographical scope. Other vertical reference systems related to the Earth gravity field shall be used to express gravity-related heights in areas that are outside the geographical scope of EVRS.
- For the vertical component in marine areas where there is an appreciable tidal range (tidal waters), the Lowest Astronomical Tide (LAT) shall be used as the reference surface.
- For the vertical component in marine areas without an appreciable tidal range, in open oceans and effectively in waters that are deeper than 200 meters, the Mean Sea Level (MSL) or a well-defined reference level close to the MSL shall be used as the reference surface."
- For the vertical component in the free atmosphere, barometric pressure, converted to height using ISO 2533:1975 International Standard Atmosphere, or other linear or parametric reference systems shall be used. Where other parametric reference systems are used, these shall be described in an accessible reference using EN ISO 19111-2:2012.

NOTE Further technical information is given in Section 6 of this document.

A.2.3. Grid test

a) Purpose: Verify that gridded data related are available using the grid compatible with one of the coordinate reference systems defined in Commission Regulation No 1089/2010

b) Reference: Annex II Section 2.1 and 2.2 of Commission Regulation 1089/2010.

c) Test Method: Check whether the dataset defined as a grid is compatible with one of the coordinate reference.

- Grid_ETRS89_GRS80 based on two-dimensional geodetic coordinates using the parameters of the GRS80 ellipsoid
- Grid_ETRS89_GRS80zn based on two-dimensional geodetic coordinates with zoning,
- Plane coordinates using the Lambert Azimuthal Equal Area projection and the parameters of the GRS80 ellipsoid (ETRS89-LAEA)
- Plane coordinates using the Lambert Conformal Conic projection and the parameters of the GRS80 ellipsoid (ETRS89-LCC)
- Plane coordinates using the Transverse Mercator projection and the parameters of the GRS80 ellipsoid (ETRS89-TMzn)

NOTE 1 Further technical information is given in Section 6 of this document.

NOTE 2 This test applies only to Hydrogeology application schema (GroundWaterBody/HydrogeologicalSurface).

A.2.4. View service coordinate reference system test

a) Purpose: Verify whether the spatial data set is available in the two dimensional geodetic coordinate system for their display with the INSPIRE View Service.

b) Reference: Annex II Section 1.4 of Commission Regulation 1089/2010

c) Test Method: Check that each instance of a spatial object types specified in the application schema(s) in section 5 is available in the two-dimensional geodetic coordinate system

NOTE Further technical information is given in Section 6 of this document.

A.2.5. Temporal reference system test

a) Purpose: Verify whether date and time values are given as specified in Commission Regulation No 1089/2010.

b) Reference: Art.11(1) of Commission Regulation 1089/2010

c) Test Method: Check whether:

- the Gregorian calendar is used as a reference system for date values;
- the Universal Time Coordinated (UTC) or the local time including the time zone as an offset from UTC are used as a reference system for time values.

NOTE Further technical information is given in Section 6 of this document.

A.2.6. Units of measurements test

a) Purpose: Verify whether all measurements are expressed as specified in Commission Regulation No 1089/2010.

b) Reference: Art.12(2) of Commission Regulation 1089/2010

c) Test Method: Check whether all measurements are expressed in SI units or non-SI units accepted for use with the International System of Units.

NOTE 1 Further technical information is given in ISO 80000-1:2009.

NOTE 2 Degrees, minutes and seconds are non-SI units accepted for use with the International System of Units for expressing measurements of angles.

A.3. Data Consistency Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/dc/Geology

http://inspire.ec.europa.eu/conformance-class/ir/ge/dc/Hydrogeoplogy

http://inspire.ec.europa.eu/conformance-class/ir/ge/dc/Geophysics

A.3.1. Unique identifier persistency test

a) Purpose: Verify whether the namespace and localId attributes of the external object identifier remain the same for different versions of a spatial object.

b) Reference: Art. 9 of Commission Regulation 1089/2010.

c) Test Method: Compare the namespace and localId attributes of the external object identifiers in the previous version(s) of the dataset with the namespace and localId attributes of the external object identifiers of current version for the same instances of spatial object / data types; To pass the test, neither the namespace, nor the localId shall be changed during the life-cycle of a spatial object.

NOTE 1 This test can be performed exclusively on the basis of the information available in the database of the data providers.

NOTE 2 When using URI this test includes the verification whether no part of the construct has been changed during the life cycle of the instances of spatial object / data types.

NOTE 3 Further technical information is given in section 14.2 of the INSPIRE Generic Conceptual Model.

A.3.2. Version consistency test

a) Purpose: Verify whether different versions of the same spatial object / data type instance belong to the same type.

b) Reference: Art. 9 of Commission Regulation 1089/2010.

c) Test Method: Compare the types of different versions for each instance of spatial object / data type

NOTE 1 This test can be performed exclusively on the basis of the information available in the database of the data providers.

A.3.3. Life cycle time sequence test

a) Purpose: Verification whether the value of the attribute beginLifespanVersion refers to an earlier moment of time than the value of the attribute endLifespanVersion for every spatial object / object type where this property is specified.

b) Reference: Art.10(3) of Commission Regulation 1089/2010.

c) Test Method: Compare the value of the attribute beginLifespanVersion with attribute endLifespanVersion. The test is passed when the beginLifespanVersion value is before endLifespanVersion value for each instance of all spatial object/data types for which this attribute has been defined.

NOTE 1 This test can be performed exclusively on the basis of the information available in the database of the data providers.

A.3.4. Validity time sequence test

a) Purpose: Verification whether the value of the attribute validFrom refers to an earlier moment of time than the value of the attribute validTo for every spatial object / object type where this property is specified.

b) Reference: Art.12(3) of Commission Regulation 1089/2010.

c) Test Method: Compare the value of the attribute validFrom with attribute validTo. The test is passed when the validFrom value is before validTo value for each instance of all spatial object/data types for which this attribute has been defined.

NOTE 1 This test can be performed exclusively on the basis of the information available in the database of the data providers.

A.3.5. Update frequency test

a) Purpose: Verify whether all the updates in the source dataset(s) have been transmitted to the dataset(s) which can be retrieved for the GE data theme using INSPIRE download services.

b) Reference: Art.8 (2) of Commission Regulation 1089/2010.

c) Test Method: Compare the values of beginning of life cycle information in the source and the target datasets for each instance of corresponding spatial object / object types. The test is passed when the difference between the corresponding values is less than 6 months.

NOTE 1 This test can be performed exclusively on the basis of the information available in the database of the data providers.

A.4. Metadata IR Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/md

A.4.1. Metadata for interoperability test

a) Purpose: Verify whether the metadata for interoperability of spatial data sets and services described in 1089/2010 Commission Regulation have been created and published for each dataset related to the GE data theme.

b) Reference: Art.13 of Commission Regulation 1089/2010

c) Test Method: Inspect whether metadata describing the coordinate reference systems, encoding, and spatial representation type have been created and published. If the spatial data set contains temporal information that does not refer to the default temporal reference system, inspect whether metadata describing the temporal reference system have been created and published. If an encoding is used that is not based on UTF-8, inspect whether metadata describing the character encoding have been created.

NOTE Further technical information is given in section 8 of this document.

A.5. Information Accessibility Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/ia/

A.5.1. Code list publication test

a) Purpose: Verify whether all additional values used in the data sets for attributes, for which narrower values or any other value than specified in Commission Regulation 1089/2010 are allowed, are published in a register.

b) Reference: Art.6(3) and Annex III Section 4.2.3 (Geology), 4.3.2 (Geophysics), 4.4.3. (Hydrogeology)

c) Test Method: For each additional value used in the data sets for code list-valued attributes, check whether it is published in a register.

NOTE Further technical information is given in section 5 of this document.

A.5.2. CRS publication test

a) Purpose: Verify whether the identifiers and the parameters of coordinate reference system are published in common registers.

b) Reference: Annex II Section 1.5

c) Test Method: Check whether the identifier and the parameter of the CRS used for the dataset are included in a register. .

NOTE Further technical information is given in section 6 of this document.

A.5.3. CRS identification test

a) Purpose: Verify whether identifiers for other coordinate reference systems than specified in Commission Regulation 1089/2010 have been created and their parameters have been described according to EN ISO 19111 and ISO 19127.

b) Reference: Annex II Section 1.3.4

c) Test Method: Check whether the register with the identifiers of the coordinate reference systems is accessible.

NOTE Further technical information is given in section 6 of this document.

A.5.4. Grid identification test

a) Purpose: Verify whether identifiers for other geographic grid systems than specified in Commission Regulation 1089/2010 have been created and their definitions have been either described with the data or referenced.

b) Reference: Annex II Section 2.1 and 2.2

c) Test Method: Check whether the identifiers for grids have been created. Inspect the dataset and/or the metadata for inclusion of grid definition.

NOTE Further technical information is given in section 6 of this document.

A.6. Data Delivery Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/de/

A.6.1. Encoding compliance test

a) Purpose: Verify whether the encoding used to deliver the dataset comply with EN ISO 19118.

b) Reference: Art.7 (1) of Commission Regulation 1089/2010.

c) Test Method: Follow the steps of the Abstract Test Suit provided in EN ISO 19118.

NOTE 1 Datasets using the default encoding specified in Section 9 fulfil this requirement.

NOTE 2 Further technical information is given in Section 9 of this document.

A.7. Portrayal Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/po/

A.7.1. Layer designation test

a) Purpose: verify whether each spatial object type has been assigned to the layer designated according to Commission Regulation 1089/2010.

b) Reference: Art. 14(1), Art14(2) and Annex III Section 4.5.

c) Test Method: Check whether data is made available for the view network service using the specified layers respectively:

Layer Name
GE.GeologicUnit
GE. <CodeListValue>[24] Example: GE.ShrinkingAndSwelling Clays
GE.GeologicFault
GE.GeologicFold
GE.GeomorphologicFeature
GE.Borehole
GE.Aquifer
GE.Aquiclude
GE.Aquitard
GE.AquiferSystems
GE.Groundwaterbody
GE.ActiveWell
GE. <CodeListValue>[25] Example: GE.gravityStation
GE. <CodeListValue>[26] Example: GE.seismicLine
GE. <CodeListValue>[27] Example: GE.groundGravitySurvey
GE. <CodeListValue>[28] Example: GE.groundMagneticSurvey

Layer Name
GE.Geophysics.3DSeismics

NOTE Further technical information is given in section 11 of this document.

Part 2 - (informative)

Conformity with the technical guideline (TG) Requirements

A.8. Technical Guidelines Conformance Class

Conformance class:

http://inspire.ec.europa.eu/conformance-class/ir/ge/tg/Geology

http://inspire.ec.europa.eu/conformance-class/ir/ge/tg/Hydrogeology

http://inspire.ec.europa.eu/conformance-class/ir/ge/tg/Geophysics

A.8.1. Multiplicity test

a) Purpose: Verify whether each instance of an attribute or association role specified in the application schema(s) does not include fewer or more occurrences than specified in section 5.

b) Reference: Feature catalogue and UML diagram of the application schema(s) in section 5 of this guideline.

c) Test Method: Examine that the number of occurrences of each attribute and/or association role for each instance of a spatial object type or data type provided in the dataset corresponds to the number of occurrences of the attribute / association role that is specified in the application schema(s) in section 5.

A.8.2. CRS http URI test

a) Purpose: Verify whether the coordinate reference system used to deliver data for INSPIRE network services has been identified by URIs according to the EPSG register.

b) Reference: Section 6 of this technical guideline

c) Test Method: Compare the URI of the dataset with the URIs in the table.

NOTE 1 Passing this test implies the fulfilment of test A6.2

NOTE 2 Further reference please see *http://www.epsg.org/geodetic.html*

A.8.3. Metadata encoding schema validation test

a) Purpose: Verify whether the metadata follows an XML schema specified in ISO/TS 19139.

b) Reference: Section 8 of this technical guideline, ISO/TS 19139

c) Test Method: Inspect whether provided XML schema is conformant to the encoding specified in ISO 19139 for each metadata instance.

NOTE 1 Section 2.1.2 of the Metadata Technical Guidelines discusses the different ISO 19139 XML schemas that are currently available.

A.8.4. Metadata occurrence test

a) Purpose: Verify whether the occurrence of each metadata element corresponds to those specified in section 8.

b) Reference: Section 8 of this technical guideline

c) Test Method: Examine the number of occurrences for each metadata element. The number of occurrences shall be compared with its occurrence specified in Section 8:

NOTE 1 Section 2.1.2 of the Metadata Technical Guidelines discusses the different ISO 19139 XML schema

A.8.5. Metadata consistency test

a) Purpose: Verify whether the metadata elements follow the path specified in ISO/TS 19139.

b) Reference: Section 8 of this technical guideline, ISO/TS 19139

c) Test Method: Compare the XML schema of each metadata element with the path provide in ISO/TS 19137.

NOTE 1 This test does not apply to the metadata elements that are not included in ISO/TS 19139.

A.8.6. Encoding schema validation test

a) Purpose: Verify whether the provided dataset follows the rules of default encoding specified in section 9 of this document

b) Reference: section 9 of this technical guideline

c) Test Method: Inspect whether provided encoding(s) is conformant to the encoding(s) for the relevant application schema(s) as defined in section 9:

NOTE 1 Applying this test to the default encoding schema described in section 9 facilitates testing conformity with the application schema specified in section 5. In such cases running this test with positive result may replace tests from A1.1 to A1.4 provided in this abstract test suite.

NOTE 2 Using Schematron or other schema validation tool may significantly improve the validation process, because some some complex constraints of the schema cannot be validated using the simple XSD validation process. On the contrary to XSDs Schematron rules are not delivered together with the INSPIRE data specifications. Automating the process of validation (e.g. creation of Schematron rules) is therefore a task and an opportunity for data providers.

A.8.7. Coverage multipart representation test

a) Purpose: Verify whether coverage data encoded as multipart messages comply with the multipart representation conformance class defined in GML Application Schema for Coverages [OGC 09-

146r2].

b) Reference: OGC standard GML Application Schema for Coverages [OGC 09-146r2].

c) Test Method: Inspect whether coverage data encoded as multipart messages comply with the multipart representation conformance class defined in GML Application Schema for Coverages [OGC 09-146r2].

NOTE 1 further information is provided in section 9.4 of this technical guideline.

NOTE 2 This test applies only to Hydrogeology application schema (GroundWaterBody/HydrogeologicalSurface).

A.8.8. Coverage domain consistency test

a) Purpose: Verify whether the encoded coverage domain is consistent with the information provided in the GML application schema.

b) Reference: Section 9.4.1.2 of this technical guideline.

c) Test Method: For multipart coverage messages compare the encoded coverage domain with the description of the coverage component in the GML application schema

NOTE 1 This test applies only to those multipart messages, where the coverage range is encoded together with the coverage domain (some binary formats).

NOTE 2 .This test does not apply to multipart messages where the coverage range is embedded without describing the data structure (e.g. text based formats).

A.8.9. Style test

a) Purpose: Verify whether the styles defined in section 11.2 have been made available for each specified layer.

b) Reference: section 11.2.

c) Test Method: Check whether the styles defined in section 11.2 have been made available for each specified layer.

Annex B: Use case - (informative)

This annex describes the use cases related to Geology, Hydrogeology & Geophysics that were used as a basis for the development of this data specification. Geological information is mainly collected or produced to be used by other thematic domains (geo-hazard assessment, ensuring safe disposal of wastes, providing construction material etc.) as described in the document "Examples of use".

The following use cases are described:

UC01: Providing geological data to detect geo-hazards

UC02: Providing geological data to ensure safe disposal of waste

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

UC04: Looking for deep fractured zones in the basement (Geothermal exploration)

UC05: Checking background radiation level changes

UC06: Providing data to undertake water balance to ensure compliance with the WFD

UC07: Groundwater reporting for WFD

UC08: Providing hydrogeological data to define significant pressure

UC09: Providing data to assess Corrosivity to Underground Assets

UC10: Providing data to plan tunneling operations safely and effectively

B.1. UC01: Providing geological data to detect geo-hazards

This use case is related to example of use:

- GE-02: Detecting geo-hazards.

Overview and involved actors

This use case is a part of a more general use case which provides risk maps in a process that involves many other data than geological data (like meteorological data, elements at risk, …) in the disaster management cycle.

The goal of this use case is therefore to deliver geological data to the engineer responsible for establishing risk maps.

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Engineers responsible for establishing risk maps using the geological information in

combination with other data.

Narrative description

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

Detailed description

Use case description	
Name	Providing geological data to detect geo-hazards
Priority	High
Description	The user selects the relevant geographic area and search for geological data: geological map, borehole data, and geotechnical data.
Pre-condition	Geological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between geological terms and user’s terms (done by the data provider?).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for geological maps with lithological and structural information.
Step 2	The user displays the geological map and accesses detailed information about the geologic units (lithology) and structures (existing faults)
Step 3	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth, water level, physical and chemical properties
Step 4	The user accesses the borehole data to get the values of the properties.
Step 5	The user searches in a metadata catalogue for geotechnical data related to the area (existing measurements), or geotechnical properties related to the lithology in general.
Step 6	The user accesses the geotechnical data to get the values of the properties.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of geological data related to the selected area.
*Data source: *INSPIRE-conformant Geology data set provided by Member Sate* *	
Description	Geological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary

Use case description	
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Geological units with:

- their related polygons
- lithology

Geologic structures (faults) with:

- their related lines
- attribute: active or non-active

Borehole data with:

- geologic unit thickness and depth
- water level
- any other properties (physical and chemical) measured

Geotechnical data with:

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

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Soils: the geotechnical properties are those of the rocks but also of the soil on a "continuous column".
- Natural Risk Zones: Geology is a provider of information about underground to engineers who has to define the risk zones.

B.2. UC02: Providing geological data to ensure safe disposal of waste

This use case is related to example of use:

- GE-03: Ensuring the safe disposal of wastes, Nuclear Waste, Carbon Capture and Storage.

Overview and involved actors

This use case is a part of a more general use case which provides geological data in a process that involves many other data than geological data (like population distribution, land use …) in the waste disposal management cycle. It is relevant for the disposal of many different kinds of waste in various geological environments. The goal of the use case is to deliver geological data to the authorities and companies responsible for safe disposal of waste.

Actors:

- Geological surveys to provide geological data (Geological Surveys represent the Member States)
- Authorities and companies responsible for safe disposal of waste using the geological data in combination with other data.

Narrative description

"Safe disposal" usually means that the waste is placed in the bedrock or in unconsolidated superficial deposits at some depth (< 2 500 meters) below the surface. Depending on the nature of the waste the actual site of disposal is either in a natural space (e.g. pore space) or in man-made space (e.g. excavation or bore hole). Examples of waste are burned nuclear fuel and carbon dioxide. Geological data is needed to build a 3D-model that is used and refined during all stages of the waste disposal process: site selection, planning, characterization, construction, and follow-up program.

Detailed description

Use case description		**Name**	**Providing geological data to ensure safe disposal of waste**
Priority	High	Description	The user selects the relevant geographic area and searches for geological data from the surface and underground: geological map, borehole data, groundwater data, geophysical and geochemical data.
Pre-condition	Geological data are available in line with INSPIRE specifications.	**Flow of events – Basic path**	

Use case description		Name	Providing geological data to ensure safe disposal of waste
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps with lithological and structural information.	Step 2	The user displays the geological map and accesses detailed information about the geologic units (lithology etc) and structures (existing faults)
Step 3	The user searches in a metadata catalogue for mineral resource data with information about location of known mineral deposits	Step 4	The user displays the mineral resource data and accesses detailed information about the deposits
Step 5	The user searches in a metadata catalogue for geophysical data with information about seismicity and survey data	Step 6	The user displays the geophysical data and accesses detailed information about the geophysical expression of the rocks
Step 7	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth, water level, physical and chemical properties, fracture properties	Step 8	The user accesses the borehole data to get the values of the properties.
Step 9	The user searches in a metadata catalogue for groundwater data with information about groundwater flow and groundwater chemistry	Step 10	The user accesses the groundwater data to get the values of the properties.
		Flow of events – Alternative path	
		Post-conditions	
Post-condition	The user has a set of geological data for 3D-modelling of the selected area.	*Data source: *INSPIRE-conformant Geology data set provided by Member Sate* *	
Description	Geological data from national sources.	Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary	Thematic scope	Geology
Scale, resolution	National to local	Delivery	INSPIRE Geology GML Application schema

Requirements from the use case

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

Geological units with:

- their related spatial objects
- lithology, mineralogical composition, chemical composition, age, contact relationships, alteration

Geologic structures (faults) with:

- their related spatial objects
- attribute: active or non-active

Mineral resource data

- location of mineral deposits

Geophysical data

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

Borehole data with:

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

Groundwater data

- location of wells
- groundwater flow
- groundwater chemistry

Relationship with other INSPIRE Themes

This use case some relationships with the following INSPIRE data themes.

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

B.3. UC03: Providing geological data to detect ground instability in a flat area

This use case is related to example of use:

- GE-02: Detecting geo-hazards.

Overview and involved actors

This use case is a very particular case which provides risk maps in a process that involves many other data than geological data (like use of the subsurface data, elements at risk…) in the land and urban management cycle.

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

Actors:

- Geological surveys to provide geological information, including hazard assessment, if available (Geological Surveys represent the Member States)
- Mining Authorities to provide information on active and abandoned underground activities
- Geological Surveys and/or Water Authorities to provide information on groundwater
- Responsible for establishing risk maps using the geological information in combination with other data.
- Land and urban planners

Narrative description

Land and urban planning need to know the ground stability for safe infrastructure development.

In flat areas, ground instabilities are mainly related to:

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

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

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

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

Detailed description

Use case description	
Name	Providing geological data to detect ground stability in a flat area
Priority	High
Description	The user views the geographic work area and search for geological data (geological map, borehole data, geotechnical data) and other related data (presence of mining, gas production, subsurface infrastructures and other anthropic underground activities, both active and abandoned; presence of permafrost; seismological zoning)
Pre-condition	Geological and the other related data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between geological terms and user's terms (done by the data provider).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for geological maps with lithological, structural and geomorphological information.
Step 2	The user displays the geological map and accesses detailed information about the geologic units (rock type, including unconsolidated natural materials and anthropogenic deposits or landfills), the landforms (indices of collapse structures), hydrogeological (watertable) and tectonic structures (existing faults)
Step 3	The user searches in a metadata catalogue for borehole data with information about geologic unit thickness and depth (including artificial landfills), water level, physical and chemical properties
Step 4	The user accesses the borehole data to get the values of the properties.
Step 5	The user searches in a metadata catalogue for geotechnical data related to the area (existing measurements), or geotechnical properties related to the materials in general.
Step 6	The user accesses the geotechnical data to get the values of the properties.
Step 7	The user downloads all the selected information to his computer and makes a specific map of the work area
Flow of events – Alternative path	

Use case description	
Post-conditions	
Post-condition 1	The user has a set of geological data related to the selected area (a specific geological map).
Post-condition 2	The same user (or a different user involved in the land and urban management) merges the geological information with the other related data and constructs a map which will be the basis for further specific, on site works, at the scale of the project.
Data source: ***INSPIRE-conformant Geology and other related data set provided by Member Sate***	
Description	Geological and other related data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Geological units, including artificial unconsolidated deposits, with:

- their related polygons
- lithology

Geologic structures (contacts (primary = original, and secondary = mechanical: faults) with:

- their related lines
- their related indications of dip and dip direction
- landforms (collapse structures, dolines)
- attribute: active or non-active

Borehole data with:

- geologic unit thickness and depth
- water level
- any other properties (physical and chemical) measured

Geotechnical data with:

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

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Soils: the geotechnical properties are those of the rocks but also of the soil on a "continuous column".
- Natural Risk Zones: Geology is a provider of information about underground to engineers who have to define the risk zones.
- Energy
- Several aspects from Annex I

B.4. UC04: Looking for deep fractured zones in the basement (Geothermal exploration)

This use case is related to example of use:

- GE-12: Use of geophysics.

Overview and involved actors

This use case is part of a more general use case of providing access to public geophysical information for users interested in mineral or geothermal exploration.

The goal of this use case is to demonstrate the interoperability between geological, borehole and geophysical data services.

Actors:

- Geological surveys to provide geological information
- Geophysicists responsible for establishing
- Geothermal exploration company (user)

Narrative description

In order to find an optimum location for a geothermal drilling the user is looking for data resources related to deep fractured zones in a specific geological unit. Borehole locations are identified in a GIS search and then a specific borehole is selected. From the list of geological units crossed by the borehole the one related to the carboniferous basement is selected and the related observations are examined. From the observation results a geophysical resistivity cross section is selected. If it is freely available the user can download the online resource, otherwise the distributor is contacted and the data is purchased.

Detailed description

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

Requirements from the use case

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

Borehole data with:

- geologic unit thickness and depth
- water level
- any other properties (physical and chemical) measured

Geological units crossed by the borehole with:

- their physical properties (conductivity) and related observations

Geophysical objects:

- geophysical method type, location, distribution metadata
- geophysical cross section, online resource, distribution metadata

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Mineral resources – for exploration
- Energy resources – for the Geothermal potential

B.5. UC05: Checking background radiation level changes

This use case is related to example of use:

- GE-12: Use of geophysics.

Overview and involved actors

This use case is part of a more general use case of providing access to public geophysical information for users interested in the physical state of environment and the impact of industrial contaminations.

The goal of this use case is to demonstrate the importance of access to geophysical monitoring data in order to locate large areas affected by possible radioactive contamination.

Actors:

- Environment agency (user)
- Geophysicists responsible for establishing

Narrative description

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

Detailed description

Use case description	
Name	Checking background radiation level changes
Priority	High
Description	
Pre-condition	Geological data are available in line with INSPIRE specifications.
Flow of events – Basic path	
Step 1	The user starts a BBOX search for airborne **geophysical surveys** carried out before the accident in the target area
Step 2	The user locates a survey and checks the measured **physical parameters**
Step 3	If the list of physical parameters include total gamma radiation the user checks the **distribution metadata** of the model and finds the link to the data provider
Step 4	The user starts a BBOX search for airborne **geophysical surveys** carried out after the accident in the target area
Step 5	The user locates a survey and checks the measured **physical parameters**
Step 6	If the list of physical parameters include total gamma radiation the user checks the **distribution metadata** of the model and finds the link to the data provider
Step 7	Data provider is contacted and the results are purchased
Step 8	Radiation maps are compared and anomalous areas are selected for further investigation
Post-conditions	
Post-condition	
Data source: ***INSPIRE-conformant Geology data set provided by Member Sate***	
Description	Geological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Geophysical Survey:

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

Geophysical features

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

- **Geophysical measurement**
- **Geophysical model**
- **Geophysical survey**

Geophysical measurement

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

Geophysical model

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

Geophysical survey

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

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

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

B.6. UC06: Providing data to undertake water balance to ensure compliance with the WFD

This use case is related to example of use:

- AQ-01: Water supply (water abstraction).

Overview and involved actors

The goal of this use case is therefore to deliver hydrogeological data to professionals responsible for establishing whether groundwater bodies are over or under abstracted according to the WFD. Examples of the professionals include regulators such as the Environment Agency of England and Wales.

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Other hydrometric organizations to provide relevant hydrological data, e.g. rainfall
- Professionals responsible for ensuring compliance with the WFD, e.g. regulator in each member state.
- Professionals responsible for establishing water supply system, for local government to support water management decision process as well as individual investors.
- Water modelers.

Narrative description

The WFD requires that a groundwater body has "good status" in that it is not over abstracted. In order to ensure that a groundwater body is not over abstracted, then a water balance needs to be undertaken. The various inputs and outputs to the system need to be quantified and the balance calculated. Importantly the proportion of abstraction compared to recharge to the aquifer has to be determined. The water balance is created for an Assessment Point (AP) for each sub-catchment.

Detailed description

Use case description	
Name	Providing data to undertake water balance to ensure compliance with the WFD
Priority	High
Description	The user selects the relevant geographic area and searches for hydrogeological and hydrological data: abstraction, baseflow, springflow, rainfall, potential evaporation.
Pre-condition	Hydrogeological and hydrometric data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between hydrogeological terms and user’s terms.
Flow of events – Basic path	

Use case description	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for hydrogeological maps and other relevant hydrological data.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater resources location (useful groundwater aquifers) and hydrogeological parameters (potential discharge of the well, drawdown)
Step 3	The user searches in a metadata catalogue for relevant hydrological data.
Step 4	The user accesses the hydrological data to get the values of the properties and combines them with the hydrogeological data to perform a water balance for the required AP.
Step 5	The user uploads the water balance back into a portal to provide information at the AP.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of hydrogeological and hydrometric data related to the selected area as well as a water balance for the relevant AP.
Data source: ***INSPIRE-conformant Geology data set provided by Member Sate***	
Description	Hydrogeological and hydrological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Hydrogeological units with:

- their related polygons
- potential discharge
- water table depth
- aquifer type

- rock lithology

Well data in relation to borehole with:

- geologic unit thickness and depth
- water level
- any other properties (physical and chemical) measured

Generally to create water balance two main information are needed:

- Recharge (rainfall, river infiltration, river vanish point)
- Discharge – groundwater abstraction (water well, effluent stream, spring or seep)

Vanishing point, spring and seep are objects of interest in Hydrography DS (Annex I)

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Hydrology: HydroPointOfInterest
- Geology: the geologic property of an aquifer

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

B.7. UC07: Groundwater reporting for WFD

This use case is related to example of use:

- AQ-05: Groundwater quality and quantity assessment.

Overview and involved actors

The implementation of the WFD requires the handling of spatial data both for the preparation of the River Basin Management Plans and for the reporting to the Commission.

Article 15 of the Water Framework Directive (WFD) requires Member States to provide information to the European Commission concerning the river basin management plans (RBMP). The RBMP covers, among others a general description of the characteristics of the river basin district (RBD) required under Article 5 and Annex II WFD including the mapping of the location and boundaries of groundwater bodies (GWB) (Annex VII, WFD).

Recommendation for the form and scope of spatial information deliver under the WFD and the Groundwater Directive (GWD) were presented in "Updated Guidance on Implementing the Geographical Information System (GIS) Elements of the EU Water policy".

Member States are obliged to deliver necessary data to fulfill Water Information System of Europe

(WISE) managed by European Environmental Agency (EEA).

Actors:

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

Narrative description

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

The spatial data concerning GWB is a basis for general maps produce:

• Map 1: Quantitative status – Identification of bodies that are at "good quantitative status" and those that are at "poor quantitative status";

• Map 2: Achievement/exceedance of standard for nitrates (value in Annex 1 of GWD or set according to paragraph 3 of Annex 1 GWD, and according to status assessment procedure in Article 4 of GWD);

• Map 3: Achievement/exceedance of standard for pesticides (combined total and individual value in Annex 1 of GWD or set according to paragraph 3 of Annex 1 GWD, and according to status assessment procedure in Article 4 of GWD);
• Map 4: Achievement/exceedance of threshold values set by Member States for other pollutants (considering in this category the list of substances as contained in Part B of Annex II of GWD and more generally any other pollutants contributing to the characterisation of groundwater bodies as being 'at risk', and according to status assessment procedure in Article 4 of GWD);
• Map 5: Trends - Identification of: (a) groundwater bodies with environmentally significant and sustained upward trends in pollutant concentrations, and (b) groundwater bodies in which trends have been reversed;

GIS data submitted by Member States will be also used to produce a **WISE Reference GIS dataset of groundwater bodies** by the EEA or its contracted partners.

GWBs provided by Member States will be merged into one dataset taking into account the description of the submitted GWBs (layered, depth range, aquifer type etc.) to produce a consistent dataset.

Detailed description

Use case description	
Name	Providing groundwater data to WISE reporting

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

Use case description	
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

The following data were requested as a minimum to be provided for each GWB (under Reporting sheet GWB1):

• Unique code;

• Name (if available);

• X co-ordinate (Longitude) of the centroid of the GWB;

• Y co-ordinate (Latitude) of the centroid of the GWB; and

• Size (surface area (m2), unique identifier for the horizon where separate overlying bodies

exist and, if possible, volume of aquifer (m3).

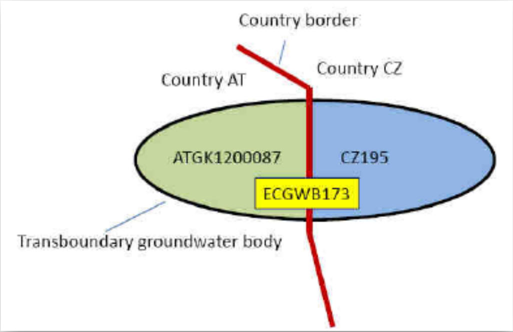
This was translated into the reporting schemas as follows:

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

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

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

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



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

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

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

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

The following attributes should be reported for each GWB

- Water body code
- Water body name
- Shape/GML file
    - Groundwaters: boundaries of all groundwater bodies or groups of groundwater bodies identified.
- For groundwater bodies or groups of groundwater bodies, if available:
    - Layered (Y/N)
    - Average depth to groundwater body (m)

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

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

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Hydrography (HY): GWB is a subset of Water Body class which is the main element in WFD directive reporting as well as base information for Water Management Plans analyzes (water balance)..
- Area management/restriction/regulation zones and reporting units (AM): there is a important relation between GWB and water related reporting units
- Environmental Monitoring Facilities (EF): location and characteristics of Groundwater monitoring facilities will be provided by EF specification, but the link to GW monitoring measurement method and properties is needed in *Geology* DS

B.8. UC08: Providing hydrogeological data to define significant pressure

This use case is related to example of use:

- AQ-04: Protecting ecosystems dependent on groundwater

Overview and involved actors

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

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Professionals responsible for biological diversity.
- Soil experts

Narrative description

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

Detailed description

Use case description	
Name	Managing the positive role aquifers play in supporting ecosystems
Priority	High
Description	The user selects the relevant geographic area and search for hydrogeological data: hydrogeological map (groundwater table level) and well data (geological profile) to estimate the risks associated with groundwater abstraction pressures on the condition of groundwater dependent ecological features.
Pre-condition	Hydrogeological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between hydrogeological terms and user's terms (done by the data provider?).
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and search in a metadata catalogue for hydrogeological maps with groundwater bodies information.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater bodies location, useful groundwater aquifers and hydrogeological parameters (potential discharge of the well, regional discharge pressures, drawdown)
Step 3	The user searches in a metadata catalogue for well data with information about geologic unit thickness and depth, water level changes, groundwater quality (physical and chemical properties)
Step 4	The user accesses the well data to get the values of the properties.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a set of hydrogeological data related to the selected area and is able to analyse data to provide information for decision makers.
Data source: ***INSPIRE-conformant Geology data set provided by Member Sate***	
Description	Hydrogeological data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Hydrogeological units with:

- their related polygons
- potential discharge
- water table depth
- rock lithology

The dependency of ecosystems on groundwater is based on some basic groundwater attributes :

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

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

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

B.9. UC09: Providing data to assess Corrosivity to Underground Assets

This use case is related to example of use:

- AQ-07: Groundwater as a hazard

Overview and involved actors

The goal of this use case is therefore to deliver hydrogeological and geochemical data to professionals responsible for operating underground assets such as water pipes and building foundations to establish whether corrosion will occur and degrade the asset sufficient to cause a leakage, etc.

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Other organizations to provide relevant geochemical data, e.g. concentration of sulphates/sulphides.
- Professionals responsible for assessing risk of corrosivity to underground assets, i.e. pipeline operators, etc.

Narrative description

Underground assets, such as iron pipes, concrete foundations are at risk from corrosion due to chemical attack from solutes found in groundwater and leached from the rock they are in contact with. To provide an understanding of areas where the potential for corrosion is greatest, then the relevant data need to be brought together and an assessment undertaken of the potential for corrosion. By combining hydrogeologcial and geochemical data then the likelihood of corrosion occurring to the underground asset can be quantified and maps produced to inform operators of these assets to be informed.

Detailed description

Use case description	
Name	Providing data to assess Corrosivity to Underground Assets
Priority	Medium
Description	The user selects the relevant geographic area and searches for hydrogeological and geochemical data: depth to water table, geochemical information - sulphate/sulphides, pH, moisture content, organic carbon and resistivity.
Pre-condition	Hydrogeological and geochemical data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between hydrogeological terms and user's terms.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps and other relevant hydrogeological and geochemical data.
Step 2	The user displays the hydrogeological map and accesses detailed information about the groundwater system (depth to water table and moisture content), rock properties (resistivity) and geochemistry (pH, Organic Carbon and sulphate/sulphide concentration)
Step 3	The user accesses the relevant data to get the values of the properties and combines them to produce potential corrosion maps for each type of asset.
Step 4	The user uploads the gridded data back into a portal to provide information for the operator of the asset.
Flow of events – Alternative path	

Use case description	
Post-conditions	
Post-condition	The user has a set of hydrogeological and geochemical data related to the selected area as well as a map of potential corrosivity..
Data source: ***INSPIRE-conformant Geology data set provided by Member Sate***	
Description	Hydrogeological and geochemical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Hydrogeological units with:

- their related polygons
- water table depth
- rock lithology

Unsaturated zone data:

- moisture content

Geochemical data:

- pH
- Sulphate/sulphide concentration

Geophysical data:

- Resistivity of the rocks

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Soils: moisture content:

- Geology: the geologic property of an aquifer

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

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

B.10. UC10: Providing data to plan tunneling operations safely and effectively

This use case is related to example of use:

- AQ-07: Groundwater as a hazard

Overview and involved actors

The goal of this use case is therefore to deliver hydrogeological data to professionals responsible for tunneling operations.

Actors:

- Geological surveys to provide geological information (Geological Surveys represent the Member States)
- Other organizations to provide relevant hydrogoelogical data, e.g. groundwater level.
- Professionals responsible for planning and undertaking tunneling operations.
-

Narrative description

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

Detailed description

Use case description	
Name	Providing data to plan tunneling operations safely and effectively
Priority	Medium
Description	The user selects the relevant geographic area and searches for geological and hydrogeological data. The geological data will be used to construct a 3D model

Use case description	
Pre-condition	Geological and hydrogeological data are available in line with INSPIRE specifications. A specific vocabulary related to the user requirements is available with a "mapping" between hydrogeological terms and user’s terms.
Flow of events – Basic path	
Step 1	The user selects on a geo-portal the area of interest and searches in a metadata catalogue for geological maps and other relevant hydrogeological data.
Step 2	The user accesses a DTM, borehole data and other relevant data to produce a 3D geological model.
Step 3	The user displays the hydrogeological map and accesses detailed information about the groundwater system (water table and moisture content).
Step 4	The user accesses the relevant data to get the values of the properties and combines them with the 3D geolgocial model to produce the required understanding of rock properties and moisture content to plan the tunneling activities.
Step 5	The user uploads the 3D geological model with groundwater data back into a portal to provide information for the tunneling organisation.
Flow of events – Alternative path	
Post-conditions	
Post-condition	The user has a 3D geological model and a set of hydrogeological data related to the selected area. The can be combined to produce a 4D understanding of groundwater flow.
Data source: ***INSPIRE-conformant Geology data set provided by Member Sate***	
Description	Hydrogeological and geochemical data from national sources.
Data provider	Each Member State
Geographic scope	All EU Member States, with appropriate cross border cooperation where necessary
Thematic scope	Geology
Scale, resolution	Scale relevant to the application (tbd)
Delivery	INSPIRE Geology GML Application schema
Documentation	INSPIRE *Geology* Data Specification

Requirements from the use case

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

Topographic data:

- DTM

Geological data:

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

Hydrogeological units with:

- their related polygons
- water table depth
- rock lithology

Unsaturated zone data:

- moisture content

Relationship with other INSPIRE Themes

This use case has some relationships with the following INSPIRE data themes:

- Soils: moisture content:
- Elevation: DTM
- Geology: the geologic property of an aquifer

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

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

Annex C: Code list values - (normative)

INSPIRE Application Schema 'Geology'

Code List
AnthropogenicGeomorphologicFeatureTypeValue
BoreholePurposeValue
CollectionTypeValue
CompositionPartRoleValue
EventEnvironmentValue
EventProcessValue
FaultTypeValue
FoldProfileTypeValue
GeochronologicEraValue
GeologicUnitTypeValue
GeomorphologicActivityValue
LithologyValue
MappingFrameValue
NaturalGeomorphologicFeatureTypeValue

AnthropogenicGeomorphologicFeatureTypeValue

Definition:	The types of anthropogenic geomorphologic feature.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/AnthropogenicGeomorphologicFeatureTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

BoreholePurposeValue

Definition:	**Purposes for which a borehole was drilled.**
Description:	EXAMPLE: mineral exploration, water pumping, site evaluation, stratigraphic research, etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/BoreholePurposeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

CollectionTypeValue

Definition:	**Types of collections of geological and geophysical objects.**
Description:	EXAMPLE: geological map, thematic map etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CollectionTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

CompositionPartRoleValue

Definition:	**Roles that a compositional part plays in a geologic unit.**
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

EventEnvironmentValue

Definition:	**Terms for the geologic environments within which geologic events take place.**
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

EventProcessValue

Definition:	Terms specifying the process or processes that occurred during an event.
Description:	EXAMPLE: deposition, extrusion, intrusion, cooling.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/EventProcessValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

FaultTypeValue

Definition:	Terms describing the type of shear displacement structure.
Description:	EXAMPLE: thrust fault, normal fault, wrench fault.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/FaultTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

FoldProfileTypeValue

Definition:	Terms specifying the type of fold.
Description:	Folds are typed according to the concave/convex geometry of the fold relative to the earth surface, and the relationship to younging direction in folded strata if known. EXAMPLE: antiform, synform, anticline, syncline, etc.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/FoldProfileTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

GeochronologicEraValue

Definition:	**Terms specifying recognised geological time units.**
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeochronologicEraValue
Values:	The INSPIRE Registry includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

GeologicUnitTypeValue

Definition:	**Terms describing the type of geologic unit.**
Description:	EXAMPLE: GeologicUnit, AllostratigraphicUnit etc
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeologicUnitTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

GeomorphologicActivityValue

Definition:	Terms indicating the level of activity of a geomorphologic feature.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeomorphologicActivityValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

LithologyValue

Definition:	**Terms describing the lithology.**
Description:	EXAMPLE: granite, sandstone, schist.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/LithologyValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

MappingFrameValue

Definition:	Terms indicating the surface on which the MappedFeature is projected.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/MappingFrameValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

NaturalGeomorphologicFeatureTypeValue

Definition:	Terms describing the type of natural geomorphologic feature.
Extensibility:	open
Identifier:	
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional valu es at any level defined by data providers.

INSPIRE Application Schema 'Hydrogeology'

Code List
ActiveWellTypeValue
AquiferMediaTypeValue
AquiferTypeValue
ConditionOfGroundwaterValue

Code List
HydroGeochemicalRockTypeValue
NaturalObjectTypeValue
StatusCodeTypeValue
WaterPersistenceValue
WaterSalinityValue

ActiveWellTypeValue

Name:	Active Well Type
Definition:	Types of active wells.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ActiveWellTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

AquiferMediaTypeValue

Name:	Aquifer Media Type
Definition:	Values describing the characteristics of the aquifer medium.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/AquiferMediaTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

AquiferTypeValue

Name:	Aquifer Type
Definition:	Types of aquifers.
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codelist/AquiferTypeValue
Values:	The allowed values for this code list comprise only the values specified in the INSPIRE Registry.

ConditionOfGroundwaterValue

Name:	Condition Of Groundwater
Definition:	Values indicating the approximate degree of change which has taken place on the natural state of groundwater.
Description:	The groundwater in a GroundWaterFlowSystem is in a variable condition, dependent on external factors, among which are diverse human activities.
Extensibility:	none
Identifier:	http://inspire.ec.europa.eu/codelist/ConditionOfGroundwaterValue
Values:	The allowed values for this code list comprise only the values specified in the INSPIRE Registry.

HydroGeochemicalRockTypeValue

Name:	Hydrogeochemical Rock Value
Definition:	Values describing the hydrogeochemical condition of the groundwater environment.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/HydroGeochemicalRockTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

NaturalObjectTypeValue

Name:	Natural Object Type
Definition:	Types of natural hydrogeological objects.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/NaturalObjectTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

StatusCodeTypeValue

Name:	Status Code Type
Definition:	Values describing the statuses of man-made hydrogeological objects.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StatusCodeTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

WaterPersistenceValue

Name:	Water Persistence Value
Definition:	Types of hydrological persistence of water.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/WaterPersistenceValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers.

WaterSalinityValue

Name:	Water Salinity
Definition:	A code list indicating salinity classes in water.
Description:	Salinity is the saltiness or dissolved salt content of a body of water. Generally, it is the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater salinity often refers to the concentration of chlorides in the water. See also total dissolved solids.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/WaterSalinityValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

INSPIRE Application Schema 'Geophysics'

Code List
CampaignTypeValue
NetworkNameValue
PlatformTypeValue
ProfileTypeValue
StationRankValue
StationTypeValue
SurveyTypeValue
SwathTypeValue

CampaignTypeValue

Definition:	Type of geophysical campaign
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CampaignTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

NetworkNameValue

Definition:	Name of geophysical network
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/NetworkNameValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

PlatformTypeValue

Definition:	Platform on which data acquisition was carried out
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/PlatformTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

ProfileTypeValue

Definition:	Type of geophysical profile
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ProfileTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

StationRankValue

Definition:	Rank of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StationRankValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

StationTypeValue

Definition:	Type of geophysical station
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/StationTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

SurveyTypeValue

Definition:	Type of geophysical survey or dataset
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SurveyTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

SwathTypeValue

Definition:	Type of geophysical swath
Description:	An initial set of values are provided in the Implementation Rules. The codelist is expected to be extended by the geophysical community. Recommendations can be found in the Technical Guidence.
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SwathTypeValue
Values:	The allowed values for this code list comprise the values specified in the INSPIRE Registry and additional values at any level defined by data providers. The INSPIRE Registry includes additional recommended values that may also be used by data providers. Before creating new terms, please check if one of them can be used.

Annex D: Data model extensions - (informative)

D.1. Introduction

The INSPIRE *Geology* and Geophysics models are both simple and designed to enable harmonised INSPIRE services. However for many use cases a wider range of more detailed geoscientific information might be required.

D.2. Use of GeoSciML

GeoSciML is a model for the exchange of detailed geoscience information which has been developed by the international geosciences community, in particular Geological Survey Organisations (*http://www.geosciml.org/*). GeoSciML version 3.1 was the starting point in developing the INSPIRE GE model and has heavily influenced its design. However GeoSciML has much broader scope than is required for INSPIRE so the INSPIRE GE model has been developed through a simplification of the required parts of GeoSciML, while aiming to retain the same overall design pattern and key features. Therefore mapping between the INSPIRE GE model and GeoSciML currently in version 3.2 is possible. The detailed mapping between both models is described in the document: **"GeoSciML 3.2 Encoding Cookbook for INSPIRE WFS services"** that is be available at:

http://www.geosciml.org/geosciml/3.2/documentation/cookbook/INSPIRE_GeoSciML_Cookbook%20_1.0.pdf.

D.3. Data model extension for Geophysics

D.3.1. *Narrative description and UML overview*

The core application schema is limited to successfully serve the complex use cases. When the request for data provisioning exceeds the limits of the *Geophysics* application schema the extension model can be used. It allows data providers to publish many types of geophysical measurements and results with sufficient detail to fulfil the user requirements documented in the use cases. The most significant difference between the core and extension models is that the extension model introduces additional elements to share observation results in a harmonized way. This is done through the ISO 19156 Observations and Measurements (O&M) standard and specialized observation classes from the INSPIRE Generic Conceptual Model. For the sake of simplicity the *GeophysicsExtension* application schema defines only a few additional observation classes that are specific to geophysical measurements and models. It is mainly left to the data provider to decide how the standard is used. However by providing controlled dictionaries and best practice examples the guidance tries to help in achieving maximum level of interoperability.

Spatial object Type - Project

The extension model provides an additional class to model geophysical *Projects*. Together with the *Campaign* class of the core model these two can be used for a more detailed description of the geophysical dataset hierarchy. In practice geophysical surveys are often organised into campaigns and projects. A large exploration project may contain several campaigns. e.g.: A big project is started with an airborne measurement campaign. After identifying the main target area a seismic campaign with several seismic lines is carried out. Meanwhile in certain areas where expensive seismic is not feasible magnetotelluric measurements are completed. Each campaign is carried out by different companies, and produce different maps, reports and datasets. The whole activity is controlled by one responsible party, the principal investigator. To model such complex hierarchies the core *Campaign* and the extension *Project* feature types can be used.

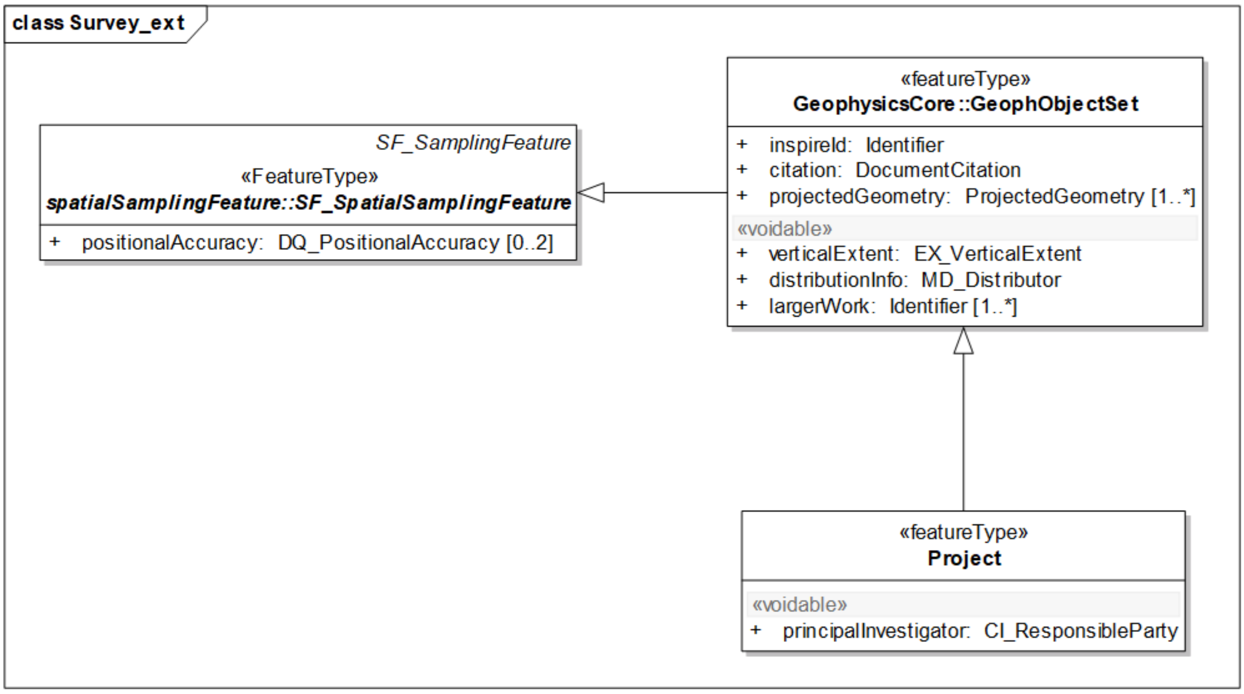


Figure 18 – UML class diagram: Project

Campaign is geophysical activity extending over a limited time range and limited area for producing geophysical measurements, processing results or models. Campaigns can be considered as parents of geophysical measurements or models. Children geophysical objects may refer to their parent campaign through the largerWork attribute.

Project is geophysical activity extending over a longer time period and larger area, containing any number of campaigns or subprojects. In the hierarchy of geophysical data sets projects are parents of geophysical campaigns, and usually cover whole exploration programs. *Project* has one added voidable attributes:

- principalInvestigator: Key party responsible for conducting research

In many cases it is useful to link observation results to collections, rather than to individual geophysical objects. (e.g. a gravity map can be associated with a gravity survey and not with a single station) Both Campaign and Project are subtypes of SF_SpatialSamplingFeature, so it can be done by using the O&M standard. While it sounds quite natural to link observations to *Campaigns*, it is not very likely that any kind of observation is going to be linked to a *Project*. Even in this case at least a shape for bounding geometry shall be provided.

GenericGeophMeasurement

The list of geophysical methods in the *GeopysicsCore* application schema is very limited. This class was added to *GeophysicsExtension* as a generic container for geophysical methods that do not fit in the core measurement types (station, profile, swath). This class adds one attribute to the supertype *GeophMeasurement*

- measurementType: Value must be one of the items listed in the *OtherMeasurementTypeValue* codelist. This codellist is expected to be extended in the future.

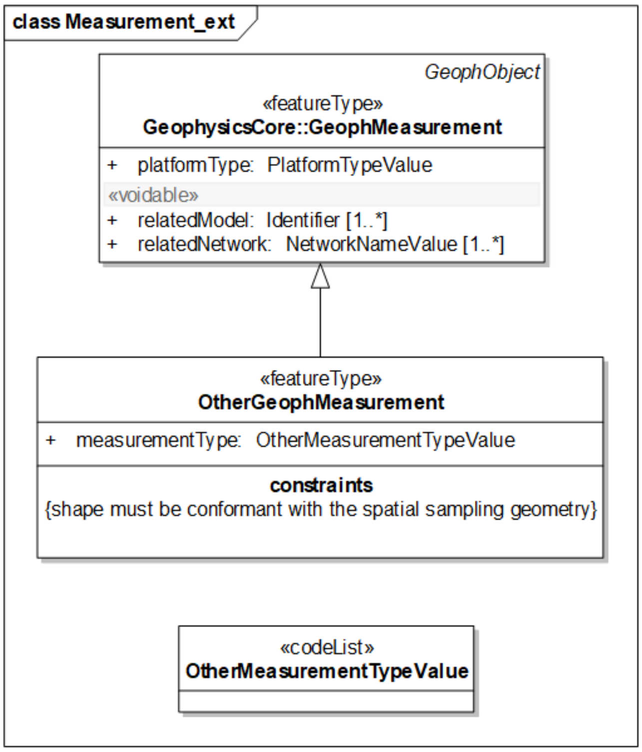


Figure 19 – UML class diagram: GenericGeophMeasurement

Publishing observation data related to a geophysical measurement is optional in INSPIRE. The *GeophObject* class has the *distributionInfo* attribute that holds metadata about data access, ordering procedures, fees etc. When the data provider wants to share observation results in a more interoperable manner the use of *SF_SpatialSamplingFeature* properties is recommended. Guidance to encode observations is given in chapter A.3.7

Models

In the *GeophysicsExtension* application schema *GeophModel* is a geophysical object that is created as a result of data processing or interpretation, representing the distribution of physical or geophysical properties within the observed spatial domain. This definition is broader than the usual concept of model in geophysics that is rather a mathematical construction, a replacement of the reality and it can be used for forward modeling. In INSPIRE under model a geophysical product is meant that can be useful not only for geophysicists, but also for specialists of other domains. It is somewhere at the end of the processing chain. Using O&M terminology the sampledFeature association of a *GeophModel* always can be connected to one or more *GeophMeasurements*.

Apart from the ones inherited from *GeophObject GeophModel* has one voidable attribute:

- relatedMeasurement: It can be used to identify related *GeophMeasurement* instances.

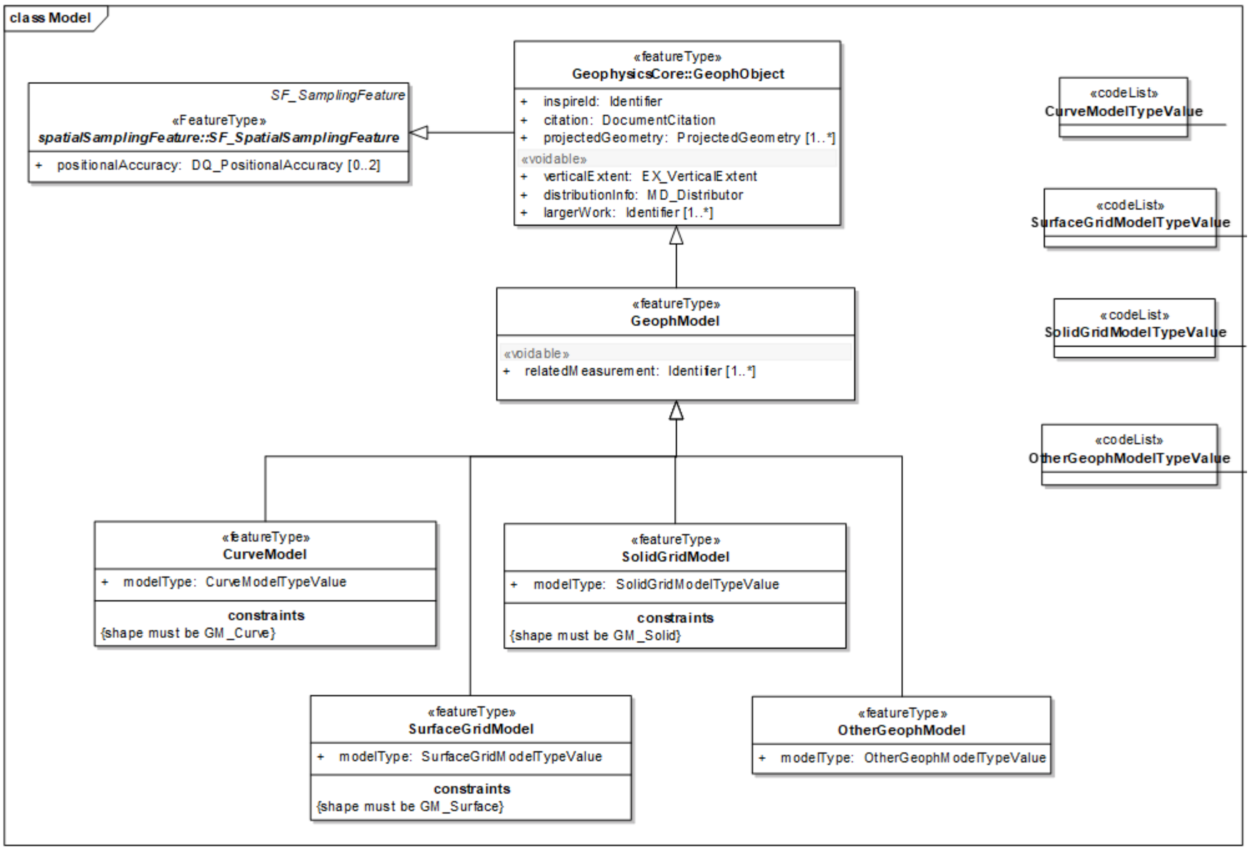


Figure 20 – UML class diagram: GeophModel

Just like measurements, geophysical models are also categorized on the basis of sampling geometry. *CurveModel* is a *GeophModel* with curve geometry. Calculated property values are referenced to a curve. Typical examples are compositLog, layerModel, seismicTimeSection.

Note 1. A 1D layerModel is represented by the trajectory perpendicular to the layer boundaries. Layer parameters are referenced to the curve section overlapping the corresponding layer. The last section of the curve ends at the depth of penetration.

CurveModel has one attribute:

- *modelType*: must be a value from the *CurveModelTypeValue* codelist.

Constraint: shape must be *GM_Curve*

SurfaceGridModel is a *GeophModel* with surface geometry. Calculated property values are referenced to a series of grid points on the surface. Typical examples are seismicDepthSection or 2D resistivity section.

It has one attribute:

- *modelType*: must be a value from the *SurfaceGridModelTypeValue* codelist.

Constraint: shape must be *GM_Surface*

SolidGridModel is a *GeophModel* with solid geometry. Calculated property values are referenced to a series of grid points in the solid. Typical examples are seismicVolume or 3D resistivity block.

It has one attribute:

- *modelType*: must be a value from the *SolidGridModelTypeValue* codelist.

Constraint: shape must be *GM_Solid*

OtherGeophModel is a *GeophModel* with any geometry not listed above.

Examples: Interpreted resistivity cross section (discrete surface coverage that contains polygon patches with resistivity values assigned to them) or Gravity point source distribution (multipoint coverage).

It has one attribute:

- *modelType*: must be a value from the *OtherGeophModelTypeValue* codelist.

How to decide between Measurement and Model?

In contrast to Geophysical measurements geophysical models represent spatial distribution of physical or geophysical properties within the observed spatial domain. Models are created by processing or interpretation and carry the characteristics of the investigated domain as a function of 1 2 or 3 spatial dimensions. It is a matter of data processing to convert measurement data from non spatial dimensions (time, frequency, electrode distance etc.) into space. As a result of this procedure the number of dimensionality increases by 1.

GeophMeasurement and GeophModel are the initial and final stage of the geophysical processing chain. However, the processing chain can be long and if the result originates from an intermediate step it is not always easy to decide which class it belongs to. Table 1. can help in the classification of a feature type.

GeophMeasurement	GeophModel
Data is spatially referenced outside or on the boundary of the investigated domain	Data is spatially referenced to the internal part of the investigated domain
Observed data is a function of some non spatial domain (propagation time, frequency, etc.) to be transformed into space by processing	Observed data is a function of space (or space and time for monitoring.)
Observed property is a geophysical property and not directly interpretable as property of the investigated domain.	Observed property is a property of the investigated domain.
Result can not be used directly for interpretation	Result can be directly used for interpretation

Examples:

- SeismicLine is GeophMeasurement (field data). Observed property is seismic amplitude as a function of time, It is not the property of the investigated domain and the data is not usable for direct interpretation.

- SeismicTimeSection is somewhere between measurement and model. It has one spatial and one non spatial domain (propagation time) to be converted into depth, but it carries information on the seismic reflectivity of the investigated domain and in practice it is often used directly for interpretation. So it is classified as a curve model.
- SeismicDepthSection is clearly a model: a 2D spatial coverage of seismic reflectivity that is directly usable for interpretation.

Observations Result and Procedure

In the O&M schema OM_Observation has four main associations: Phenomenon, Domain, Range, and ProcessUsed (**Figure 21**). Phenomenon connects to the observedProperty. Domain is the observed spatial domain with the featureOfInterest at the target end. Range means the result that was acquired while examining the target. These two relates to each other like domain and range of GML coverages.

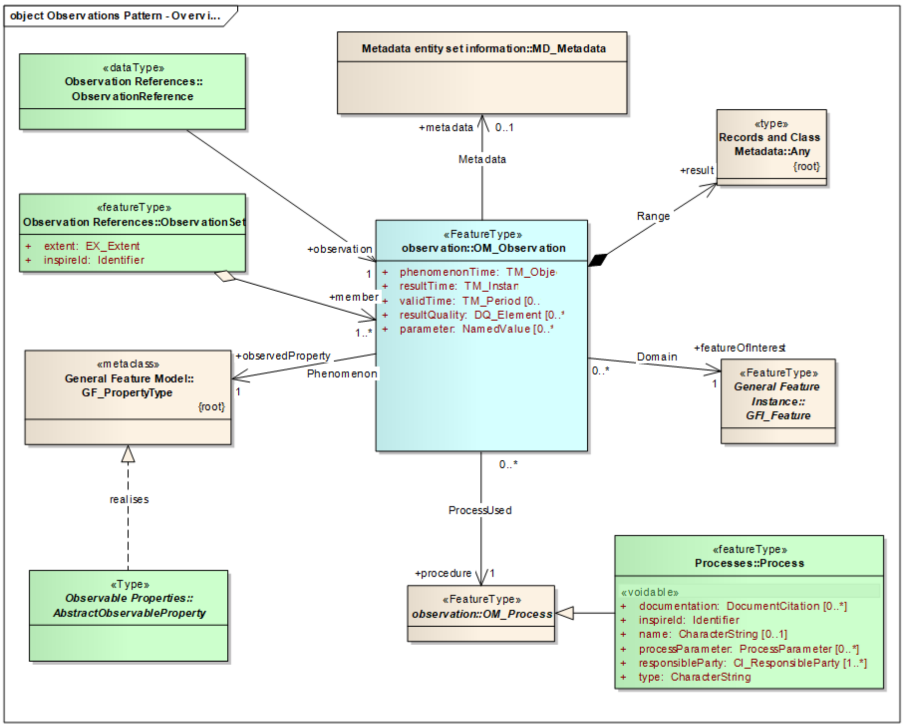


Figure 21 – UML class diagram: Observations overview (GCM)

Results contain observedProperty values characterising the featureOfInterest. ProcessUsed links to a procedure that was used to generate results. Type of result is "Any" since it may represent the value of any feature property. The procedure has the abstract OM_Process type with no properties and serves as a base class for observation processes. Using these concepts any type of observation can be fully described, and it is true for geophysical observations as well.

Geophysics has a rich history of describing observation processes and results, and strong industrial standards for data exchange. Many of the standards were developed long before O&M. However, most geophysical data resources can fit to the O&M concept and plugged into some of the above associations. The *GeophysicsExtension* application schema does not provide a full scale model for geophysical objects. Instead, providing a few auxiliary classes it helps to use the O&M standard as a frame for geophysical information.

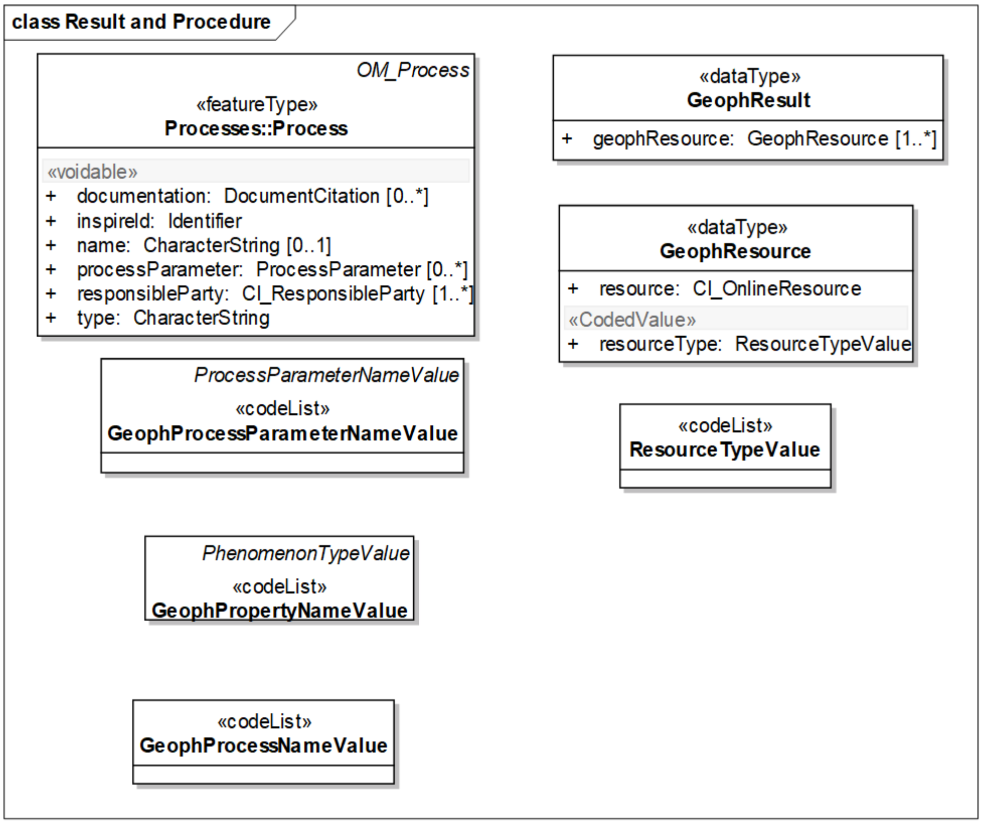


Figure 22 – UML class diagram: Result and Procedure

In the INSPIRE Generic Conceptual Model OM_Process has a specialized subclass: Processes::Process. (**Figure 22**) It has the role of describing generic procedures that are common in practice and can be referenced from many observations that were made in the same or similar way. It has name, identifier, documentation, responsibleParty to inform the user about the nature of the procedure and the authority that maintains the record. ProcessParameters are names of important parameters that are characteristic to the procedure. A useful set of names is available in the hierarchical GeophProcessParameterNameValue codelist. In geophysical terminology process parameters can be considered as header parameters. An instance of Processes::Process contains only the names and descriptions. It is the parameter property of OM_Observation that holds the values and tell how a generic procedure was applied in a specific case. In order to assure consistency between the processParameters in the procedure and the parameters within OM_Observation, constraints should be applied.

Example: A generic process is 2D seismic data acquisition. Suitable processParameters in this case are sampling rate, sensor spacing, minimum offset, coverage, etc. An observation instance contains the values that give the user an idea about the most important conditions that influenced data production.

Codelist GeophProcessNameValue contains common names that can be used as the name attribute of Processes ::Process.

GeophResult is a container class for geophysical result files. The INSPIRE recommendation for encoding observations is to use specialized observations with proper coverage types from the Generic Conceptual Model, if appropriate. For non coverage observations the Sensor Web Enablement (SWE) schema can be used to encode results. Annex A contains several examples to demonstrate best practices and to help data providers to encode their results. Very often in geophysics data is provided in widely used industry standard format, and XML encoding is not an option. In such cases *GeophResult* is used to include data resources in *GeophysicalObject*s. The class has one attribute:

- *geophResource*: Any number of geophResource items can be included in *GeophResult*.

GeophResource has two attributes:

- *resource*: Data access is provided as CI_OnlineResource, a URL for online access, and an optional description about the resource.
- *resourceType*: Type must be one of the items in the *ResourceTypeValue* codelist.

O&M data must contains physical and geophysical property names either as references to observed properties or embedded in the result. For such referencing items in the GeophPropertyNameValue codelist are recommended.

D.3.2. The use of O&M in the GeophysicsExtension schema

SF_SpatialSamplingFeature

Both *GeophObject* and *GeophObjectSet* are derived from SF_SpatialSamplingFeature. Direct observations do not exist in geophysics, it is always about sampling. Geophysical measurements are artefacts that are created with the only intention to realize sampling. The ultimate feature of interest is a part of the earth. The final outcome is a spatial distribution of some physical property of the observed domain, usually the result of a processing chain. Each processing step can be exactly modelled as a separate sampling feature with its' own observation, procedure, observed property and result. The output of one step is the input of the next one. In other words: the sampling feature of one step becomes the sampled feature of the next one. It means that geophysical models are also sampling features that realize sampling by mathematical procedures. The difficulty of modelling geophysical entities comes from the fact that the processing chain can be very long and the intermediate observations are often hidden or out of interest. Intermediate outputs are bundled with final results. Lots of ambiguities can be explained by this condition. As a compromise in INSPIRE the geophysical processing chain is cut into two parts. The first part is represented by GeophMeasurement, the second by GeophModel. The scope of measurement, model, and the differences are explained in chapter D.2.1. (How to decide between Measurement and Model?)

As a minimum, SF_SamplingFeature requires two properties: shape and sampledFeature. Shape is the geometry of the domain where the sampled values are referenced. SampledFeature can be any feature that is considered as the target of observation. An efficient way of binding geology and geophysics is to refer to one or more geological units. If no specific feature can be named, reference to a generic concept (e.g. *http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere*) can be used. Data provisioning by the *GeophysicsCore* application schema does not have to go any further in using O&M. An example samplingFeature representing a seismic line

```
<sams:SF_SpatialSamplingFeature gml:id="sf-1"/>
   <sam:sampledFeature
xlink:href="http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere"/>
```

```
    <sams:shape>
       <gml:Curve gml:id="crv-1" srsDimension="2" srsName="EPSG:32700">
          <gml:segments>
             <gml:LineStringSegment>
                <gml:pos>654583 76651</gml:pos>
                <gml:pos>665473 76552</gml:pos>
                <gml:pos>654563 76653</gml:pos>
                <gml:pos>665453 76554</gml:pos>
                <gml:pos>654543 76655</gml:pos>
                <gml:pos>665433 76556</gml:pos>
             </gml:LineStringSegment>
          </gml:segments>
       </gml:Curve>
    </sams:shape>
</sams:SF_SpatialSamplingFeature>
```

OM_Observation

To be able to serve requirements identified in the use cases further elements provided by the O&M standard has to be used. Measurement details must be documented in one or more relatedObservation elements. Results originating from different processes must be separated in different observations. It is a matter of convention what is included in a process. A list of process types is available in the GeophProcessNameValue codelist. Example processes from the dictionary:

- *2DseismicDataAcquisition*
- *2DseismicProcessing*
- *airborneDataAcquisition*
- *boreholeLogging*
- *gravityProcessing*
- *inversion*
- *magneticObservation*
- *timeDomainEMSounding*
- *verticalElectricSounding*

Associated process parameter names and category values can be found in the GeophProcessParameterNameValue hierarchical codelist. Process parameter names and allowed category values are available as narrower terms of the appropriate elements.

Example: Following the GCM Observation schema definition a process descriptor file for 2DseismicDataAcquisition would look like this:

```
<ompr:Process gml:id="prc1">
   <ompr:documentation
xlink:href="http://any.institution/geophProcess/2DseisDAQ.html"/>
   <ompr:inspireld>
      <base:Identifier>
```

```
        <base:localId>PRC_2D_SeismicDataAcquisition</base:localId>
        <base:namespace>http://any.org/process</base:namespace>
      </base:Identifier>
    </ompr:inspireld>
    <ompr:name>2D_SeismicDataAcquisition</ompr:name>
    <ompr:processParameter>
      <ompr:ProcessParameter>
        <ompr:description>sensor type</ompr:description>
        <ompr:name
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parame
ter/SEN_TYPE">SEN_TYPE</ompr:name>
      </ompr:ProcessParameter>
    </ompr:processParameter>
    <ompr:processParameter>
      <ompr:ProcessParameter>
        <ompr:description>sensor spacing</ompr:description>
        <ompr:name
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parame
ter/SEN_SPACING">SEN_SPACING</ompr:name>
      </ompr:ProcessParameter>
    </ompr:processParameter>
    <ompr:processParameter>
      <ompr:ProcessParameter>
        <ompr:description>reference to industry standard resource</ompr:description>
        <ompr:name
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ_Parame
ter/ industryStandardResource">industryStandardResource</ompr:name>
      </ompr:ProcessParameter>
    </ompr:processParameter>
…
…
…
```

```
    <ompr:responsibleParty>
      <gmd:CI_ResponsibleParty>
        <gmd:organisationName>
          <gco:CharacterString>any organisation</gco:CharacterString>
        </gmd:organisationName>
        <gmd:role>
          <gmd:CI_RoleCode codeListValue="custodian" codeList=""/>
        </gmd:role>
      </gmd:CI_ResponsibleParty>
    </ompr:responsibleParty>
    <ompr:type>2D_SeismicDataAcquisition</ompr:type>
</ompr:Process>
```

Any GeophProfile of type 2D seismicLine can refer to this process record in its relatedObservation element. An example OM_Observation instance for such a 2D seismic data acquisition:

```
<om:OM_Observation gml:id="obs-1">
      <om:phenomenonTime>
         <gml:TimePeriod gml:id="tp-1">
            <gml:beginPosition>2000-01-01T08:00:0.0</gml:beginPosition>
            <gml:endPosition>2000-01-04T08:00:0.0</gml:endPosition>
         </gml:TimePeriod>
      </om:phenomenonTime>
      <om:resultTime>
         <gml:TimeInstant gml:id="ti-02">
            <gml:timePosition>2000-01-01T08:00:0.0</gml:timePosition>
         </gml:TimeInstant>
      </om:resultTime>
      <om:procedure
xlink:href="http://anyCompany/processes/2DSeismicDataAcquisition.xml"/>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_T
YPE"/>
            <om:value>
               <gml:Category
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_TY
PE">geophone</gml:Category>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_T
YPE"/>
            <om:value>
               <gml:Category
codeSpace="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_TY
PE">vibrator</gml:Category>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SEN_S
PACING"/>
            <om:value>
               <gml:Quantity uom="m">5</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
```

```
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/SRC_S
PACING"/>
            <om:value>
               <gml:Quantity uom="m">50</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/NUM_C
H"/>
            <om:value>
               <gml:Quantity uom="m">1024</gml:Quantity>
            </om:value>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/indus
tryStandardResource"/>
            <om:value xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123.sps"/>
         </om:NamedValue>
      </om:parameter>
      <om:parameter>
         <om:NamedValue>
            <om:name
xlink:href="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/2DseisDAQ/indus
tryStandardResource"/>
            <om:value xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123.ukooa"/>
         </om:NamedValue>
      </om:parameter>
      <om:observedProperty
xlink:href="http://geomind.elgi.hu/skos/GeophProperty/seismics/seismicAmplitude"/>
      <om:featureOfInterest xlink:href="../../.."/>
      <om:result xsi:type="gml:ReferenceType" xlink:href="RSC_asd-123"/>
   </om:OM_Observation>
```

Referencing the generic process by the xlink:href attribute makes the code compact and more readable.

```
<om:procedure xlink:href=" http://anyCompany/2DSeismicDataAcquisition.xml"/>
```

The series of <om:parameter> elements follow the definitions in the process descriptor. Category parameter values are taken from the narrower terms in the SKOS dictionary. E.g.: value of SRC_TYPE shall be one of \{vibrator, explosive, hammer, airgun}. Numeric values must be encoded as gml:Quantity elements completed with unit of measurement. For referencing Industry standard resource files the industryStandardResource parameter is used. The value of the parameter is a URL pointing to the resource itself. Seismic process descriptors like SPS and UKOOA files shall be accessed through this parameter. URL can be an entry point to a secure data service maintained by the data provider.

Note: Hierarchical code list dictionaries were constructed from GEOMIND parameter catalogues, and cover only a few of the most important geophysical methods. These dictionaries were set up for demonstration purposes to support encoding of geophysical procedures in INSPIRE documents. A full coverage of all geophysical methods can't be the task of the INSPIRE data specification. The responsibility to improve the geophysical SKOS dictionaries will be passed to appointed organizations representing the geophysical community.

The OM_Observation instance contains important temporal information about the geophysical object, such as phenomenonTime, and resultTime. PhenomenonTime can be a time instant or a time range and refers to the time of the sampling activity. For a seismic line it is reasonable to use time range documenting the measurement start and measurement end. For a survey station measurement providing a time instant is appropriate. ResultTime rather means the time instant from when result is available.

observedProperty

Observations always focus on some property of the feature of interest. It is either a physical property of the ultimate feature of interest, or a more abstract geophysical property that is measured or simulated by the geophysical process. It can also be a composit property that is a group of properties measured together. The om:observedProperty element is used to include such information in the OM_Observation element. A list of geophysical properties is available at *http://geomind.elgi.hu/skos/GeophProperty.xml*. The ObservableProperty application schema in the GCM Observation package allows data providers to define complex properties with statistical measures and constraints like "total magnetic field average over 1 minute period derived from 1 second averages". Example:

```
<omop:ObservableProperty gml:id="op1">
   <omop:basePhenomenon
codeSpace="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/magneticPropert
y">MAG_T</omop:basePhenomenon>
   <omop:uom uom="nT"/>
  <omop:statisticalMeasure>
       <omop:StatisticalMeasure gml:id="sm1">
          <omop:derivedFrom>
             <omop:StatisticalMeasure gml:id="sm2">
                <omop:statisticalFunction
codeSpace="http://sweet.jpl.nasa.gov/2.0/mathStatistics.ow">Mean</omop:statisticalFunc
tion>
                <omop:aggregationTimePeriod>PT1S</omop:aggregationTimePeriod>
             </omop:StatisticalMeasure>
          </omop:derivedFrom>
          <omop:statisticalFunction
codeSpace="http://sweet.jpl.nasa.gov/2.0/mathStatistics.ow">Mean</omop:statisticalFunc
tion>
```

```
         <omop:aggregationTimePeriod>PT1M</omop:aggregationTimePeriod>
      </omop:StatisticalMeasure>
   </omop:statisticalMeasure>
</omop:ObservableProperty>
```

featureOfInterest

The feature of interest (FOI) of a direct observation is the natural target that is observed (color of an apple – observedProperty is color, FOI is apple). When sampling is carried out the observations' feature of interest is the sampling feature itself. The proximate target of a seismic observation is the seismic line and not the earth. The observed property is the seismic amplitude measured on the geophones that are part of the seismic line. This is expressed by the xlink:href attribute that points back to the SF_SpatialSamplingFeature:

```
<om:featureOfInterest xlink:href="../../.."/>
```

Result

There are several ways to include geophysical results in an OM_Observation instance. In the case of coverage observations, or when results are available in XML format, inline encoding or referencing directly from the om:result element is recommended. When results are provided in non XML industry standard format, or more result files are bundled together the GeophResult element shall be used. An example seismic field data result package may look like this (pseudo XML encoding):

```
GeophResult
   geophResource
      resource
         linkage “http://any.institution/getItem?id=asd-123.1.1.segy”
         description “SEG-Y field data line-1.1”
      resourceType
"http://inspire.ec.europa.eu/codelist/ResourceTypeValue/seismicResource/SEG-Y "
   geophResource
      resource
         linkage “http://any.institution/getItem?id=asd-123.1.2.segy”
         description “SEG-Y field data line-1.2”
      resourceType "
http://inspire.ec.europa.eu/codelist/ResourceTypeValue/seismicResource/SEG-Y "
   geophResource
      resource
         linkage “http://any.institution/getItem?id=asd-123.1.3.segy”
         description “SEG-Y field data line-1.3”
      resourceType "
http://inspire.ec.europa.eu/codelist/ResourceTypeValue/seismicResource/SEG-Y "
```

Dividing data sets

When larger geophysical data sets extend over concession area boundaries, there may be a request to divide observation results into separate peaces. In such cases the use of SamplingFeatureComplex elements are recommended. Parts can be encoded in individual SF_SpatialSamplingFeature elements, and results are accessed at separate web locations with different distribution options. The main geophysical object contains the shape of the whole complex and the links to the related sampling features.

```
<sams:SF_SpatialSamplingFeature gml:id="sf-1"/>
   <sam:sampledFeature
xlink:href="http://sweet.jpl.nasa.gov/2.2/realmGeol.owl#Lithosphere"/>
   <sam:relatedSamplingFeature>
      <sam:SamplingFeatureComplex>
         <sam:role xlink:href="http://geomind.elgi.hu/skos/role/part.xml"/>
         <sam:relatedSamplingFeature xlink:href="part1.xml"/>
      </sam:SamplingFeatureComplex>
   </sam:relatedSamplingFeature>
   <sam:relatedSamplingFeature>
      <sam:SamplingFeatureComplex>
         <sam:role xlink:href="http://geomind.elgi.hu/skos/role/part.xml"/>
         <sam:relatedSamplingFeature xlink:href="part2.xml"/>
      </sam:SamplingFeatureComplex>
   </sam:relatedSamplingFeature>
   <sams:shape>
      <gml:Curve gml:id="crv-1" srsDimension="2" srsName="EPSG:32700">
         <gml:segments>
            <gml:LineStringSegment>
               <gml:pos>654583 76651</gml:pos>
               <gml:pos>665473 76552</gml:pos>
               <gml:pos>654563 76653</gml:pos>
               <gml:pos>665453 76554</gml:pos>
               <gml:pos>654543 76655</gml:pos>
               <gml:pos>665433 76556</gml:pos>
            </gml:LineStringSegment>
         </gml:segments>
      </gml:Curve>
   </sams:shape>
</sams:SF_SpatialSamplingFeature>
```

Using Coverages

In principle any geophysical observation result can be encoded as GML coverage. To achieve a higher level of interoperability the use of coverages is highly recommended in INSPIRE. At the same time GML and other XML based encodings are not very common in geophysics, and there are situations when it is neither practical nor possible. Though, there are several ways to efficiently bind XML and binary data, converting huge seismic data files is still not an option. In cases when data exchange is based on widely accepted international standards, the use of those standards must be supported. On the other hand, out of the hydrocarbon industry the weight of standards is not so high, in fact, the lack standards and the virulence of ad-hoc formats is typical. In such cases following the O&M standard and the coverage model is a good alternative for data exchange.

The recommendation of the INSPIRE Cross Thematic Working Group on Observations & Measurements is to use GCM specialized observations when it is possible [DS-D2.9]. The abundance of geophysical data types and the need of supporting industrial standards make the exclusive usage of coverage observations impossible. To avoid fragmentation of the data model a more generic approach seems to be more appropriate in the geophysical domain. However, in result encoding whenever it is feasible the coverage types recommended in the [DS-D2.9] document should be used. (RectifiedGridCoverage, ReferenceableGridCoverage, MultiPointCoverage, TImeSeries)

The GML coverage model supports all discrete coverage types to encode many geophysical data types (*http://www.opengis.net/gmlcov/1.0* name space):

- MultiPointCoverage
- MultiCurveCoverage
- MultiSurfaceCoverage
- MultiSolidCoverage

It also provides coverage types for gridded geophysical data:

- RectifiedGridCoverage
- ReferenceableGridCoverage

The table below gives an overview of how results of different geophysical methods can be encoded in principle by the GML coverage model.

Coverage Type	Geophysical Feature Type	Subtype
gmlcov:MultiPointCoverage	GeophStation	gravityStation
gmlcov:MultiPointCoverage	GeophStation	magneticStation
gmlcov:MultiPointCoverage	Campaign	gravityProcessingCampaign
gmlcov:MultiCurveCoverage	CurveModel	layerModel
gmlcov:MultiCurveCoverage	CurveModel	compositLog
gmlcov:MultiSurfaceCoverage	DiscreteSurfaceModel	horizontalCrossSection
gmlcov:MultiSurfaceCoverage	DiscreteSurfaceModel	verticalCrossSection
gmlcov:MultiSolidCoverage	DiscreteSolidModel	bodyReconstruction
gmlcov:RectifiedGridCoverage	SurfaceGridModel	horizontalParameterGrid
gmlcov:RectifiedGridCoverage	SolidGridModel	seismicVolume
gmlcov:ReferenceableGridCoverage	SurfaceGridModel	verticalParameterGrid
gmlcov:ReferenceableGridCoverage	GeophProfile	boreholeLog
gmlcov:ReferenceableGridCoverage	GeophProfile	flightLine

TimeSeries	GeophStation	magneticStation (observatory,secular station)
TimeSeries	GeophStation	seismologicalStation (observatory)

Encoding GeophStation results

It seems to be reasonable not to use different encoding on the basis of the number of points included in a data set. DomainSet of a MultiPointCoverage is one or more points. In this case a station is considered a multipoint object with one single member. (For single point data CV_DiscretePointCoverage could also be used). The following example shows the encoding of gravity station measurement:

```
<gmlcov:MultiPointCoverage>
   <gml:multiPointDomain>
      <gml:MultiPoint gml:id="mp-1" srsDimension="3" srsName="EPSG:23700"
axisLabels="x y z" uomLabels="m m m">
         <gml:pointMember>
            <gml:Point gml:id="p-1">
               <gml:pos>654543 76654 123.4</gml:pos>
            </gml:Point>
         </gml:pointMember>
      </gml:MultiPoint>
   </gml:multiPointDomain>
   <gml:rangeSet>
      <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList ts=" " cs="\n">751752.0 0.05</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name="observedGravity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/observedGravity">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="errorOfClosure">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/errorOfClosure">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
```

```
</gmlcov:MultiPointCoverage>
```

Encoding processing campaign results

Multipoint coverage can be used to deliver results of point observation collections. The following example shows the results of a gravity processing campaign:

```
<gmlcov:MultiPointCoverage gml:id="mpc-1">
   <gml:multiPointDomain>
      <gml:MultiPoint gml:id="mp-1" srsDimension="2" srsName="EPSG:4326">
         <gml:pointMember>
            <gml:Point gml:id="stn-001">
               <gml:pos>654543 76674</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-002">
               <gml:pos>654553 76634</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-003">
               <gml:pos>654573 76654</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-004">
               <gml:pos>654593 76624</gml:pos>
            </gml:Point>
         </gml:pointMember>
         <gml:pointMember>
            <gml:Point gml:id="stn-005">
               <gml:pos>654533 76614</gml:pos>
            </gml:Point>
         </gml:pointMember>
      </gml:MultiPoint>
   </gml:multiPointDomain>
   <gml:rangeSet>
      <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList cs="\n" ts=" ">stn-001 980000 980000 980000 0 0
stn-002 980000 980000 980000 0 0
stn-003 980000 980000 980000 0 0
stn-004 980000 980000 980000 0 0
stn-005 980000 980000 980000 0 0</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord id="drec-1">
         <swe:field name="identifier">
```

```
            <swe:Text>
               <swe:identifier/>
            </swe:Text>
         </swe:field>
         <swe:field name="observedGravity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/observedGravity">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="gravityFreeAirAnomaly">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/gravityFreeAirAnomaly">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="gravityBouguerAirAnomaly">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/gravityBouguerAnomaly">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="innerTopoCorrection">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophProcessParameterNameValue/gravit
yProcessParameter/topoCorrection/innerTopoCorrection">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="totalTopoCorrection">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophProcessParameterNameValue/gravit
yProcessParameter/topoCorrection/totalTopoCorrection">
               <swe:uom code="microGal"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:MultiPointCoverage>
```

Encoding LayerModels

Layer model is a generic concept for representing a 1D structure. An efficient way of encoding is to use MultiCurveCoverage. Typical use cases are delivering inversion results from VES, TDEM, or MT measurements. Composit logs or borehole data can also be encoded like this. Originally GeoSciML also uses CurveCoverage to describe boreholes. Curve segments of the multi curve domain coincide with the layers. For positions a 3D coordinate system is used. The following example shows a horizontally layered earth with vertical curve segments below the station location. Range data contains resistivity and chargeability values from the inversion of a VES/IP sounding station.

```
<gmlcov:MultiCurveCoverage gml:id="mcc-1">
   <gml:multiCurveDomain>
      <gml:MultiCurve gml:id="mc-1" srsDimension="3" srsName="EPSG:23700"
axisLabels="x y z" uomLabels="m m m">
         <gml:curveMember>
            <gml:LineString gml:id="ls-1">
               <gml:pos>654543 76654 0</gml:pos>
               <gml:pos>654543 76654 -1</gml:pos>
            </gml:LineString>
         </gml:curveMember>
         <gml:curveMember>
            <gml:LineString gml:id="ls-2">
               <gml:pos>654543 76654 -1</gml:pos>
               <gml:pos>654543 76654 -10</gml:pos>
            </gml:LineString>
         </gml:curveMember>
         <gml:curveMember>
            <gml:LineString gml:id="ls-3">
               <gml:pos>654543 76654 -10</gml:pos>
               <gml:pos>654543 76654 -100</gml:pos>
            </gml:LineString>
         </gml:curveMember>
      </gml:MultiCurve>
   </gml:multiCurveDomain>
   <gml:rangeSet>
         <gml:DataBlock>
         <gml:rangeParameters/>
         <gml:tupleList ts=" " cs="\n">2.1 0.1
         2.2 0.2
         2.3 0.3</gml:tupleList>
      </gml:DataBlock>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name="resistivity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/electromagneti
cProperty/resistivity">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
         </swe:field>
         <swe:field name="chargeability">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/electromagneti
cProperty/chargeability">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
```

```
        </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:MultiCurveCoverage>
```

Encoding VerticalParameterGrid

The following example shows a resistivity cross section encoded as ReferenceableGridCoverage. Grid geometry is defined by node locations in a 3D coordinate system. The trace of the sample profile is a straight line in SW-NE direction. Nodes are located on the surface in a vertical plain. According to the rangeType element the coverage contains resistivity values for each node.

NOTE Referenceable grids can be used for nodes with uneven spacing or to project grid data to curved surfaces (e.g.: vertical section along a meandering profile)

```
<gmlcov:ReferenceableGridCoverage gml:id="rgc-1">
   <gml:domainSet>
      <gmlrgrid:ReferenceableGridByArray gml:id="rga1" dimension="2" srsDimension="3"
axisLabels="x z"  uomLabels="m m">
         <gml:limits>
            <gml:GridEnvelope>
               <gml:low>0 0</gml:low>
               <gml:high>3 3</gml:high>
            </gml:GridEnvelope>
         </gml:limits>
         <gml:axisLabels>x z</gml:axisLabels>
         <gml:posList count="16">654543 76654 0
654543 76654 -1
654543 76654 -2
654543 76654 -3
654553 76664 0
654553 76664 -1
654553 76664 -2
654553 76664 -3
654563 76674 0
654563 76674 -1
654563 76674 -2
654563 76674 -3
654573 76684 0
654573 76684 -1
654573 76684 -2
654543 76684 -3</gml:posList>
         <gmlrgrid:sequenceRule>Linear</gmlrgrid:sequenceRule>
      </gmlrgrid:ReferenceableGridByArray>
   </gml:domainSet>
   <gml:rangeSet>
      <gml:QuantityList uom="mV">1.0 2.0 3.0 4.0 2.0 3.0 4.0 5.0 3.0 4.0 5.0 6.0 4.0
5.0 6.0 7.0</gml:QuantityList>
   </gml:rangeSet>
   <gmlcov:rangeType>
```

```
      <swe:DataRecord id="drec-1">
         <swe:field name="resistivity">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/electromagneti
cProperty/resistivity">
               <swe:uom code="mV"/>
            </swe:Quantity>
         </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:ReferenceableGridCoverage>
```

Encoding HorizonalParameterGrid

The following example shows a Bouguer anomaly map encoded as RectifiedGridCoverage. Grid geometry is defined by the origin and two offset vectors in a 2D coordinate system. Grid spacing is 10 m in both directions. According to the rangeType element the coverage contains Bouguer anomaly values for each node.

```
<gmlcov:RectifiedGridCoverage gml:id="rgc-1">
   <gml:rectifiedGridDomain>
      <gml:RectifiedGrid gml:id="rg-1" dimension="2" axisLabels="x y" srsDimension="2"
uomLabels="m m" srsName="EPSG:23700">
         <gml:limits>
            <gml:GridEnvelope>
               <gml:low>0 0</gml:low>
               <gml:high>3 3</gml:high>
            </gml:GridEnvelope>
         </gml:limits>
         <gml:axisLabels>x y</gml:axisLabels>
         <gml:origin>
            <gml:Point gml:id="p-1">
               <gml:pos>654543 76654</gml:pos>
            </gml:Point>
         </gml:origin>
         <gml:offsetVector>10 0</gml:offsetVector>
         <gml:offsetVector>0 10</gml:offsetVector>
      </gml:RectifiedGrid>
   </gml:rectifiedGridDomain>
   <gml:rangeSet>
      <gml:QuantityList uom="ohmm">1 2 3 4 2 3 4 5 3 4 5 6 4 5 6 7</gml:QuantityList>
   </gml:rangeSet>
   <gmlcov:rangeType>
      <swe:DataRecord>
         <swe:field name=" gravityBouguerAnomaly ">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue/gravimetricPro
perty/gravityBouguerAnomaly">
               <swe:uom code="ohmm"/>
            </swe:Quantity>
```

```
        </swe:field>
      </swe:DataRecord>
   </gmlcov:rangeType>
</gmlcov:RectifiedGridCoverage>
```

In practice grid coverages may contain large amount of data. XML text encoding in such cases is not practical. The [DS-D2.9] document contains recommendations on "out-of band result encoding" explaining how to include optimized binary files in the rangeSet element.

Encoding GeophStation Data as SensorML

Intermediate results like measurement data often contain non spatial coordinates (frequency, pressure, electrode distance etc.) as domain set. In such cases coverage encoding is not applicable, instead SensorML can be used. The following example illustrates the encoding of Vertical Electric Sounding data as SensorML System:

```
<sml:System>
   <gml:description>VES Sounding Data</gml:description>
   <gml:name>VES_test-0001</gml:name>
   <sml:identification>
      <sml:IdentifierList>
         <sml:identifier>
            <sml:Term>
               <sml:codeSpace xlink:href="http://mfgi.hu"/>
               <sml:value>VES_test-0001</sml:value>
            </sml:Term>
         </sml:identifier>
      </sml:IdentifierList>
   </sml:identification>
   <sml:parameters>
      <sml:ParameterList>
         <sml:parameter name="ARR_TYPE">
            <swe:Category
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/A
RR_TYPE">
               <swe:value>schlumberger</swe:value>
            </swe:Category>
         </sml:parameter>
         <sml:parameter name="AZM">
            <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/A
ZM">
               <swe:uom code="deg"/>
               <swe:value>45.0</swe:value>
            </swe:Quantity>
         </sml:parameter>
      </sml:ParameterList>
   </sml:parameters>
   <sml:components>
      <sml:ComponentList>
```

```
        <sml:component name="VES_test-0001.1">
           <sml:Component>
              <gml:description>AB-Ro series with 0.5m MN</gml:description>
              <sml:outputs>
                 <sml:OutputList>
                    <sml:output name="AB-RO_0.5">
                       <swe:DataArray>
                          <swe:elementCount>
                             <swe:Count>
                                <swe:value>5</swe:value>
                             </swe:Count>
                          </swe:elementCount>
                          <swe:elementType name="ABMN-AppRes record">
                             <swe:DataRecord>
                                <swe:field name="AB">
                                   <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/A
B_DIST">
                                      <swe:uom code="m"/>
                                   </swe:Quantity>
                                </swe:field>
                                <swe:field name="MN">
                                   <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/M
N_DIST">
                                      <swe:uom code="m"/>
                                   </swe:Quantity>
                                </swe:field>
                                <swe:field name="APP_RES">
                                   <swe:Quantity
definition="http://inspire.ec.europa.eu/GeophProcessParameterNameValue/VES_Parameter/A
PP_RES">
                                      <swe:uom code="ohmm"/>
                                   </swe:Quantity>
                                </swe:field>
                             </swe:DataRecord>
                          </swe:elementType>
                          <swe:encoding>
                             <swe:TextBlock decimalSeparator="." blockSeparator="\n"
tokenSeparator=","/>
                          </swe:encoding>
                          <swe:values>
3.2,0.5,123.4
6.4,0.5,122.3
8.0,0.5,121.1
12.8,0.5,120,.0
16.0,0.5,119.8
                                   </swe:values>
                       </swe:DataArray>
                    </sml:output>
                 </sml:OutputList>
```

```
                </sml:outputs>
             </sml:Component>
          </sml:component>
       </sml:ComponentList>
    </sml:components>
</sml:System>
```

NOTE In principle gml allows the definition of non spatial coordinate systems and so with proper CRS referencing frequency, pressure or instrumental time axis can also be used in coverages for encoding "location". This would also solve the problem of handling seismic time sections (SamplingCurve) and depth sections (SamplingSurface) in a different way that may seem weird for seismic experts. However, until such definitions are not available using SensorML is considered to be best practice.

D.3.3. Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema GeophysicsExtension
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
CurveModel	GeophysicsExtension	«featureType»
CurveModelTypeValue	GeophysicsExtension	«codeList»
GeophModel	GeophysicsExtension	«featureType»
GeophProcessNameValue	GeophysicsExtension	«codeList»
GeophProcessParameterNameValue	GeophysicsExtension	«codeList»
GeophPropertyNameValue	GeophysicsExtension	«codeList»
GeophResource	GeophysicsExtension	«dataType»
GeophResult	GeophysicsExtension	«dataType»
OtherGeophMeasurement	GeophysicsExtension	«featureType»
OtherGeophModel	GeophysicsExtension	«featureType»
OtherGeophModelTypeValue	GeophysicsExtension	«codeList»
OtherMeasurementTypeValue	GeophysicsExtension	«codeList»
Project	GeophysicsExtension	«featureType»
ResourceTypeValue	GeophysicsExtension	«codeList»
SolidGridModel	GeophysicsExtension	«featureType»

Type	Package	Stereotypes
SolidGridModelTypeValue	GeophysicsExtension	«codeList»
SurfaceGridModel	GeophysicsExtension	«featureType»
SurfaceGridModelTypeValue	GeophysicsExtension	«codeList»

D.3.3.1. Spatial object types

D.3.3.1.1. CurveModel

CurveModel

Subtype of:	GeophModel
Definition:	Geophysical model that represents a curve coverage of some geophysical properties
Description:	Distribution of physical or geophysical properties along a curve. Examples: layer model from 1D inversion, interpreted borehole log.
Stereotypes:	«featureType»

Attribute: modelType

Value type:	CurveModelTypeValue
Definition:	Type of curve model
Description:	It must be a value from the CurveModelTypeValue codelist.
Multiplicity:	1

Constraint: shape must be GM_Curve

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

D.3.3.1.2. GeophModel

GeophModel	
Subtype of:	GeophObject
Definition:	Geophysical object that is created as a result of geophysical data processing or interpretation
Description:	Models represent spatial distribution of physical or geophysical properties within the observed spatial domain. The sampledFeature association of a GeophModel (as a sampling feature) usually connects to one or more GeophMeasurements.
Stereotypes:	«featureType»
Attribute: relatedMeasurement	
Value type:	Identifier
Definition:	Identifier of the geophysical measurement that was used to create the model result.
Description:	It can be used to identify related *GeophMeasurement* instances.
Multiplicity:	1..*
Stereotypes:	«voidable»

D.3.3.1.3. OtherGeophMeasurement

OtherGeophMeasurement	
Subtype of:	GeophMeasurement
Definition:	Generic class for any geophysical measurement type that is listed in the GeophMeasurementTypeValue code list.
Stereotypes:	«featureType»
Attribute: measurementType	
Value type:	OtherMeasurementTypeValue
Definition:	Type of geophysical measurement
Description:	Type must be one of the items in the GeophMeasurementTypeValue codelist.
Multiplicity:	1

OtherGeophMeasurement	
Constraint: shape must be conformant with the spatial sampling geometry	
Natural language:	shape must be conformant with the spatial sampling geometry
OCL:	

D.3.3.1.4. OtherGeophModel

OtherGeophModel	
Subtype of:	GeophModel
Definition:	Geophysical model that represents a coverage of physical or geophysical properties
Description:	Geophysical model type that is listed in the "OtherGeophModelTypeValue" code list.
Stereotypes:	«featureType»
Attribute: modelType	
Value type:	OtherGeophModelTypeValue
Definition:	Type of geophysical model
Description:	It must be a value from the OtherGeophModelTypeValue codelist
Multiplicity:	1

D.3.3.1.5. Project

Project	
Subtype of:	GeophObjectSet
Definition:	Geophysical activity extending over a longer time range and larger area, containing any number of campaigns or subprojects
Description:	In the hierarchy of geophysical data sets projects are parents of geophysical campaigns, and usually cover whole exploration programs.
Stereotypes:	«featureType»

Project	
Attribute: principalInvestigator	
Value type:	CI_ResponsibleParty
Definition:	Main party responsible for the project
Multiplicity:	1
Stereotypes:	«voidable»

D.3.3.1.6. SolidGridModel

SolidGridModel	
Subtype of:	GeophModel
Definition:	Geophysical model that represents a solid grid coverage of physical or geophysical properties
Description:	3D grid of physical or geophysical properties. Examples are seismic volume, or 3D resistivity grid from DC tomography.
Stereotypes:	«featureType»
Attribute: modelType	
Value type:	SolidGridModelTypeValue
Definition:	Type of solid grid model
Description:	It must be a value from the SolidGridModelTypeValue codelist
Multiplicity:	1
Constraint: shape must be GM_Solid	
Natural language:	shape must be GM_Solid
OCL:	inv: shape.oclIsKindOf(GM_Solid)

D.3.3.1.7. SurfaceGridModel

SurfaceGridModel	
Subtype of:	GeophModel
Definition:	Geophysical model that represents a surface grid coverage of physical or geophysical properties
Description:	Surface grid of physical or geophysical properties. Examples are seismic depth section, 2D resistivity grid from DC tomography.
Stereotypes:	«featureType»
Attribute: modelType	
Value type:	SurfaceGridModelTypeValue
Definition:	Type of surface grid model
Description:	It must be a value from the SurfaceGridModelTypeValue codelist
Multiplicity:	1
Constraint: shape must be GM_Surface	
Natural language:	shape must be GM_Surface
OCL:	inv: shape.oclIsKindOf(GM_Surface)

D.3.3.2. Data types

D.3.3.2.1. GeophResource

GeophResource	
Definition:	Resource of any geophysical information
Stereotypes:	«dataType»
Attribute: resource	
Value type:	CI_OnlineResource
Definition:	Linkage to online resource with optional description
Multiplicity:	1

GeophResource	
Attribute: resourceType	
Value type:	ResourceTypeValue
Definition:	Type of geophysical resource
Description:	Type must be one of the items in the ResourceTypeValue codelist.
Multiplicity:	1
Stereotypes:	«CodedValue»

D.3.3.2.2. GeophResult

GeophResult	
Definition:	Container for geophysical measurement and processing results
Description:	To be used in place of OM_Observation result
Stereotypes:	«dataType»
Attribute: geophResource	
Value type:	GeophResource
Definition:	Resource of any geophysical information
Description:	Any number of geophResource items can be included in *GeophResult*.
Multiplicity:	1..*

D.3.3.3. Code lists

D.3.3.3.1. CurveModelTypeValue

CurveModelTypeValue	
Definition:	Type of curve model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CurveModelTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.2. GeophProcessNameValue

GeophProcessNameValue	
Definition:	Proposed names for geophysical processes
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophProcessNameValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.3. GeophProcessParameterNameValue

GeophProcessParameterNameValue	
Definition:	hierarchical codelist of geophysical process parameter names
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophProcessParameterNameValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.4. GeophPropertyNameValue

GeophPropertyNameValue	
Definition:	hierarchical codelist of geophysical property names
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.5. OtherGeophModelTypeValue

OtherGeophModelTypeValue	
Definition:	Other type of geophysical model
Description:	none of the following types: curve model, surface grid model solid grid model. The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/OtherGeophModelTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.6. OtherMeasurementTypeValue

OtherMeasurementTypeValue	
Definition:	Type of geophysical measurement
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/OtherMeasurementTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.7. ResourceTypeValue

ResourceTypeValue	
Definition:	Type of geophysical resource
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ResourceTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.8. SolidGridModelTypeValue

SolidGridModelTypeValue	
Definition:	Type of solid grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SolidGridModelTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.3.9. SurfaceGridModelTypeValue

SurfaceGridModelTypeValue	
Definition:	Type of surface grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SurfaceGridModelTypeValue
Values:	The allowed values for this code list comprise the values specified in Annex D and additional values at any level defined by data providers. Annex D includes recommended values that may be used by data providers.

D.3.3.4. Imported types (informative)

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

D.3.3.4.1. CI_OnlineResource

CI_OnlineResource	
Package:	Citation and responsible party information
Reference:	Geographic information — Metadata [ISO 19115:2003/Cor 1:2006]

D.3.3.4.2. CI_ResponsibleParty

CI_ResponsibleParty	
Package:	Citation and responsible party information
Reference:	Geographic information — Metadata [ISO 19115:2003/Cor 1:2006]

D.3.3.4.3. GeophMeasurement

GeophMeasurement (abstract)	
Package:	Geophysics
Reference:	INSPIRE Data specification on *Geology* [DS-D2.8.II.4]
Definition:	Generic spatial object type for geophysical measurements.
Description:	Geophysical measurements collect data outside or on the boundary of the observed spatial domain.

D.3.3.4.4. GeophObject

GeophObject (abstract)	
Package:	Geophysics
Reference:	INSPIRE Data specification on *Geology* [DS-D2.8.II.4]
Definition:	A generic class for geophysical objects.
Description:	GeophObject models single geophysical entities that are used for spatial sampling either by means of data acquisition or data processing.

D.3.3.4.5. GeophObjectSet

GeophObjectSet	
Package:	Geophysics
Reference:	INSPIRE Data specification on *Geology* [DS-D2.8.II.4]
Definition:	Generic class for collections of geophysical objects
Description:	It is a set of geophysical objects that are grouped by some common property. p.e: created in the same measuring campaign. GeophObjectSets are used for spatial sampling either by means of data acquisition or data processing. The produced result of a geophObjectSet is always collective, e.g. a map constructed from the results of the individual member objects.

D.3.3.4.6. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

D.3.4. GeophysicsExtension - Code Lists

INSPIRE Application Schema 'GeophysicsExtension'

Code List
CurveModelTypeValue

Code List
GeophProcessNameValue
GeophProcessParameterNameValue
GeophPropertyNameValue
OtherGeophModelTypeValue
OtherMeasurementTypeValue
ResourceTypeValue
SolidGridModelTypeValue
SurfaceGridModelTypeValue

CurveModelTypeValue

Definition:	Type of curve model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/CurveModelTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

compositLog

Name:	compositLog
Definition:	A set of processed or interpreted physical parameter curves along the axis of a borehole

layerModel

Name:	layerModel
Definition:	1D layer model, encoded as discrete curve coverage.

seismicTimeSection

Name:	seismicTimeSection
Definition:	Series of seismic property - two way time functions referenced to CDP locations

GeophProcessNameValue

Definition:	Proposed names for geophysical processes
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophProcessNameValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

VES

Name:	VES
Definition:	Procedure to acquire Vertical Electric Sounding data

TDEMSounding

Name:	TDEMSounding
Definition:	Procedure to acquire TDEM sounding data

boreholeLogging

Name:	boreholeLogging
Definition:	Procedure to acquire borehole logging data

MT_Sounding

Name:	MT_Sounding
Definition:	Procedure to acquire magnetotelluric Sounding data

MT_Processing

Name:	MT_Processing
Definition:	magnetotelluric data processing

MT_Preprocessing

Name:	MT_Preprocessing
Definition:	calculation of complex impedance tenzor and tipper

2D_MT_Inversion

Name:	2D_MT_Inversion
Definition:	2D inversion of magnetotelluric soundings

3D_MT_Inversion

Name:	3D_MT_Inversion
Definition:	3D inversion of magnetotelluric soundings

2DseismicDataAcquisition

Name:	2DseismicDataAcquisition
Definition:	Procedure to acquire 2D seismic data

3DseismicDataAcquisition

Name:	3DseismicDataAcquisition
Definition:	Procedure to acquire 3D seismic data

airborneDataAcquisition

Name:	airborneDataAcquisition
Definition:	Procedure to acquire airborne geophysical data

2DseismicProcessing

Name:	2DseismicProcessing
Definition:	2D seismic data processing

staticCorrection

Name:	staticCorrection
Definition:	static correction

velocityAnalysis

Name:	velocityAnalysis
Definition:	velocity analysis

timeStacking

Name:	timeStacking
Definition:	time stacking

timeMigration

Name:	timeMigration
Definition:	time migration

depthMigration

Name:	depthMigration
Definition:	depth migration

depthConversion

Name:	depthConversion
Definition:	depth conversion

3DseismicProcessing

Name:	3DseismicProcessing
Definition:	3D seismic data processing

inversion

Name:	inversion
Definition:	generic geophysical inversion

gravityObservation

Name:	gravityObservation
Definition:	procedures to acquire gravity station data

gravityProcessing

Name:	gravityProcessing
Definition:	gravity data processing

normalCorrection

Name:	normalCorrection
Definition:	Correction of gravity field variation due to geographic latitude

heightCorrection

Name:	heightCorrection
Definition:	Correction of gravity variation due to elevation difference

topoCorrection

Name:	topoCorrection
Definition:	Correction of the gravity effect due to topography

bouguerCorrection

Name:	bouguerCorrection
Definition:	Bouguer correction

magneticObservation

Name:	magneticObservation
Definition:	magnetic observation

magneticFieldMonitoring

Name:	magneticFieldMonitoring
Definition:	magnetic field monitoring

earthquakeObservation

Name:	earthquakeObservation
Definition:	earthquake observation

ambientNoiseObservation

Name:	ambientNoiseObservation
Definition:	ambient noise observation

magneticProcessing

Name:	magneticProcessing
Definition:	magnetic processing

normalCorrection

Name:	normalCorrection
Definition:	Correction of magnetic field variation due to geographic latitude and longitude

GeophProcessParameterNameValue

Definition:	hierarchical codelist of geophysical process parameter names
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophProcessParameterNameValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

VES_Parameter

Name:	VES_Parameter
Definition:	Vertical Electric Sounding process parameter

VES_ARR_TYPE

Name:	VES_ARR_TYPE
Definition:	Electrode array
Description:	allowed values are narrower terms
Parent:	VES_Parameter

schlumberger

Name:	schlumberger
Definition:	Schlumberger array
Parent:	VES_ARR_TYPE

wenner

Name:	wenner
Definition:	Wenner array
Parent:	VES_ARR_TYPE

AB_MIN

Name:	AB_MIN
Definition:	minimum distance between A and B electrodes
Parent:	VES_Parameter

AB_MAX

Name:	AB_MAX
Definition:	maximum distance between A and B electrodes
Parent:	VES_Parameter

AZM

Name:	AZM
Definition:	azimuth of the layout,angle between north and the AB line direction (header parameter)
Parent:	VES_Parameter

AB_DIST

Name:	AB_DIST
Definition:	Distance between A B current electrodes
Parent:	VES_Parameter

MN_DIST

Name:	MN_DIST
Definition:	Distance between M N potential electrodes
Parent:	VES_Parameter

TDEM_ProcessParameter

Name:	TDEM_ProcessParameter
Definition:	TDEM process parameters

TDEM_ARR_TYPE

Name:	TDEM_ARR_TYPE
Definition:	Layout array type
Description:	allowed values are narrower terms
Parent:	TDEM_ProcessParameter

CIL

Name:	CIL
Definition:	Central Induction Loop sounding array
Parent:	TDEM_ARR_TYPE

singleLoop

Name:	singleLoop
Definition:	Singel Loop sounding array
Parent:	TDEM_ARR_TYPE

offset

Name:	offset
Definition:	Sounding array, RX loop is separated from Tx loop
Parent:	TDEM_ARR_TYPE

AZM

Name:	AZM
Definition:	Azimuth of layout
Parent:	TDEM_ProcessParameter

LOOP_SZ_MIN

Name:	LOOP_SZ_MIN
Definition:	Smallest TX loop - side length of the equivalent square
Parent:	TDEM_ProcessParameter

LOOP_SZ_MAX

Name:	LOOP_SZ_MAX
Definition:	Largest TX loop - side length of the equivalent square
Parent:	TDEM_ProcessParameter

TX_CURR

Name:	TX_CURR
Definition:	current loaded into to the transmitter loop, or the earth
Parent:	TDEM_ProcessParameter

TM_OFFS

Name:	TM_OFFS
Definition:	channel time
Parent:	TDEM_ProcessParameter

TOFF_TM

Name:	TOFF_TM
Definition:	duration of turn off ramp in case of linear ramp
Parent:	TDEM_ProcessParameter

TON_TM

Name:	TON_TM
Definition:	duration of turn on process
Parent:	TDEM_ProcessParameter

RX_DELAY

Name:	RX_DELAY
Definition:	delay of Receiver in transmitter time
Parent:	TDEM_ProcessParameter

BASE_FREQ

Name:	BASE_FREQ
Definition:	current wave base frequency in Hz
Parent:	TDEM_ProcessParameter

LOOP_SZ_X

Name:	LOOP_SZ_X
Definition:	transmitter loop side length in X direction
Parent:	TDEM_ProcessParameter

LOOP_SZ_Y

Name:	LOOP_SZ_Y
Definition:	transmitter loop side length in Y direction
Parent:	TDEM_ProcessParameter

NUM_OF_TURNS

Name:	NUM_OF_TURNS
Definition:	number of turns in the transmitter loop
Parent:	TDEM_ProcessParameter

CURR_WAVE_FORM

Name:	CURR_WAVE_FORM
Definition:	current wave form in the transmitter loop
Description:	allowed values are narrower terms
Parent:	TDEM_ProcessParameter

rectangularBipolar

Name:	rectangularBipolar
Definition:	bipolar square wave with idle periods
Parent:	CURR_WAVE_FORM

rectangularBipolar

Name:	rectangularBipolar
Definition:	triangular wave
Parent:	CURR_WAVE_FORM

RX_COIL_AREA

Name:	RX_COIL_AREA
Definition:	effective area of receiver coil
Parent:	TDEM_ProcessParameter

boreholeLoggingParameter

Name:	boreholeLoggingParameter
Definition:	Borehole logging process parameters

WELL_ID

Name:	WELL_ID
Definition:	well identifier
Parent:	boreholeLoggingParameter

WELL_BTM

Name:	WELL_BTM
Definition:	bottom of well
Parent:	boreholeLoggingParameter

DPTH_MIN

Name:	DPTH_MIN
Definition:	minimum depth of logging
Parent:	boreholeLoggingParameter

DPTH_MAX

Name:	DPTH_MAX
Definition:	maximum depth of logging
Parent:	boreholeLoggingParameter

LOG_TYPE

Name:	LOG_TYPE
Definition:	reference to log parameter name
Parent:	boreholeLoggingParameter

industryStandardResource

Name:	industryStandardResource
Definition:	reference to LAS, WITSML etc. files
Parent:	boreholeLoggingParameter

WTR_LEV

Name:	WTR_LEV
Definition:	water level
Parent:	boreholeLoggingParameter

DREF

Name:	DREF
Definition:	Depth Reference
Parent:	boreholeLoggingParameter

STRT

Name:	STRT
Definition:	First Index Value
Parent:	boreholeLoggingParameter

STOP

Name:	STOP
Definition:	Last Index Value
Parent:	boreholeLoggingParameter

STEP

Name:	STEP
Definition:	STEP
Parent:	boreholeLoggingParameter

X

Name:	X
Definition:	X or East-West coordinate
Parent:	boreholeLoggingParameter

Y

Name:	Y
Definition:	Y or North South coordinate
Parent:	boreholeLoggingParameter

LATI

Name:	LATI
Definition:	Latitude
Parent:	boreholeLoggingParameter

LONG

Name:	LONG
Definition:	Longitude
Parent:	boreholeLoggingParameter

RUN_DEPTH

Name:	RUN_DEPTH
Definition:	nth Run Depth Interval
Parent:	boreholeLoggingParameter

NMAT_DEPTH

Name:	NMAT_DEPTH
Definition:	Neutron Matrix Depth interval
Parent:	boreholeLoggingParameter

DMAT_DEPTH

Name:	DMAT_DEPTH
Definition:	Density Matrix Depth interval
Parent:	boreholeLoggingParameter

SMAT_DEPTH

Name:	SMAT_DEPTH
Definition:	Sonic Matrix Depth
Parent:	boreholeLoggingParameter

DIST

Name:	DIST
Definition:	Cumulative increment of drilling.
Parent:	boreholeLoggingParameter

HRS

Name:	HRS
Definition:	Hours of drilling
Parent:	boreholeLoggingParameter

TBR

Name:	TBR
Definition:	Total barrels returned
Parent:	boreholeLoggingParameter

I_RF

Name:	I_RF
Definition:	Depth Datum Elevation (from MSL)
Parent:	boreholeLoggingParameter

I_DC

Name:	I_DC
Definition:	Magnetic Declination (if I_AT not magnetic)
Parent:	boreholeLoggingParameter

I_KO

Name:	I_KO
Definition:	Kick off Depth (M.D. of kick off point)
Parent:	boreholeLoggingParameter

I_ONS

Name:	I_ONS
Definition:	N/S Offset of well ref point to top hole
Parent:	boreholeLoggingParameter

I_OEW

Name:	I_OEW
Definition:	E/W Offset of well ref point to top hole
Parent:	boreholeLoggingParameter

CLSR

Name:	CLSR
Definition:	Closure (horizontal) length
Parent:	boreholeLoggingParameter

TIEMD

Name:	TIEMD
Definition:	Tie Point Measured depth
Parent:	boreholeLoggingParameter

TIETVD

Name:	TIETVD
Definition:	Tie Point True Vertical depth
Parent:	boreholeLoggingParameter

TIEDEV

Name:	TIEDEV
Definition:	Tie Point Deviation
Parent:	boreholeLoggingParameter

TSTT

Name:	TSTT
Definition:	TEST Top Depth
Parent:	boreholeLoggingParameter

TSTB

Name:	TSTB
Definition:	TEST Bottom Depth
Parent:	boreholeLoggingParameter

ISIP

Name:	ISIP
Definition:	Initial Shut in pressure
Parent:	boreholeLoggingParameter

FSIP

Name:	FSIP
Definition:	Final Shut in pressure
Parent:	boreholeLoggingParameter

RATE

Name:	RATE
Definition:	Production Rate
Parent:	boreholeLoggingParameter

RUN

Name:	RUN
Definition:	Run Number
Parent:	boreholeLoggingParameter

RUNS

Name:	RUNS
Definition:	# of Runs for this well.
Parent:	boreholeLoggingParameter

TSTN

Name:	TSTN
Definition:	TEST Number
Parent:	boreholeLoggingParameter

BS

Name:	BS
Definition:	Bit Size
Parent:	boreholeLoggingParameter

WRAP

Name:	WRAP
Definition:	ONE LINE PER DEPTH STEP
Parent:	boreholeLoggingParameter

NULL

Name:	NULL
Definition:	NULL VALUE
Parent:	boreholeLoggingParameter

COMP

Name:	COMP
Definition:	COMPANY
Parent:	boreholeLoggingParameter

WELL

Name:	WELL
Definition:	WELL
Parent:	boreholeLoggingParameter

FLD

Name:	FLD
Definition:	FIELD
Parent:	boreholeLoggingParameter

LOC

Name:	LOC
Definition:	LOCATION
Parent:	boreholeLoggingParameter

STAT

Name:	STAT
Definition:	STATE
Parent:	boreholeLoggingParameter

PROV

Name:	PROV
Definition:	PROVINCE
Parent:	boreholeLoggingParameter

CTRY

Name:	CTRY
Definition:	COUNTRY
Parent:	boreholeLoggingParameter

CNTY

Name:	CNTY
Definition:	County
Parent:	boreholeLoggingParameter

UWI

Name:	UWI
Definition:	UNIQUE WELL ID
Parent:	boreholeLoggingParameter

LIC

Name:	LIC
Definition:	LICENSE NUMBER
Parent:	boreholeLoggingParameter

SRVC

Name:	SRVC
Definition:	Service Company
Parent:	boreholeLoggingParameter

DATE

Name:	DATE
Definition:	Service Date
Parent:	boreholeLoggingParameter

GDAT

Name:	GDAT
Definition:	Geodetic Datum
Parent:	boreholeLoggingParameter

HZCS

Name:	HZCS
Definition:	Horizontal Co-ordinate System
Parent:	boreholeLoggingParameter

C_SRS

Name:	C_SRS
Definition:	Core Source
Parent:	boreholeLoggingParameter

C_TY

Name:	C_TY
Definition:	Core Type
Parent:	boreholeLoggingParameter

C_DATE

Name:	C_DATE
Definition:	Recovery Date (Date Core Cut) \{DD/MM/YYYY}
Parent:	boreholeLoggingParameter

C_FM

Name:	C_FM
Definition:	Primary Formation Cored
Parent:	boreholeLoggingParameter

C_AC

Name:	C_AC
Definition:	Analyzing Company
Parent:	boreholeLoggingParameter

C_AD

Name:	C_AD
Definition:	Analysis Date \{DD/MM/YYYY}
Parent:	boreholeLoggingParameter

CDES

Name:	CDES
Definition:	Core description
Parent:	boreholeLoggingParameter

RIG

Name:	RIG
Definition:	Drilling Rig name
Parent:	boreholeLoggingParameter

CONTR

Name:	CONTR
Definition:	Contractor
Parent:	boreholeLoggingParameter

I_DT

Name:	I_DT
Definition:	SURVEY_DATE \{DD/MM/YYYY}
Parent:	boreholeLoggingParameter

I_CO

Name:	I_CO
Definition:	Recording Company
Parent:	boreholeLoggingParameter

I_AT

Name:	I_AT
Definition:	Azimuth North Type (e.g. Grid/ True)
Parent:	boreholeLoggingParameter

I_GD

Name:	I_GD
Definition:	Geodetic datum
Parent:	boreholeLoggingParameter

I_CP

Name:	I_CP
Definition:	COMPUTE_METHOD (e.g. Radius of Curvature)
Parent:	boreholeLoggingParameter

I_CS

Name:	I_CS
Definition:	COORDINATE_SYSTEM_NAME e.g. UTM18N
Parent:	boreholeLoggingParameter

TOPN

Name:	TOPN
Definition:	Formation Top Name
Parent:	boreholeLoggingParameter

TOPSRC

Name:	TOPSRC
Definition:	Formation Top Source
Parent:	boreholeLoggingParameter

TOPDR

Name:	TOPDR
Definition:	Tops Depth Reference
Parent:	boreholeLoggingParameter

DDES

Name:	DDES
Definition:	TEST Recovery Description
Parent:	boreholeLoggingParameter

BLOWD

Name:	BLOWD
Definition:	BLOW DESCRIPTION
Parent:	boreholeLoggingParameter

TESTT

Name:	TESTT
Definition:	Test Type
Parent:	boreholeLoggingParameter

LMF

Name:	LMF
Definition:	Log Measured From
Parent:	boreholeLoggingParameter

API

Name:	API
Definition:	API Number
Parent:	boreholeLoggingParameter

APD

Name:	APD
Definition:	Above Permanent Data
Parent:	boreholeLoggingParameter

EREF

Name:	EREF
Definition:	Elevation of Depth Reference
Parent:	boreholeLoggingParameter

PDAT

Name:	PDAT
Definition:	Permanent Data
Parent:	boreholeLoggingParameter

RUN_DATE

Name:	RUN_DATE
Definition:	Run date
Parent:	boreholeLoggingParameter

MT_Parameter

Name:	MT_Parameter
Definition:	Magnetotelluric Sounding process parameters

AZM

Name:	AZM
Definition:	azimuth of the layout (direction of Ex)
Parent:	MT_Parameter

FREQ_MIN

Name:	FREQ_MIN
Definition:	smallest frequency
Parent:	MT_Parameter

FREQ_MAX

Name:	FREQ_MAX
Definition:	largest frequency
Parent:	MT_Parameter

MT_MEAS_TYPE

Name:	MT_MEAS_TYPE
Definition:	MT measurement type
Description:	allowed values are narrower terms
Parent:	MT_Parameter

LMT

Name:	LMT
Definition:	Long period Magnetotelluric Sounding
Parent:	MT_MEAS_TYPE

BBMT

Name:	BBMT
Definition:	Broad band Magnetotelluric Sounding
Parent:	MT_MEAS_TYPE

AMT

Name:	AMT
Definition:	Audio frequency Magnetotelluric Sounding
Parent:	MT_MEAS_TYPE

RMT

Name:	RMT
Definition:	Radio frequency Magnetotelluric Sounding
Parent:	MT_MEAS_TYPE

industryStandardResource

Name:	industryStandardResource
Definition:	reference to SEG-EDI file GeophResource
Parent:	MT_Parameter

2DseismicDAQ_Parameter

Name:	2DseismicDAQ_Parameter
Definition:	2D seismic data acquisition process parameters

SRC_TYPE

Name:	SRC_TYPE
Definition:	type of acoustic source
Description:	allowed values are narrower terms
Parent:	2DseismicDAQ_Parameter

vibrator

Name:	vibrator
Definition:	vibrator
Parent:	SRC_TYPE

explosive

Name:	explosive
Definition:	explosive
Parent:	SRC_TYPE

hammer

Name:	hammer
Definition:	hammer
Parent:	SRC_TYPE

airgun

Name:	airgun
Definition:	airgun
Parent:	SRC_TYPE

SEN_TYPE

Name:	SEN_TYPE
Definition:	type of acoustic sensor
Description:	allowed values are narrower terms
Parent:	2DseismicDAQ_Parameter

geophone

Name:	geophone
Definition:	geophone
Parent:	SEN_TYPE

hydrophone

Name:	hydrophone
Definition:	hydrophone
Parent:	SEN_TYPE

seismograph

Name:	seismograph
Definition:	seismograph
Parent:	SEN_TYPE

SEN_SPACING

Name:	SEN_SPACING
Definition:	distance between sensors (geophones)
Parent:	2DseismicDAQ_Parameter

SRC_SPACING

Name:	SRC_SPACING
Definition:	distance between sources
Parent:	2DseismicDAQ_Parameter

NUM_CH

Name:	NUM_CH
Definition:	number of channels
Parent:	2DseismicDAQ_Parameter

CVRG

Name:	CVRG
Definition:	coverage
Parent:	2DseismicDAQ_Parameter

SAMP_RATE

Name:	SAMP_RATE
Definition:	Time distance between samples
Parent:	2DseismicDAQ_Parameter

TM_OFFS_MIN

Name:	TM_OFFS_MIN
Definition:	time offset of the earliest sample
Parent:	2DseismicDAQ_Parameter

TM_OFFS_MAX

Name:	TM_OFFS_MAX
Definition:	time offset of the latest sample
Parent:	2DseismicDAQ_Parameter

NRST_OFFS

Name:	NRST_OFFS
Definition:	distance between the source and the nearest sensor
Parent:	2DseismicDAQ_Parameter

SEIS_METHOD

Name:	SEIS_METHOD
Definition:	type of seismic method
Description:	allowed values are narrower terms
Parent:	2DseismicDAQ_Parameter

refraction

Name:	refraction
Definition:	refraction
Parent:	SEIS_METHOD

reflection

Name:	reflection
Definition:	reflection
Parent:	SEIS_METHOD

SEIS_WAVE_TYPE

Name:	SEIS_WAVE_TYPE
Definition:	seismic wave type
Description:	allowed values are narrower terms
Parent:	2DseismicDAQ_Parameter

P

Name:	P
Definition:	Primary wave
Parent:	SEIS_WAVE_TYPE

S

Name:	S
Definition:	Secondary wave
Parent:	SEIS_WAVE_TYPE

industryStandardResource

Name:	industryStandardResource
Definition:	reference to SPS, UKOOA,SEG-Y etc. files
Parent:	2DseismicDAQ_Parameter

airborneDAQ_Parameter

Name:	airborneDAQ_Parameter
Definition:	Airborne geophysical data acquisition process parameter

PAR_TYPE

Name:	PAR_TYPE
Definition:	measured geophysical parameter
Parent:	airborneDAQ_Parameter

AVG_SPACING

Name:	AVG_SPACING
Definition:	average distance between data points
Parent:	airborneDAQ_Parameter

LINE_DIST

Name:	LINE_DIST
Definition:	average distance between flight lines
Parent:	airborneDAQ_Parameter

TIELINE_DIST

Name:	TIELINE_DIST
Definition:	average distance between tielines
Parent:	airborneDAQ_Parameter

FLGT_HGT

Name:	FLGT_HGT
Definition:	average flight height
Parent:	airborneDAQ_Parameter

NAV_MODE

Name:	NAV_MODE
Definition:	navigation mode
Description:	allowed values are narrower terms
Parent:	airborneDAQ_Parameter

visual

Name:	visual
Definition:	visual navigation
Parent:	NAV_MODE

microfix

Name:	microfix
Definition:	navigation by microfix
Parent:	NAV_MODE

video

Name:	video
Definition:	navigation by video
Parent:	NAV_MODE

DGPS

Name:	DGPS
Definition:	navigation by differencial GPS
Parent:	NAV_MODE

FLGT_SPD

Name:	FLGT_SPD
Definition:	average flight speed
Parent:	airborneDAQ_Parameter

2DseismicProcParameter

Name:	2DseismicProcParameter
Definition:	2D seismic data processing parameters

CDP_SPACING

Name:	CDP_SPACING
Definition:	distance between CDP-s
Parent:	2DseismicProcParameter

CDP_FRST

Name:	CDP_FRST
Definition:	serial num of first CDP
Parent:	2DseismicProcParameter

CDP_LST

Name:	CDP_LST
Definition:	serial num of last CDP
Parent:	2DseismicProcParameter

CORR_STATIC

Name:	CORR_STATIC
Definition:	static correction
Description:	allowed values are narrower terms
Parent:	2DseismicProcParameter

shallowRefraction

Name:	shallowRefraction
Definition:	static correction by shallow refraction seismics
Parent:	CORR_STATIC

acousticLog

Name:	acousticLog
Definition:	static correction by acoustic log
Parent:	CORR_STATIC

automatic

Name:	automatic
Definition:	automatic static correction
Parent:	CORR_STATIC

industryStandardResource

Name:	industryStandardResource
Definition:	reference to SPS, UKOOA,SEG-Y etc. Files
Parent:	2DseismicProcParameter

inversionProcParameter

Name:	inversionProcParameter
Definition:	Inversion process parameters

MOD_DIM

Name:	MOD_DIM
Definition:	number of model dimensions
Parent:	inversionProcParameter

INV_METHOD

Name:	INV_METHOD
Definition:	type of optimization method
Description:	allowed values are narrower terms
Parent:	inversionProcParameter

leastSquares

Name:	leastSquares
Definition:	inversion by least squares method
Parent:	INV_METHOD

marquardt

Name:	marquardt
Definition:	Marquardt inversion
Parent:	INV_METHOD

simulatedAnnealing

Name:	simulatedAnnealing
Definition:	inversion by simulated annealing
Parent:	INV_METHOD

geneticAlgorithm

Name:	geneticAlgorithm
Definition:	inversion by genetic algorithm
Parent:	INV_METHOD

INV_TYPE

Name:	INV_TYPE
Definition:	type of inversion
Description:	allowed values are narrower terms
Parent:	inversionProcParameter

single

Name:	single
Definition:	single inversion
Description:	inversion of a single dataset
Parent:	INV_TYPE

joint

Name:	joint
Definition:	joint inversion
Description:	simultaneous inversion of several datasets of different types
Parent:	INV_TYPE

gravityProcessParameter

Name:	gravityProcessParameter
Definition:	Gravity station process parameters

errorOfClosure

Name:	errorOfClosure
Definition:	error of closure
Parent:	gravityProcessParameter

gravityDatum

Name:	gravityDatum
Definition:	gravity datum
Description:	allowed values are narrower terms
Parent:	gravityProcessParameter

IGSN71

Name:	IGSN71
Definition:	IGSN71
Parent:	gravityDatum

Potsdam

Name:	Potsdam
Definition:	Potsdam
Parent:	gravityDatum

MGH50

Name:	MGH50
Definition:	Hungarian gravity datum 1950
Parent:	gravityDatum

MGH2000

Name:	MGH2000
Definition:	Hungarian gravity datum 2000
Parent:	gravityDatum

normalCorrectionFormula

Name:	normalCorrectionFormula
Definition:	Type of equation used for normal correction
Description:	allowed values are narrower terms
Parent:	gravityProcessParameter

somigliana

Name:	somigliana
Definition:	correction formula by Somigliana
Parent:	normalCorrectionFormula

cassinis

Name:	cassinis
Definition:	correction formula by Cassinis
Parent:	normalCorrectionFormula

helmert

Name:	helmert
Definition:	correction formula by Helmert
Parent:	normalCorrectionFormula

heiskanen

Name:	heiskanen
Definition:	correction formula by Heiskanen
Parent:	normalCorrectionFormula

heightCorrectionFormula

Name:	heightCorrectionFormula
Definition:	Type of equation used for normal correction
Description:	allowed values are narrower terms
Parent:	gravityProcessParameter

firstOrderFormula

Name:	firstOrderFormula
Definition:	first order formula
Parent:	heightCorrectionFormula

SecondOrderFormula

Name:	SecondOrderFormula
Definition:	second order formula
Parent:	heightCorrectionFormula

bouguerCorrectionFormula

Name:	bouguerCorrectionFormula
Definition:	Type of equation used for normal correction
Description:	allowed values are narrower terms
Parent:	gravityProcessParameter

bouguerPlate

Name:	bouguerPlate
Definition:	correction using Bouguer plate
Parent:	bouguerCorrectionFormula

sphericalCap

Name:	sphericalCap
Definition:	correction using spherical cap
Parent:	bouguerCorrectionFormula

bouguerCorrectionDensity

Name:	bouguerCorrectionDensity
Definition:	density used for Bouguer correction
Parent:	gravityProcessParameter

topoCorrectionDensity

Name:	topoCorrectionDensity
Definition:	density used for topographic correction
Parent:	gravityProcessParameter

topoCorrection

Name:	topoCorrection
Definition:	topoCorrection process parameters
Description:	allowed values are narrower terms
Parent:	gravityProcessParameter

innerTopoCorrection

Name:	innerTopoCorrection
Definition:	value of inner zone topo correction
Parent:	topoCorrection

totalTopoCorrection

Name:	totalTopoCorrection
Definition:	value of total topo correction
Parent:	topoCorrection

magneticProcessParameter

Name:	magneticProcessParameter
Definition:	Magnetic station process parameters

IGRF_SYS

Name:	IGRF_SYS
Definition:	Reference to IGRF coefficients that were used to calculate the normal magnetic field
Description:	example: http://www.ngdc.noaa.gov/IAGA/vmod/igrf11coeffs.txt
Parent:	magneticProcessParameter

SAMP_RATE

Name:	SAMP_RATE
Definition:	frequency of sampling in hertz for magnetic observatory time series
Parent:	magneticProcessParameter

MAG_RESOL

Name:	MAG_RESOL
Definition:	resolution of magnetic field measurement in picoTesla
Parent:	magneticProcessParameter

GAUSS_FILT_WDTH

Name:	GAUSS_FILT_WDTH
Definition:	width of convolution filter time window for magneticobservatory time series
Parent:	magneticProcessParameter

GAUSS_FILT_SIGMA

Name:	GAUSS_FILT_SIGMA
Definition:	scale factor (standard deviation) of Gauss convolution filter for magnetic observatory time series
Parent:	magneticProcessParameter

HIGH_CUT_FREQ

Name:	HIGH_CUT_FREQ
Definition:	HighCut frequency of analogue filter for magnetic observatory time series
Parent:	magneticProcessParameter

GeophPropertyNameValue

Definition:	hierarchical codelist of geophysical property names
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/GeophPropertyNameValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

VES_Property

Name:	VES_Property
Definition:	Vertical Electric Sounding property

APP_RES

Name:	APP_RES
Definition:	apparent resistivity calculated by Ohms law
Parent:	VES_Property

APP_CHRG

Name:	APP_CHRG
Definition:	apparent chargeability
Parent:	VES_Property

CURR

Name:	CURR
Definition:	current of the AB current dipole
Parent:	VES_Property

VOLTAGE

Name:	VOLTAGE
Definition:	voltage measured no the MN electric dipole
Parent:	VES_Property

TDEM_Property

Name:	TDEM_Property
Definition:	TDEM sounding property

APP_RES_LT

Name:	APP_RES_LT
Definition:	apparent resistivity calculated by late time approximation
Parent:	TDEM_Property

APP_RES_ET

Name:	APP_RES_ET
Definition:	apparent resistivity calculated by early time approximation
Parent:	TDEM_Property

APP_RES

Name:	APP_RES
Definition:	apparent resistivity
Parent:	TDEM_Property

VOLTAGE

Name:	VOLTAGE
Definition:	voltage measured by the receiver loop or potential electrodes
Parent:	TDEM_Property

DHDT

Name:	DHDT
Definition:	time derivative of the magnetic field in the direction of the Rx loop axis
Parent:	TDEM_Property

DHXDT

Name:	DHXDT
Definition:	time derivative of the magnetic field X component
Parent:	TDEM_Property

DHYDT

Name:	DHYDT
Definition:	time derivative of the magnetic field Y component
Parent:	TDEM_Property

DHZDT

Name:	DHZDT
Definition:	time derivative of the magnetic field Z component
Parent:	TDEM_Property

boreholeLoggingProperty

Name:	boreholeLoggingProperty
Definition:	borehole looging property

MATR

Name:	MATR
Definition:	Neutron Porosity Matrix
Parent:	boreholeLoggingProperty

C_TP

Name:	C_TP
Definition:	Core Top Depth
Parent:	boreholeLoggingProperty

C_BS

Name:	C_BS
Definition:	Core Base Depth
Parent:	boreholeLoggingProperty

C_RC

Name:	C_RC
Definition:	Recovered Amount (Length)
Parent:	boreholeLoggingProperty

C_DI

Name:	C_DI
Definition:	Core Diameter
Parent:	boreholeLoggingProperty

CORT

Name:	CORT
Definition:	Core top depth
Parent:	boreholeLoggingProperty

CORB

Name:	CORB
Definition:	Core Bottom Depth
Parent:	boreholeLoggingProperty

DDEP

Name:	DDEP
Definition:	Depth
Parent:	boreholeLoggingProperty

ROP

Name:	ROP
Definition:	Rate of Penetration
Parent:	boreholeLoggingProperty

WOB

Name:	WOB
Definition:	Weight on bit
Parent:	boreholeLoggingProperty

RPM

Name:	RPM
Definition:	Rotations per minute
Parent:	boreholeLoggingProperty

TQ

Name:	TQ
Definition:	Torque on bit in amps
Parent:	boreholeLoggingProperty

PUMP

Name:	PUMP
Definition:	Mud pump pressure
Parent:	boreholeLoggingProperty

TSPM

Name:	TSPM
Definition:	Total strokes per minute
Parent:	boreholeLoggingProperty

GPM

Name:	GPM
Definition:	Gallons per minute
Parent:	boreholeLoggingProperty

ECD

Name:	ECD
Definition:	Effective circulation density
Parent:	boreholeLoggingProperty

MD

Name:	MD
Definition:	Measured Depth
Parent:	boreholeLoggingProperty

TVD

Name:	TVD
Definition:	True Vertical Depth
Parent:	boreholeLoggingProperty

AZIM

Name:	AZIM
Definition:	Borehole Azimuth
Parent:	boreholeLoggingProperty

DEVI

Name:	DEVI
Definition:	Borehole Deviation
Parent:	boreholeLoggingProperty

RB

Name:	RB
Definition:	Relative Bearing
Parent:	boreholeLoggingProperty

NSDR

Name:	NSDR
Definition:	North South drift
Parent:	boreholeLoggingProperty

EWDR

Name:	EWDR
Definition:	East West drift
Parent:	boreholeLoggingProperty

TOPT

Name:	TOPT
Definition:	Formation Top Depth
Parent:	boreholeLoggingProperty

TOPB

Name:	TOPB
Definition:	Formation Base Depth
Parent:	boreholeLoggingProperty

DEPT

Name:	DEPT
Definition:	Depth
Parent:	boreholeLoggingProperty

DPHI

Name:	DPHI
Definition:	Density Porosity
Parent:	boreholeLoggingProperty

GR

Name:	GR
Definition:	Gamma Ray
Parent:	boreholeLoggingProperty

PEF

Name:	PEF
Definition:	Photoelectric Factor
Parent:	boreholeLoggingProperty

RHOB

Name:	RHOB
Definition:	Bulk Density
Parent:	boreholeLoggingProperty

NEUT

Name:	NEUT
Definition:	Neutron Porosity
Parent:	boreholeLoggingProperty

DEN

Name:	DEN
Definition:	Density Porosity
Parent:	boreholeLoggingProperty

SPOR

Name:	SPOR
Definition:	Sonic Porosity
Parent:	boreholeLoggingProperty

PERM

Name:	PERM
Definition:	Core permeability
Parent:	boreholeLoggingProperty

CPOR

Name:	CPOR
Definition:	Core porosity
Parent:	boreholeLoggingProperty

OIL

Name:	OIL
Definition:	Core Oil saturation
Parent:	boreholeLoggingProperty

SWTR

Name:	SWTR
Definition:	Core water saturation
Parent:	boreholeLoggingProperty

OILVOL

Name:	OILVOL
Definition:	Core oil volume
Parent:	boreholeLoggingProperty

WTR

Name:	WTR
Definition:	Core water volume
Parent:	boreholeLoggingProperty

MDEN

Name:	MDEN
Definition:	Density Porosity Matrix
Parent:	boreholeLoggingProperty

DTMA

Name:	DTMA
Definition:	Sonic Porosity Matrix
Parent:	boreholeLoggingProperty

seismicProperty

Name:	seismicProperty
Definition:	seismic property

seismicReflectivity

Name:	seismicReflectivity
Definition:	seismic reflectivity
Parent:	seismicProperty

seismicVelocity

Name:	seismicVelocity
Definition:	seismic velocity type
Parent:	seismicProperty

Vp

Name:	Vp
Definition:	primary wave velocity
Parent:	seismicVelocity

Vs

Name:	Vs
Definition:	secondary wave velocity
Parent:	seismicVelocity

seismicAmplitude

Name:	seismicAmplitude
Definition:	seismic amplitude
Parent:	seismicProperty

gravimetricProperty

Name:	gravimetricProperty
Definition:	gravimetric property

density

Name:	density
Definition:	density used for gravity corrections
Parent:	gravimetricProperty

gravityBouguerAnomaly

Name:	gravityBouguerAnomaly
Definition:	Bouguer anomaly
Parent:	gravimetricProperty

gravityFreeAirAnomaly

Name:	gravityFreeAirAnomaly
Definition:	Observed gravity corrected for latitude and elevation of the station
Parent:	gravimetricProperty

observedGravity

Name:	observedGravity
Definition:	Observed gravity field
Parent:	gravimetricProperty

magneticProperty

Name:	magneticProperty
Definition:	magnetometric property

IGRF

Name:	IGRF
Definition:	Magnetic scalar potential (V) calculated by International Geomagnetic Reference Field coefficients
Parent:	magneticProperty

magneticFieldVector

Name:	magneticFieldVector
Definition:	magnetic field vector
Parent:	magneticProperty

MAG_X

Name:	MAG_X
Definition:	X (north) component of the magnetic field.
Parent:	magneticFieldVector

MAG_Y

Name:	MAG_Y
Definition:	Y (east) component of the magnetic field.
Parent:	magneticFieldVector

MAG_Z

Name:	MAG_Z
Definition:	Vertical magnetic field
Parent:	magneticFieldVector

MAG_T

Name:	MAG_T
Definition:	magnetic total field
Parent:	magneticProperty

MAG_H

Name:	MAG_H
Definition:	Horizontal magnetic field
Parent:	magneticProperty

MAG_INCL

Name:	MAG_INCL
Definition:	Inclination of magnetic field, downward deviation from horizontal.
Parent:	magneticProperty

MAG_DECL

Name:	MAG_DECL
Definition:	Declination of magnetic field, clockwise deviation from true North
Parent:	magneticProperty

magneticFieldAnomaly

Name:	magneticFieldAnomaly
Definition:	magnetic field anomaly
Parent:	magneticProperty

MAG_DT

Name:	MAG_DT
Definition:	Total magnetic field anomaly, relativ to normal magnetic field
Parent:	magneticFieldAnomaly

MAG_DZ

Name:	MAG_DZ
Definition:	Vertical magnetic field anomaly , relative to normal magnetic field
Parent:	magneticFieldAnomaly

MAG_DH

Name:	MAG_DH
Definition:	Horizontal magnetic field anomaly, relative to normal magnetic field
Parent:	magneticFieldAnomaly

electromagneticProperty

Name:	electromagneticProperty
Definition:	electromagnetic property

conductivity

Name:	conductivity
Definition:	Electric conductivity
Parent:	electromagneticProperty

resistivity

Name:	resistivity
Definition:	Electric resistivity
Parent:	electromagneticProperty

chargeability

Name:	chargeability
Definition:	Electric chargeability
Parent:	electromagneticProperty

radiometricProperty

Name:	radiometricProperty
Definition:	radiometric property

totalGammaRadiation

Name:	totalGammaRadiation
Definition:	Intensity of total gamma radiation
Parent:	radiometricProperty

RAD_TC

Name:	RAD_TC
Definition:	total count
Parent:	radiometricProperty

RAD_EQ_TH

Name:	RAD_EQ_TH
Definition:	equivalent thorium intensity
Parent:	radiometricProperty

RAD_EQ_U

Name:	RAD_EQ_U
Definition:	equivalent uranium intensity
Parent:	radiometricProperty

RAD_K

Name:	RAD_K
Definition:	kalium intensity
Parent:	radiometricProperty

RAD_TH

Name:	RAD_TH
Definition:	thorium intensity
Parent:	radiometricProperty

RAD_U

Name:	RAD_U
Definition:	uranium intensity
Parent:	radiometricProperty

RAD_DR

Name:	RAD_DR
Definition:	dose rate
Parent:	radiometricProperty

RAD_TR

Name:	RAD_TR
Definition:	total radioactivity
Parent:	radiometricProperty

RAD_CS137

Name:	RAD_CS137
Definition:	caesium137 intensity
Parent:	radiometricProperty

seismologicProperty

Name:	seismologicProperty
Definition:	seismologic property

seismologyMagnitude

Name:	seismologyMagnitude
Definition:	Earthquake magnitude
Parent:	seismologicProperty

seismologyfocalDistribution

Name:	seismologyfocalDistribution
Definition:	Distribution of earthquake focuses
Parent:	seismologicProperty

MT_Property

Name:	MT_Property
Definition:	MT property

MT_Ex

Name:	MT_Ex
Definition:	X (north) component of the electric field.
Parent:	MT_Property

MT_Ey

Name:	MT_Ey
Definition:	Y (east) component of the electric field.
Parent:	MT_Property

MT_Hx

Name:	MT_Hx
Definition:	X (north) component of the magnetic field.
Parent:	MT_Property

MT_Hy

Name:	MT_Hy
Definition:	Y (east) component of the magnetic field.
Parent:	MT_Property

MT_Hz

Name:	MT_Hz
Definition:	Z (vertical) component of the magnetic field.
Parent:	MT_Property

MT_impedanceTensor

Name:	MT_impedanceTensor
Definition:	MT impedance tensor
Parent:	MT_Property

MT_RE_Zxx

Name:	MT_RE_Zxx
Definition:	Real part of the complex Zxx diagonal element that couples parallel electric(Ex) and magnetic(Hx) field
Parent:	MT_impedanceTensor

MT_IM_Zxx

Name:	MT_IM_Zxx
Definition:	Imaginary part of the complex Zxx diagonal element that couples parallel electric(Ex) and magnetic(Hx) field
Parent:	MT_impedanceTensor

MT_RE_Zxy

Name:	MT_RE_Zxy
Definition:	Real part of the complex Zxy off-diagonal element that couples orthogonal electric(Ex) and magnetic(Hy) field
Parent:	MT_impedanceTensor

MT_IM_Zxy

Name:	MT_IM_Zxy
Definition:	Imaginary part of the complex Zxy off-diagonal element that couples orthogonal electric(Ex) and magnetic(Hy) field
Parent:	MT_impedanceTensor

MT_RE_Zyx

Name:	MT_RE_Zyx
Definition:	Real part of the complex Zyx off-diagonal element that couples orthogonal electric(Ey) and magnetic(Hx) field
Parent:	MT_impedanceTensor

MT_IM_Zyx

Name:	MT_IM_Zyx
Definition:	Imaginary part of the complex Zyx off-diagonal element that couples orthogonal electric(Ey) and magnetic(Hx) field
Parent:	MT_impedanceTensor

MT_RE_Zyy

Name:	MT_RE_Zyy
Definition:	Real part of the complex Zyy diagonal element that couples parallel electric(Ey) and magnetic(Hy) field
Parent:	MT_impedanceTensor

MT_IM_Zyy

Name:	MT_IM_Zyy
Definition:	Imaginary part of the complex Zyy diagonal element that couples parallel electric(Ey) and magnetic(Hy) field
Parent:	MT_impedanceTensor

MT_RE_Tx

Name:	MT_RE_Tx
Definition:	Real part of tipper Tx element, that couples Hz and Hx magnetic field
Parent:	MT_impedanceTensor

MT_IM_Tx

Name:	MT_IM_Tx
Definition:	Imaginary part of tipper Tx element that couples Hz and Hx magnetic field
Parent:	MT_impedanceTensor

MT_RE_Ty

Name:	MT_RE_Ty
Definition:	Real part of tipper Ty element that couples Hz and Hy magnetic field
Parent:	MT_impedanceTensor

MT_IM_Ty

Name:	MT_IM_Ty
Definition:	Imaginary part of tipper Tx element that couples Hz and Hy magnetic field
Parent:	MT_impedanceTensor

MT_resistivity

Name:	MT_resistivity
Definition:	MT apparent resistivity
Parent:	MT_Property

MT_ROxx

Name:	MT_ROxx
Definition:	MT resistivity calculated from Zxx
Parent:	MT_resistivity

MT_ROxy

Name:	MT_ROxy
Definition:	apparent resistivity calculated from Zxy
Parent:	MT_resistivity

MT_ROyx

Name:	MT_ROyx
Definition:	apparent resistivity calculated from Zyx
Parent:	MT_resistivity

MT_ROyy

Name:	MT_ROyy
Definition:	apparent resistivity calculated from Zyy
Parent:	MT_resistivity

MT_phase

Name:	MT_phase
Definition:	MT phase
Parent:	MT_Property

MT_PHxx

Name:	MT_PHxx
Definition:	phase of Zxx
Parent:	MT_phase

MT_PHxy

Name:	MT_PHxy
Definition:	phase of Zxy
Parent:	MT_phase

MT_PHyx

Name:	MT_PHyx
Definition:	phase of Zyx
Parent:	MT_phase

MT_PHyy

Name:	MT_PHyy
Definition:	phase of Zyy
Parent:	MT_phase

OtherGeophModelTypeValue

Definition:	Other type of geophysical model
Description:	none of the following types: curve model, surface grid model solid grid model. The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/OtherGeophModelTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

spotModel

Name:	spotModel
Definition:	Geophysical model constructed from elements with point geometry
Description:	Representation may be a discrete point coverage

earthquakeFocalPoint

Name:	earthquakeFocalPoint
Definition:	Geophysical model representing distribution of earthquake focal points
Parent:	spotModel

persistantScatterer

Name:	persistantScatterer
Definition:	Geophysical model representing distribution of persistant scatterers identified by radar interferometry
Parent:	spotModel

discreteSurfaceModel

Name:	discreteSurfaceModel
Definition:	Geophysical model constructed from discrete elements with surface geometry
Description:	Representation may be a discrete surface coverage

horizontalCrossSection

Name:	horizontalCrossSection
Definition:	Geophysical model constructed from discrete surface elements in a horizontal cross section
Parent:	discreteSurfaceModel

verticalCrossSection

Name:	verticalCrossSection
Definition:	Geophysical model constructed from discrete surface elements in a vertical cross section
Parent:	discreteSurfaceModel

discreteSolidModel

Name:	discreteSolidModel
Definition:	Geophysical model constructed from discrete elements with solid geometry
Description:	Representation may be a discrete solid coverage

geophysicalBodyReconstruction

Name:	geophysicalBodyReconstruction
Definition:	Geophysical model of reconstructed 3D bodies, as a result of complex interpretation.
Parent:	discreteSolidModel

OtherMeasurementTypeValue

Definition:	Type of geophysical measurement
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/OtherMeasurementTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

3DMultielectrodeDC

Name:	3dmultielectrodedc
Definition:	DC resistivity and/or chargeability (IP) measurement carried out with a larger set of electrodes in order to define 3D electric property distribution in a volume of the earth. Also known as 3D resistivity tomography.

ResourceTypeValue

Definition:	Type of geophysical resource
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/ResourceTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

boreholeLoggingResource

Name:	boreholeloggingresource
Definition:	borehole logging resource

coverage

Name:	coverage
Definition:	standard coverage defined by geometry value pairs, or domain set and range set.

EDI

Name:	edi
Definition:	SEG standard for magnetotelluric data

IAGA2002

Name:	iaga2002
Definition:	IAGA2002 data exchange format

IMFV1.22

Name:	imfv1.22
Definition:	GIN Dissemination Format for Minute Values

INTERMAGNETResource

Name:	intermagnetresource
Definition:	INTERMAGNET data resource

LAS

Name:	las
Definition:	Log ASCII Standard

magneticResource

Name:	magneticresource
Definition:	magnetic resource

magnetotelluricResource

Name:	magnetotelluricresource
Definition:	magnetotelluric resource

OGC_Resource

Name:	ogc_resource
Definition:	OGC standard resource

SEG-D

Name:	seg-d
Definition:	SEG standard for seismic data

SEG-Y

Name:	seg-y
Definition:	SEG standard for seismic data

seismicResource

Name:	seismicresource
Definition:	seismic resource

SensorML

Name:	sensorml
Definition:	Sensor Model Language resource

SPS

Name:	sps
Definition:	SHELL Processing Support File

SWE

Name:	swe
Definition:	Sensor Web Enablement resource

UKOOA	
Name:	ukooa
Definition:	seismic navigation file
WITSML	
Name:	witsml
Definition:	Well site Information Transfer Standard Markup Language

SolidGridModelTypeValue

Definition:	Type of solid grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SolidGridModelTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

parameterBlock	
Name:	parameterblock
Definition:	Gridded distribution of physical or geophysical properties in a volume of the earth
seismicVolume	
Name:	seismicvolume
Definition:	Gridded distribution of seismic properties in a volume of the earth

SurfaceGridModelTypeValue

Definition:	Type of surface grid model
Description:	The codelist is expected to be extended by the geophysical community. Recommendations are provided in the Technical Guidence
Extensibility:	open
Identifier:	http://inspire.ec.europa.eu/codelist/SurfaceGridModelTypeValue
Values:	The table below includes recommended values that may be used by data providers. Before creating new terms, please check if one of them can be used.

horizontalParameterGrid

Name:	horizontalparametergrid
Definition:	Gridded distribution of physical or geophysical properties over a horizontal cross section of the earth

seismicDepthSection

Name:	seismicdepthsection
Definition:	Seimic property distribution over a vertical cross section of the earth

seismicHorizon

Name:	seismichorizon
Definition:	3D surface identified by some pattern within a 3D seismic volume.

verticalParameterGrid

Name:	verticalparametergrid
Definition:	Gridded distribution of physical or geophysical properties over a vertical cross section of the earth

Annex E: Aquifers and Groundwater bodies - (informative)

E.1. Aquifers and Groundwater bodies

E.1.1. Introduction

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

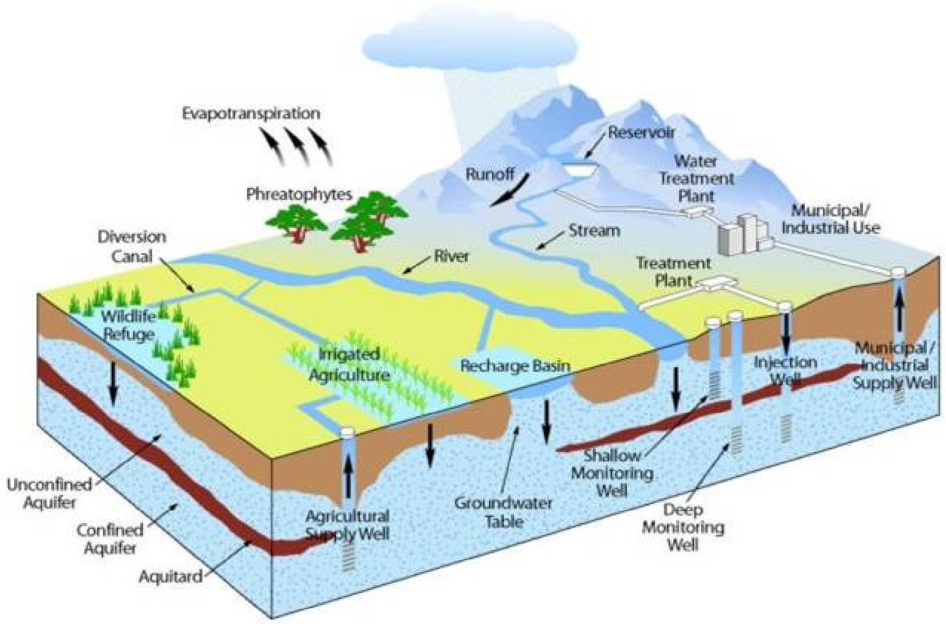


Fig. 1 Summary of groundwater processes.

The European Union has recognized the need for a consistent framework for legislation on water management. According to the Water Framework Directive (WFD) introduced in 2000 water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such.

Hydrogeology describes the flow, condition of occurrence and behaviour of water in the underground environment. It is a science located between hydrology and geology, whilst it is necessary to have an understanding of both disciplines. Hydrological processes are responsible for the quantity of water supply e.g. as a result of aquifer recharge. On the other hand, the physical properties and composition of the geologic materials (rocks and sediments) create the main environment for groundwater flow and storage and rocks and sediments also influence groundwater quality as a result of their chemical composition.

Groundwater can be both a resource and a problem depending on what activity is being undertaken. A positive benefit is abstraction for drinking water supply, whereas groundwater flooding causes significant problems to properties and transport infrastructure. Hydrogeology has a direct influence on the environment; groundwater abstraction not only provides water for human consumption but also can cause changes in water flow direction and in some cases may have a dramatic impact on surface water bodies. Overexploitation in an area where groundwater dependent ecosystems are located may change the water table level or the chemical composition of water which may lead to irreversible changes in the ecosystems.

In terms of INSPIRE, the groundwater domain has many connections and dependencies on other human activities described in other themes (Area Management, Soil, Environmental Facilities, Energy Resources, Hydrography, Protected Sites, Utility and Governmental Services). Contamination introduced to groundwater systems takes years to decades to be cleaned out. Prediction is a problem but slow rates of flushing and low rates of degradation are significant issues.

This document intends to introduce groundwater issues to the members of the INSPIRE *Geology* and Mineral Resources TWG.

E.1.2. Background to groundwater processes

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

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

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

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

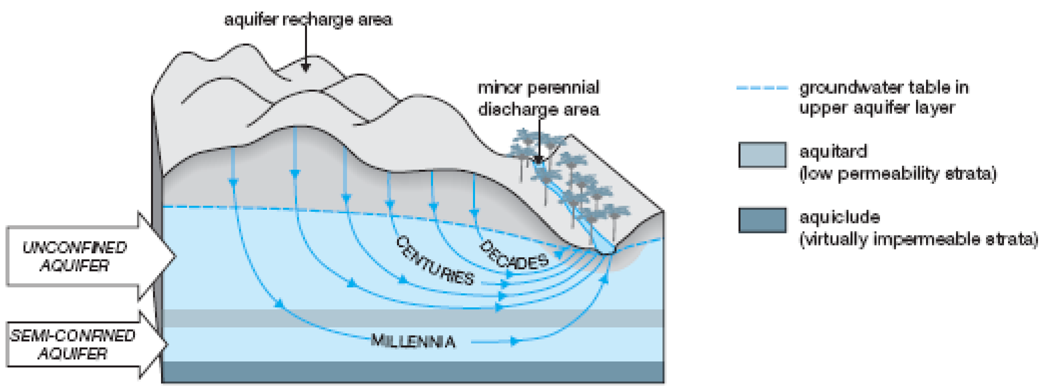


Fig. 2 Example groundwater system showing inflows and outflows and time of travel of water through the system. (GWMate briefing note no. 2: Characterization of Groundwater Systems).

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

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

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

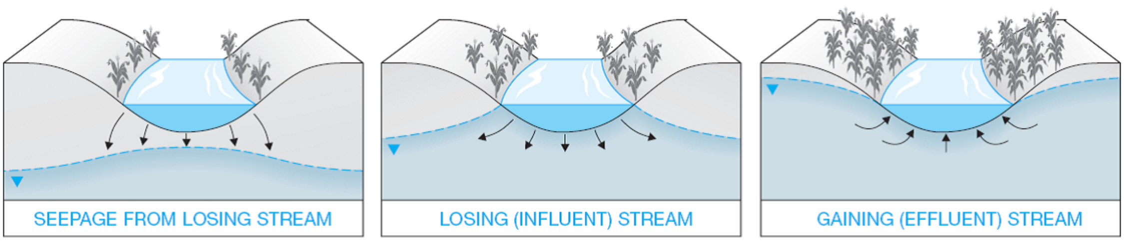


Fig. 3 Different types of river-aquifer interaction (GWMate briefing note no. 2: Characterization of Groundwater Systems).

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

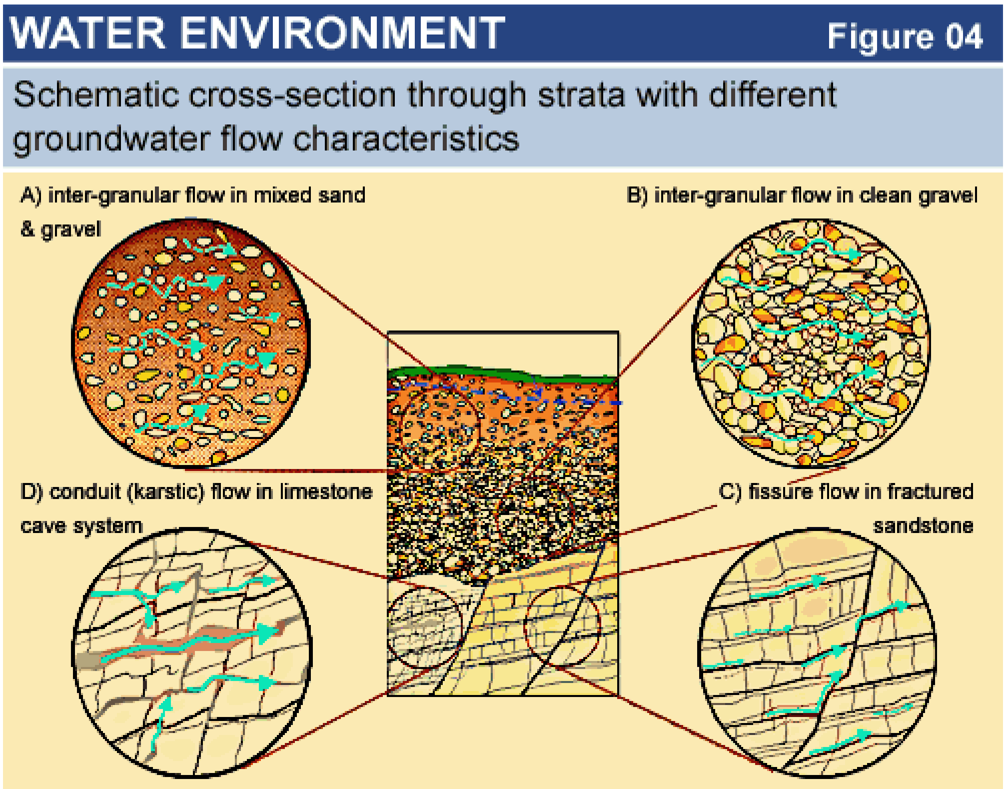


Fig. 4 Different types of flow regimes in groundwater systems (www.goodquarry.com).

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

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

E.1.3. Description of issues

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

Groundwater flow

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

Pollution

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

Natural attenuation

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

Saline aquifers

Saline aquifers occur in a range of settings. Aquifers in close proximity to estuaries and the sea are often saline. Deep aquifers with old or "connate" waters are also often highly saline. Basins of internal drainage, where evaporation is the only outflow are highly saline. Saline intrusion is a problem where abstraction occurs in aquifers close to saline water bodies. Careful management has to be undertaken to avoid despoiling the systems permanently. However, deep saline aquifers are being considered for disposal of supercritical CO_2. Finally highly saline aquifers that are the result of evaporative processes often contain economically important minerals and are exploited commercially.

Geotechnical considerations

The interaction of groundwater with the built environment is extremely important. As the water content or pore pressure of the ground changes so does its geotechnical properties. For example, rising groundwater in cities causes problems with deep foundations and tunnels. An understanding of water movement in the sub-surface is, therefore, important to ensure safe construction of buildings. Dewatering of aquifers for temporary works is also important to allow sub-water table working in construction works.

Groundwater monitoring

Groundwater, in view of its prevalence and quality is a very important source of supply for the population with drinking water. Because of its economic importance and the widespread risks to water quality caused by pollution discharged to the ground, it requires special protection. This protection is achieved, inter alia, by using amonitoring network for both qualitative and quantitative aspects of groundwater status.

Geohazards

As well as being a resource, groundwater can cause problems either by appearing at the surface or by entering sub-surface structures. Groundwater flooding is one such problem. Under extreme recharge events, the water table can rise to the surface and result in flooding. Groundwater flooding differs from surface water flooding in that it is often long-lasting, typically of the order of weeks to months and can affect areas not identified in traditional flood risk mapping. Unlike surface water floods, it is not possible to control this phenomenon easily by flood defences.

Other geohazards that are related to groundwater include:

- landslides
- swell-shrink clays
- subsidence

All of these geohazards need an assessment of water movement in the sub-surface to understand how they occur and what influence human activity and climate change will have on them.

Heat

Heat flows both into and out of aquifers are increasingly being recognised as a way of reducing reliance on fossil fuels. Groundwater systems and aquifers are being developed to be used as a temporary store for heat. Systems may be based on pumping groundwater into and out of an aquifer using boreholes, such as Ground Source Heat Pumps (GSHP), or heat exchange in trenches or boreholes for Ground Coupled Heat Pumps (GCHP). Groundwater can also be used to exploit hotter rocks close to the surface by pumping cold water down or abstracting hot water. These systems can be used to heat, cool and power systems in buildings. Where very elevated groundwater temperatures are found, electricity generation is possible.

Mineral resources

Exploitation of mineral resources requires the control of water where it isn’t wanted and supply of water where it is in short supply. So-called "wet working" of mines requires removal of water where it enters the mine. However mining requires water to operate its processes so in some areas, where water is scare, then groundwater can be used for supply purposes. Groundwater can be rich in minerals and the economic extraction of minerals from groundwaters is possible for high value minerals such as Lithium. As well as this mineral waters can be thought of groundwater as an economic resource, with the dissolved solids giving the water its taste, e.g. bottled waters.

E.1.4. Approach to data models

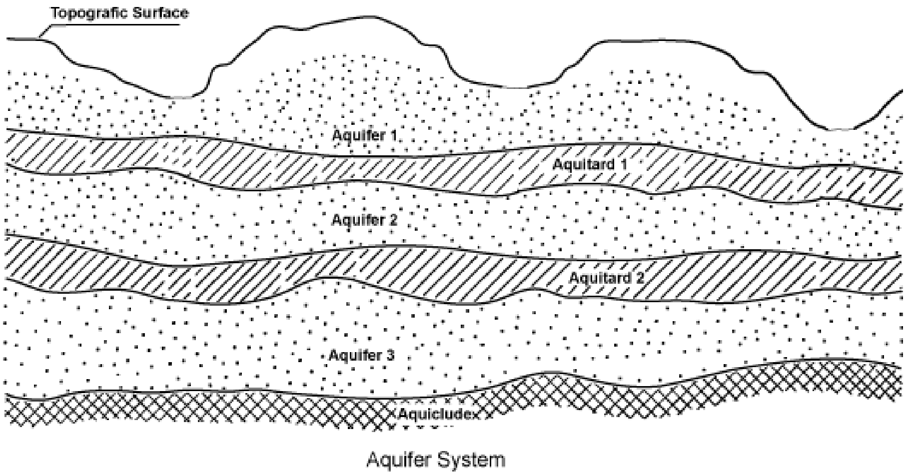


Fig. 5 Example of an aquifer system

The Aquifer System is dependent of rock properties such as permeability and porosity for water flow and storage. Generally the two main components are Aquifers (e.g. sand and gravel) where water flow is may easily occur and Aquitards, which are poorly permeable formations (e.g. clay) that do not yield water freely to a well or a spring. However, an aquitard may transmit appreciable water to or from adjacent aquifers.

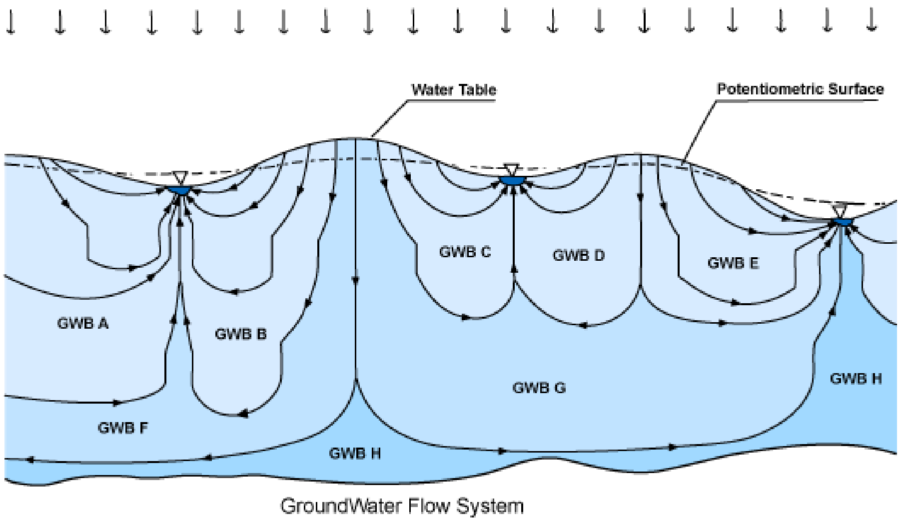


Fig. 6 Example of a groundwater flow system

The aquifer system provides a framework for the groundwater flow system and encompasses it. The nature of the groundwater flow system depends partly on the aquifer system but also on factors such as the geometry of the water table (or confined potentiometric surface) and the location of discharge points such as rivers, springs and wells. Groundwater bodies are discrete bodies of groundwater lying within a groundwater flow system'.

The basic idea of the INSPIRE model for groundwater is to identify two basic elements: the Aquifer System (dependent on the geological conditions) and the Groundwater Flow System. Both components taken together create the Hydrogeological System.

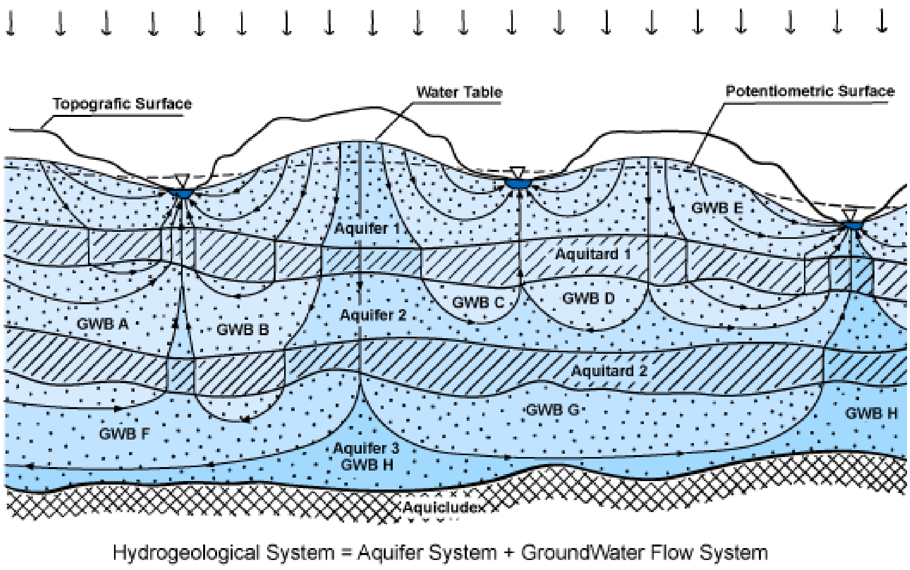


Fig. 7 Example of an hydrogeological system

The mutual relationships between those components create and build the condition for groundwater flow. The main assessment of model is base on the hydrodynamic processes (groundwater flow).

E.1.5. Relevant EU legislation

There is a significant amount of EU legislation that impacts on groundwater systems and their management. The following provides a list of the relevant EU legislation. The most important piece of legislation in terms of shaping how groundwater systems are conceptualised and managed is the water framework Directive. This legislation has encapsulated the changes in approach to the study of groundwater flow described above.

Bathing Water Directive 76/160/EEC
Birds Directive 79/409/EEC
Drinking Water Directive 98/83/EEC
Major Accidents (Seveso) Directive 96/82/EC
Environment Impact Assessment 85/337/EEC
Sewage Sludge Directive 86/278/EEC
Urban Wastewater Treatment Directive 91/271/EEC
Plant Protection Products Directive 91/414/EEC
Nitrates Directive 91/676/EEC
Habitats Directive 92/43/EEC
Integrated Pollution Prevention Control 96/61/EEC
Nitrates Directive
Urban Wastewater Treatment Directive
Plant Protection Products Directive - Directive 91/414/EEC, OJ L230 of 19.08.1991
Biocides Directive - Directive 98/8/EC, OJ L123 of 24.04.1998
Integrated Pollution Prevention and Control (IPPC) Directive - Directive 96/61/EEC, OJ L257 of 10.10.1996
Landfill Directive - Directive 99/31/EC, OJ L182 of 16.07.1999
Waste Framework Directive - Directive 2006/12/EC, OJ L102 of 11.04.2006
Construction Product Directive - Directive 89/106/EC, OJ L40 of 11.02.1989

Floods Directive 2007/60/EC
Water Framework Directive (2000/60/EC)
Groundwater Directive (2006/118/EC)
Groundwater Directive (80/ 68/EEC)

[1] The common document template is available in the "Framework documents" section of the data specifications web page at http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2

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

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

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

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

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

[7] For Annex IIIII, the consultation and testing phase lasted from 20 June to 21 October 2011.

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

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

[10] UML – Unified Modelling Language

[11] Conceptual models related to specific areas (e.g. INSPIRE themes)

[12] In the case of the Annex IIIII data specifications, the extracted requirements are used to formulate an amendment to the existing Implementing Rule.

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

[14] If no version or publication date are specified, the "latest available version" shall be used.

[15] OJ L 326, 4.12.2008, p. 12.

[16] The Implementing Rules and Technical Guidelines on INSPIRE Network Services are available at http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5

[17] Further details and examples will be included in a future version of the Guidelines for the encoding of spatial data [DS-D2.7

[18] OJ L 274, 20.10.2009, p. 9.

[19] One layer shall be made available for each code list value, in accordance with Art. 14(3).

[20] One layer shall be made available for each code list value, in accordance with Art. 14(3).

[21] One layer shall be made available for each code list value, in accordance with Art. 14(3).

[22] One layer shall be made available for each code list value, in accordance with Art. 14(3).

[23] One layer shall be made available for each code list value, in accordance with Art. 14(3).

[24] One layer shall be made available for each ThematicClassificationValue code list value, in accordance with Art. 14(3).

[25] One layer shall be made available for each StationTypeValue code list value, in accordance with Art. 14(3).

[26] One layer shall be made available for each ProfileTypeValue code list value, in accordance with Art. 14(3).

[27] One layer shall be made available for each SurveyTypeValue code list value, in accordance with Art. 14(3).

[28] One layer shall be made available for each SurveyTypeValue code list value, in accordance with Art. 14(3).