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Author(s)	SEtech (Geotechnical Engineers) Ltd
Document Owner	M. Charlesworth
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Summary	This guideline defines the format for information produced during contouring activities for marine geophysical/ hydrographic survey. Used correctly the guideline facilitates easy use and reuse of the data. An Excel template is also provided if required.
Keywords	Hydrography, Geology, Bathymetric Contours, Depth Contour Map

Change history		
Version	**Date**	**Change**
1.0	18/01/2012	First draft of document
1.1	26/01/2012	QC release
1.2	09/02/2012	INSPIRE assessment finalised; Changes incorporated following QC process; Draft for MEDIN review release
1.3	27/03/2012	Changes incorporated following consultation process
1.4	29/03/2012	Changes to section 1 to reflect product guideline; final release

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1.1 Scope and Data Format for Submission to DAC (Data Archive Centre)

This guideline covers the representation of contours and isolines interpreted from hydrographic and geophysical survey. It covers the methodologies used and the derived processed data. Contour data are propagated from the following data sources:

- Bathymetry from MBES and SBES data – depth contours
- Magnetometer/magnetic gradiometer surfaces – equipotential contours
- Gravity/ Gravimeter surfaces – equipotential contours
- Single channel seismic records – structural and isoline contours (isopach and isobath)
- Multi channel seismic records – structural and isoline contours (isopach, isobath and isochron)

These data sources are documented in the following MEDIN data guidelines:

- MEDIN data guideline for multibeam echosounder (MBES) data
- MEDIN data guideline for single beam echosounder (SBES) data
- MEDIN data guideline for magnetometer/ magnetic gradiometer data
- MEDIN data guideline for gravimeter/gravity data
- MEDIN data guideline for single channel seismic (sub bottom profiler) data
- MEDIN data guideline for multi channel seismic data

Contours are either interpreted by hand or through computer software analysis methods. A defined increment is selected based on the range of the data, the resolution of the data and any cartographic charting scales applicable.

If a 1m increment is selected for bathymetry, the contour will be picked out to pass through every whole metre based on the surrounding data. There are different types of contour according to the data and its purpose, for example Isopachs reflect the depth (from seafloor or reduced water depth) of geological units, but magnetic contours will depict equipotential field lines. This is reflected in typology included in the contour data sample.

The guideline builds upon previous data specification work undertaken by International Association of Oil and Gas Producers (OGP) Seabed Survey Data Model (SSDM) (see http://www.epsg.org/ssdm.html), ICES and NGDC. The guideline considers contours as one data class, with typology specified to differentiate between different contour forms.

MEDIN has a network of Data Archive Centres (DAC) where data can be submitted for archiving by organisations wishing to share data, but do not retain long term archive facilities themselves. Contour data may be submitted as part of the overall geophysical survey data package.

Where geophysical survey data are supplied to a DAC it is recommended that the data are incorporated within a standard documented folder structure as this reduces data archiving costs. For an example folder structure refer to the BGS Offshore Acquisition Folder Structure at http://www.bgs.ac.uk/downloads/start.cfm?id=2256.

An inventory of files and their respective sizes, and supply formats and media should be provided to the DAC. This can also be incorporated within the folder structure if necessary e.g. as part of the data processing log.

This guideline documents ASCII, GIS and CAD formats transport formats suitable for contour data. ASCII is essentially a system independent file format which renders the data more readily reusable by MEDIN stakeholders and is the preferred exchange format for DACs. Contour data may also be provided in GIS and CAD formats compliant with the following geometries/ data types:

- Curve (line) geometry for delineation of depth areas as contours

Polygon geometry can be used for delineation of areas as contours, but there will also be a requirement for line geometry in some areas where a polygon cannot be constituted. Therefore for consistency line geometry is recommended. In some GIS and CAD formats the Z value of the contour line can be stored with the contour geometry and this is specified as an option.

The following documented ASCII exchange data formats are recommended, but may incur a processing overhead due to potential import issues:

ICES
Standard GF3 Subset for Digitised Contour Maps (Marine Geophysical Data)
http://ocean.ices.dk/Formats/gf3.aspx

NGDC
GEODAS 2D Vector Data Format – VCT00
http://ngdc.noaa.gov/mgg/dat/geodas/docs/vct00.htm

Guideline processed data table 2.3 defines the format suitable for processed data exchange by GIS and CAD format, and provide an extension for ASCII formats. ASCII provides a system independent file format which renders the data more readily reusable by MEDIN stakeholders. Where CAD formats are supplied, ideally the data set should be provided in its entirety in one file, in real world (as opposed to paper) coordinates.

1.2 Background to Product Guidelines

The Marine Environmental Data and Information Network (MEDIN) is working towards creating a framework of consistent standards covering the major types of data collection undertaken in the marine environment around the UK. The principle benefits of this suite of standards are:

- Allows contracting organisation to easily specify a format that data should be returned in that can be readily used and includes all relevant attributes
- Provides a consistent format for contractors to work to (rather than a different format for each contract)
- Data can be readily exported to Data Archiving Centres and other users
- Instils good practice amongst users

Each standard defines the data and information that must be stored with a particular data type to ensure it can be readily used and reused. As this type of information is specific for different data types, guidelines are developed for each type. This document describes one such format. Other standards can be accessed through www.oceannet.org.

MEDIN provides standards for data and products. This product guideline describes the necessary information which should be provided when a product has been derived from raw data. The information in the tables below should be included in a MEDIN discovery metadata record.

1.3 Using this Product Guideline

This guideline specifically relates to data products associated with or derived from acquired and processed geophysical and hydrographic data. The base data from which these data products are derived from or associated with are covered in the guidelines listed in section 1.1. The base data guidelines specify sections that refer to information that can be collated at different levels as shown below:

Project - a collection of surveys that have been completed for a common purpose
Survey - a uniquely identifiable programme of data collection such as a research cruise, moored instrument deployment or survey event
Fixed Station – a target location used as the basis for replicate sample events and for repeat monitoring surveys
Sample Event – a sample specific event of data collection
Sampling Methodology (Data Production Tools) – Details of any method or instruments used to collect the data
Sample Data – the data

Where geophysical data are documented the terminology for the MEDIN guidelines sections differs slightly: Sample Event is termed '**Line Event**', Sampling Methodology is termed '**Acquisition Methodology**' and Sample Data are termed '**Processed Data**'. Processed data will most commonly be documented in the Processed Data section as the data volumes concerned with geophysical data normally require that raw data be provided in industry logged formats designed to store large volumes of data efficiently.

For products it is not necessary to include project and survey metadata on this basis; instead a MEDIN discovery metadata record should be provided. This approach is specified to accommodate derived products that may be collated from single or multiple projects and surveys. The MEDIN discovery metadata record should however reflect:

1) the sources of data which have been used to derive the product which is typically information contained in the Project, Survey, Sample/ Line Event and Sampling/Acquisition Methodology tables of the originating data guidelines.
2) the information in the following tables which will allow users to understand how the product has been derived

The information can be reflected using the discovery metadata elements abstract, geographical bounding box, temporal reference/extent, vertical extent, lineage, spatial resolution and additional information (link to external reports/ source) metadata elements.

Within this product guideline the following optional tables are also provided:

Data Extent – to reflect the derived data extent; information documented here can also be included within the discovery metadata as an alternative

Derivation Methodology (Data Production Tools) – to document data processing and interpolation; information documented here can also be included within the discovery metadata as an alternative

The tables below outline the product fields, a description and where available a term list and/or format given at the end of each field which should be used to store the information. Each field is either mandatory, conditional or optional as indicated by M, C, or O respectively. Conditional means that the field must be completed if a value is known. In the absence of an existing spreadsheet or database to hold the below information, it is recommended that the template available to download from the MEDIN website is used. Instructions are provided in the template.

In the event that historical data which does not have all the necessary mandatory fields is being configured into this guideline, then it is permissible to use the following entry terms:

Term	Description
unknown	The correct value is not known to and not computable by the creator of this information. However a correct value probably exists.
inapplicable	There is no appropriate value. To be used in cases where metadata elements cannot be set null due to schema constraints.

In some cases it may be necessary to extend this guideline for a specific purpose such as a specific exchange of data between applications or to fulfil the needs of a specific project. This is permissible however we advise that the broad structure and format is maintained and that where possible controlled vocabularies are used. As any extension to the structure and format may be useful for other organisations please inform MEDIN of further agreements.

1.4 Further information on the SeaDataNet, ICES and EPSG term lists

The available catalogues of term lists used for this MEDIN data guideline are provided primarily by SeaDataNet, the International Council for the Sea (ICES) and EPSG. If a term is not available in a recommended list then please contact MEDIN to arrange for the term to be added.

The SeaDataNet list may be viewed at http://seadatanet.maris2.nl/v_bodc_vocab/welcome.aspx . By clicking on the list any term may be searched for by using the drop-down menus or all terms viewed by clicking search. The terms may be viewed in groups of 15 or may be downloaded into an excel file.

The ICES term lists are available at http://www.ices.dk/datacentre/reco/
Select which list you require from the ‘Reference Code List’ drop-down box. The results are shown for the selected list and may be downloaded into MS Excel by selecting the inverted green arrow.

There are a number of ways of describing a spatial dataset. Common horizontal coordinate reference systems include WGS84 and British National Grid. Common vertical coordinate reference systems include Highest Astronomical Tide and Ordnance Datum Newlyn (ODN). It is important that which coordinate reference system used for a data set is recorded so conversions can be carried out between reference systems. The EPSG database of coordinate reference systems (http://www.epsg.org/Geodetic.html) provides a dictionary of reference systems. In brief, to find a code click on the OGP Online Registry and if you know the title (eg WGS84) then type this in the ‘Name’ field and click search. The

name, code and further information is displayed. If you are looking for a specific type of reference system such as ‘vertical’ then click in the ‘Type’ box, hover over coordinate reference system and click on vertical and then click the search button and all recorded vertical reference systems are shown. If you want to search for a reference system in a particular part of the world (e.g. Northern Ireland Grid) the you may do so by submitting a term to the ‘Area’ box or fill out the lat and longs then click search. The website also provides a database of the reference systems and web services to access the information.

1.5 Updates and Feedback

If you have any comments or feedback on this guidelines please contact enquiries@oceannet.org . Standards develop over time and it is likely that this standard will change in the future. We advise that you return to the oceannet website to identify new versions and that you sign up to the MEDIN Standards e-mail listing (e-mail mecha@bodc.ac.uk) and Marine Data News to be kept informed of developments.

2.1 Derivation Extent (Contouring) This is an **optional** table which holds processing and data extent information for the processed contour data. The information contained here can be stored in the MEDIN discovery metadata record instead and for some software this information is automatically generated within the metadata for the data product. This information can be completed for each type of contour data product derived from the survey as required.

M, C, O indicate which fields are M - mandatory (must be filled in), C - conditional (must be filled in if exists in data resource), or O - optional respectively.

Heading	M, C, O	Description	Recommended Term List or Format
Product Identifier	M	A unique identifier for the product under consideration. Replicate identifiers should be suffixed to the end of a sample identifier using an underscore such as _1 or _a. Can be a file name specific to the product	Free text; e.g. E5, PHJ7936 GB004_1 GB004_3 Contours.shp
Start Date and Time	M	The start date/time of derivation	yyyy-mm-dd or yyyy-mm-dd hh:mm:ss e.g. 2009-01-24 13:33:00
Minimum KP/ Distance along	O	Minimum chainage according to kilometre post (KP) scheme or length and direction of programmed line/ transect. For contours that may be in sections along a route	Decimal kilometres for KP scheme e.g. 1.005 Decimal metres for distance scheme e.g. 1005.00
Minimum X Coordinate	M	The minimum X coordinate of the product, longitude or easting as per the defined coordinate reference system. For longitude, east is positive and west is negative.	Decimal degrees; minimum of six decimal places. e.g. -3.476363 **Or** Decimal Number; Units = metres e.g. 234865.55
Minimum Y Coordinate	M	The minimum Y coordinate of the product, latitude or easting as per the defined coordinate	Decimal degrees; minimum of six decimal places.

Heading	M, C, O	Description	Recommended Term List or Format
		reference system. For latitude, north is positive and south is negative.	e.g. 54.583736 **Or** Decimal Number; Units = metres e.g. 5963487.00
End Date and Time	M	The end date/time of the derivation	yyyy-mm-dd or yyyy-mm-dd hh:mm:ss e.g. 2009-01-24 13:33:00
Maximum KP/ Distance along	O	Maximum chainage according to kilometre post (KP) scheme or length and direction of programmed line/ transect. For contours that may be in sections along a route	Decimal kilometres for KP scheme e.g. 125.023 Decimal metres for distance scheme e.g. 125023.00
Maximum X Coordinate	M	The maximum X coordinate of the product, longitude or easting as per the defined coordinate reference system. For longitude, east is positive and west is negative.	Decimal degrees; minimum of six decimal places. e.g. -3.476363 **Or** Decimal Number; Units = metres e.g. 234865.55
Maximum Y Coordinate	M	The maximum Y coordinate of the product, latitude or easting as per the defined coordinate reference system. For latitude, north is positive and south is negative.	Decimal degrees; minimum of six decimal places. e.g. 54.583736 **Or** Decimal Number; Units = metres e.g. 5963487.00
Upper contour value	C	The maximum contour value	Decimal number; e.g. 24.3
Lower contour value	C	The minimum contour value	Decimal number; e.g. 24.6

Heading	M, C, O	Description	Recommended Term List or Format
Time Zone	C	Give the time zone in which the date and time of the data derivation is made, if different to the survey time zone (preferably Coordinated Universal Time (UTC))	Free Text; e.g. UTC
Spatial coordinate reference system	C	Describe the system of spatial referencing if different to main survey spatial referencing. (See section 1.4 on accessing term lists).	Term List; http://www.epsg.org/Geodetic.html e.g. WGS84 code: EPSG::7030; British National Grid (projected) code: EPSG::27700; ETRS89 / UTM zone 28N code: EPSG::25828; ETRS89 / UTM zone 29N code: EPSG::25829; ED50 code: EPSG::4230; UTM31N code: EPSG::23031

2.2 Derivation Method (Data Production Tools) This is an **optional** table to document the processing undertaken to derive the data product. The information contained here can be stored in the MEDIN discovery metadata record as an alternative. The information in this table can be completed for each data product under consideration. Where a survey or processing report has been provided reflecting the information contained within this table, the table does not need to be completed, however reference to the report should be made in the MEDIN discovery metadata record.

M, C, O indicate which fields are M - mandatory (must be filled in), C - conditional (must be filled in if exists in data resource), or O - optional respectively.

Heading	M, C, O	Description	Recommended Term List or Format
Product Identifier	M	A unique identifier for the product under consideration. Replicate identifiers should be suffixed to the end of a sample identifier using an underscore such as _1 or _a. Define for each class/type of contour. Can be a file name specific to the product	Free text; e.g. E5, PHJ7936 GB004_1 GB004_3 Contours.shp
Processing Type	M	Indicate how the contour product was achieved	Text; from list Interpretation by hand on charts Interpretation by hand with software Software analysis and generation
Analysis Software	C	State processing and analysis software	Free text; e.g. ESRI ArcGIS 3D Analyst
Analysis Software Version	O	State processing and analysis software version	Free text; e.g. v10.1
Processing organisation	C	The organization(s) that processed the data if different from the collector identified in 2.2 Originator. Contact MEDIN to add an organization to this list	Term List; European Directory of Marine Organisations http://www.seadatanet.org/Metadata/EDMO e.g. 2588 ABP Marine Environmental Services Ltd

Heading	M, C, O	Description	Recommended Term List or Format
Storage medium	O	The storage medium used for the data	Free text; e.g. 1TB Portable Hard drive, DVD, Dell Precision R5500, 4TB RAID 5 external hard drive
Storage Format	O	Data format for processed data products	Free text; e.g. ESRI shape file for contour lines
Processing personnel	O	Names of the personnel who were involved in processing the contour data	Free text; personnel name(s) separated by semi-colon if more than one personnel involved; indicate organisation name in brackets if more than one organisation involved. e.g. John Doe; Henry Rice (MEConsulting) GIS Data Processing; Harriet Smith (MarineConsult) Contour Interpretation; Jamie Creed (MarineConsult) Quality Control
Processing notes	O	Any further notes on data processing that may be of relevance.	Free text; e.g. Contours were generated at 1m and 5m intervals
Processing QC notes	O	Any further notes on data processing that may be of relevance.	Free text; e.g. QC procedure applied using Integrated Management System procedures
Quality control scheme	O	Description of any quality control scheme that data were audited under during the processing	Free text; e.g. Data audited using outcomes defined in scope of work

2.3a) Contour Data When providing the contour data it must be provided with the MEDIN discovery metadata record. The preferred format for contour data are where each contour is represented in as continuous a line as possible. The following table is based on the OGP SSDM GIS feature classes Isochron, Isopach, and Bathymetry_Contours.

M, C, O indicate which fields are M - mandatory (must be filled in), C - conditional (must be filled in if exists in data resource), or O - optional respectively.

Heading	M, C, O	Description	Recommended Term List or Format
Product Identifier	M	A unique identifier for the product under consideration. Replicate identifiers should be suffixed to the end of a sample identifier using an underscore such as _1 or _a. Define for each class/type of contour. Can be a file name specific to the product	Free text; e.g. E5, PHJ7936 GB004_1 GB004_3 Contours.shp
Survey Code Identifier	O	The survey code can be stated to allow links to be built to the original survey (where one survey = one data product set)	Free text; e.g. http://www.noc.ac.uk/JCR3022; http://www.bennett.ac.uk/RIBJULY_03_01)
Survey End Date	O	Option to provide a temporal reference based on survey end date	yyyy-mm-dd or yyyy-mm-dd hh:mm:ss e.g. 2009-01-24 13:33:00
Feature ID	M	Unique numeric identifier for the contour line	Number; e.g. 1
Contour Type	M	Type of contour depicted; as an alternative this can be included in the file name.	Text; From list: Structural Isopach Isochron Isobath Bathymetric Equipotental Gravity

Heading	M, C, O	Description	Recommended Term List or Format
			Equipotental Magnetic
Contour Value	M	Value represented by contour	Decimal Number; e.g. 2.5
Surface or Structure Description	O	Option to describe the structure or surface contoured where applicable	Free text; e.g. Top of chalk Base of Unit C
Reflector Number	C	State the shallow reflector number the profile relates to as applicable	Text; Recommended term list from OGP SSDM Domain REFLECTOR_NUMBER Reflector 1 ……. Reflector 20
Geologic Unit	C	State the shallow geologic unit the profile relates to as applicable	Text; Recommended term list from OGP SSDM Domain GEOLOGIC_UNIT Unit A ….. Unit E
Horizon	C	State the intermediate geologic horizon the profile relates to as applicable	Text; Recommended term list from OGP SSDM Domain GEOLOGIC_HORIZON Horizon 1 ….. Horizon 20
Stratigraphic Sequence Number	C	Stratigraphic sequence number of profile element for survey	Number; e.g. 2
Vertical Datum/ Elevation Reference	C	Specify reduced water depth vertical datum or elevation reference	Term List; SeaDataNet depth measurement reference planes (L111) e.g. LAT e.g. sea_level
Contour Class	O	Contour classification – optional specification for cartographic purposes	Text; From List Major Minor
Contour Interval	O	Optional specification of contour	Free Text;

Heading	M, C, O	Description	Recommended Term List or Format
		interval	e.g. 1m
Contour Units	O	Option to specify contour units	Text; From List: Metres TWT ms nT nT/m mGal m/s^2
CAD Layer Name	C	CAD Layer Name (if applicable)	Free text; e.g. Bathymetric_Contours
Source Data	O	Source data from which contours were derived	Free text; e.g. MBES and SBES data sets for area
Remarks	O	Option to store remarks if required	Free text; e.g. contours smoothed
Geometry	C	Storage of contour geometry	Curve (line) Z storage optional

2.3b) Contour Data – ASCII/ Excel Extension

The information in table 2.3a) is included in a header in an ASCII file or placed in a worksheet of a Microsoft Excel file. Instead of using the GIS geometry as specified in table 2.3a), for the provision of coordinates the following listing is recommended, either underneath the header information in an ASCII file or in a second worksheet in Excel:

Product ID	Feature ID	Elevation	X	Y
Product Identifier	*Number*	*Decimal*	X1	Y1
Product Identifier	*Number*	*Decimal*	X2	Y2
Product Identifier	*Number*	*Decimal*	*Xn*	*Yn*

The Product ID and Feature ID column allows multiple contours to be defined, for one distinct product set in table 2.3a). A new data set should be instigated for a new set of contours for a certain product identifier.

APPENDIX - INSPIRE Compatibility Analysis

MEDIN is registered as a Spatial Data Interest Community with INSPIRE and complies with the requirements of INSPIRE metadata implementing rules. MEDIN is also working towards compliance with web service and data implementing rules. This section of the guideline provides an assessment of compliance for this data type with Annex I, II & III data themes and data model implementing rules.

The INSPIRE data model is built on the foundation schemas ISO/TC211 Geographic Information/ Geomatics (includes metadata), EarthResourceML and GeoSciML. These schemas are designed for encoding data within XML (GML) data services and data transport formats. The data structure is hierarchical/object-oriented in nature. A base or main application schema defines the common spatial object types, data types and union data types (which provide a choice of data structure for the same element). Reusable application schemas are then linked to the main schema according to the type of data.

There are two main packages that directly encompass contours: INSPIRE Annex II Data Specification for the Elevation theme and Annex III Data Specification for Sea Regions – Extension.

The Elevation application schema Elevation – Vector Elements provides data specifications for storing Contour Lines and Depth Contours. The Sea Regions – Extension application schema provides data specifications for storing Marine Isolines.

The Elevation – Base application schema is defined to store the following common properties:

- Data type ElevationReference/ElevationCRSReference provides the following attributes to store information about the coordinate reference system (CRS):
    - Storage of origin of vertical CRS (datumPosition)
    - Storage of water level value (enumerated) datumWaterLevel
    - Definition of the measured elevation, enumerated as height or depth (ElevationCRSReference)
    - verticalCRSIdentifer for storing the identifier from a vocabulary; namely the EPSG Id
    - verticalCRSName for storing the text identifier for the vertical CRS
- Feature/spatial object type ElevationDataSet, which defines the data set, with the attributes dataSetName and Extent
- Feature/spatial object type ElevationFeature, a child (components) of ElevationDataSet for which attributes beginLifeSpanVersion (date/time) and endLifeSpanVersion (date/time) are stored, along with an Inspire identifier
- ElevationPropertyTypeValue – height or depth

- SurfaceTypeValue – DTM (digital terrain model) or DSM (digital surface model), in this case digital surface model best describes bathymetry

The Elevation – Vector Elements package is of prime relevance for the storage of bathymetry contours. This package is linked through ElevationFeature in the Elevation Base package and inherits the ElevationReference from this package. Within Elevation – Vector Elements feature/spatial object type Elevation Vector Object is the primary feature type and Elevation Line feature/spatial object type is defined as a child. ContourLine and DepthContour are defined as children/subtypes of ElevationLine.

ElevationLine is defined to store a GM_Curve (line) as the representation of the contour, for which the attributes ElevationPropertyTypeValue (height or depth) and the propertyValue (measure), i.e. the value represented by the line are stored.

Spatial object type DepthContour is a child of Elevation Line and provides storage mechanism for the following additional attributes:

- contourLineType – master, ordinary or auxiliary
- elevationCase (yes or no, to indicate if depth contour represents and area with a depth lower than itself)
- equidistance (to indicate contour interval)

The Sea Regions – Extension application schema could possibly be used to store isoline type contours, specifically isopach and isobath.

The spatial object type MarineIsoLine is defined within this application schema as a GM_Multicurve (multiline) and stores the following attributes:

- Number of contours
- Contour values
- Phenomenon - property represented by the contours, could be used to store the feature represented e.g. top of chalk
- Valid time

It is specified that MarineIsoLine should be derived from an OceanGeographicFeature of the same phenomenon to provide an overview of the phenomena. This would require that geophysical features are stored within a package intended for oceanographic observation, instead of utilising the geophysics packages provided. This could possibly be achieved through utilisation of the Geophysics Extension schema, which provides more flexible approaches to data storage in that the ISO 19156 Observations and Measurements schema is utilised; this package is also used to form the Ocean Geographic Features application schema.

It is not possible to identify a clear structure for storing contours of magnetic and gravity equipotential. The surface grid model in the Annex II Geophysics Core application schema facilitates the storage of magnetic and gravity surface models, but there is not a clear contour representation mechanism as is shown between MarineIsoLine and OceanGeographicFeature above. There may be potential to use the spatial object types GeophProfile or GeophModel.

All candidate data for inclusion within the INSPIRE framework require defined processes to transform the data from a flat file or GIS format to the spatial data model specified with the INSPIRE Annex themes specifications. The information provided here is intended as verification of the data against the INSPIRE data specification in readiness for inclusion.