

The INSPIRE harmonisation: the Geological Map of Italy at 1:100,000 scale

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Abstract: The INSPIRE Directive institute a European infrastructure for spatial information to support the environmental policies of the European Union. In the mainframe of the Directive, 34 different themes that represents different environmental information has been identified. One of this is the Geology theme; it is split into three sub-themes and represent a "reference data theme" because it provides basic knowledge on the physical properties and composition of rocks and sediments, their structure and their age as represented in geological maps, as well as geomorphological features.

In the feature catalogue of the INSPIRE application schema Geology has been defined the term lists for the information types. Some of these are fully compliant with the features defined in the 1:100.000 scale geological map database and are used in the semantic harmonization procedure

Keywords: Geological map of Italy, INSPIRE, GeoSciML, Open Data

1. Introduction

The foundation of the Royal Geological Survey of Italy as a Section of the Royal Corps of Mine occurred on 15 June 1873, establishing the conditions for a systematic geological survey and mapping of the whole Italian territory. The main institutional task of the Geological Survey was, in fact, the "formation and publication of the Geological Map of Italy". Following an initial organizational phase, the geological field activity started in 1877 and continued, with alternating events, until 1976. In this long span of time, have been realized 277 geological sheets at the scale of 1:100.000, most of them in two different editions that complete the entire Italian territory (Figure 1).

The geological cartography produced during this period reflects the enormous evolutionary process of both geological knowledge and cartographic technologies. This problem reflects, in the first instance, the extreme terminological inhomogeneity in the description of the geological characteristics of rock bodies. In addition, the evolution of geological sciences has allowed the introduction of innovative scientific concepts, geological elements and cartographic symbols compared to the maps produced in the early stages of the project. An attempt to solve this problem was addressed, but only partially realized, producing a second edition of the geological cartography. In fact, thanks to a special "cartographic law", in 1960 started a second phase of the project aimed to the completion of the cartography and to a renewal of

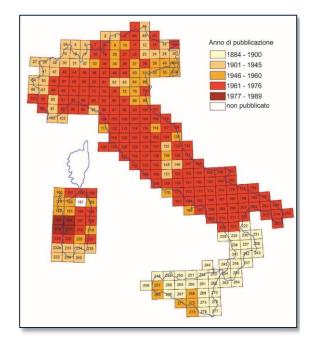


Figure 1. State of realization of the Geological map of Italy 1:100,000 scale.

out-of-date geological maps. With the National Law 68/1960, the Geological Survey of Italy becomes one the National Cartographic Agencies in Italy.

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At the end of the project, officially closed in 1989, the informatization of cartographic data was not yet in use, nor the widespread use of geographic information systems, at least in Italy. For this reason, for many years the only possibility to study and consult geological cartography was through printed sheets.

In the occasion of the 32^{nd} International Geological Congress that was held in Florence in 2004, the Geological Survey of Italy launched a process to scan in raster format and digitise the 277 geological sheets.

2. To apply the geological INSPIRE data model to produce a harmonized geological map.

The INSPIRE implementation rules on interoperability of spatial data sets and services and guidance documents on data specification are based on the UML data models developed by the INSPIRE thematic working groups. These data models are maintained in a common UML repository, which also stores previous revisions of the models.

The rules for applying the INSPIRE UML model for the geology theme are illustrated in a wide document, in this case is the INSPIRE Data Specification for the Geology spatial data theme, which explain how to mapping each single table from the original database to the UML model (https://inspire.ec.europa.eu/id/document/tg/ge).

The original data following a detailed procedure, highresolution tiff files were acquired from which the following shape files were obtained: UNI GEOL Geological units in polygonal form); STRATIM (dip and azimuth of geological bodies, points); SIMBOLI (geological symbols, point); FAGLIE (faults, lines); PIEGHE (folds, lines); TERRAZZI (marine and fluvial erosional or depositional surfaces, polygons); SEZIONI (trace of geological sections, lines). In addition, a database has been produced which, by linking a unique identifier to each polygon on the map, contains all the information derived from the description of the rock bodies as in the legend units: name of the lithostratigraphic unit, geological age, lithology, depositional environment, texture, and layering.

A subset of the field contained in the database has been elaborated following the guidelines and the data specification of the INSPIRE directive (https://inspire.ec.europa.eu/).

The features mapped to the INSPIRE data model consists of CollectionType, MappedFeatures, GeologicUnit, CompositionPart, GeologicEvent.

The elaborated data model permitted us to define the following attributes:

- LithologyValue1,
- CompositionPartRole,
- LithologyValue2,
- LithologyValue3,
- GeochronologicEra,
- EventEnvironment,
- EventProcess,
- Foliation.

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	http://inspire.ec.europa.eu/codelist/LithologyValue
is version:	http://inspire.ec.europa.eu/codelist/LithologyValue:1
est version:	http://inspire.ec.europa.eu/codelist/LithologyValue
sel:	Lithology
finition:	Terms describing the lithology.
scription:	EXAMPLE: granite, sandstone, schist.

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Themes:	Geology						
Application schema:	Geology						
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andesite	fin	e grained igneous rock		eu-technical		Valid	
anorthosite	an	orthositic rock		eu-technical		Valid	
anorthositic rock	ph	aneritic igneous rock		eu-technical		Valid	
anthracite coal	c0	coal		eu-technical		Valid	
anthropogenic consolidated material	an	anthropogenic material		eu-legal		Valid	
anthropogenic material		compound material		eu-legal		Valid	
anthropogenic unconsolidated material	an	thropogenic material		eu-legal		Valid	
aphanite		rock		eu-legal		Valid	
apite		phaneritic igneous rock		eu-technical		Valid	
arenite		sandstone		eu-technical		Valid	
ash and lapill				eu-technical		Valid	
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basic igneous rock		basic igneous material		eu-technical		Valid	
bauxite		material formed in surficial environment		eu-technical		Valid	
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Figure 2. *Example of LithologyValue from the Registry* (https://inspire.ec.europa.eu/codelist/LithologyValue)

The advantage of sharing data in a standard format allows information to be available at European level. In particular, the terms used for harmonization are part of vocabularies present as codelists shared at European level. Each term refers to a URL maintained in the INSPIRE Registry which explains in detail the term that is associated.

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🕑 Help us improving the Re	3gistry software ! Please fill our quick s	urvey at http://europa.eu/!Bn84Ct 🖒					
ID:	http://inspire.ec.europa.eu/co	delist/LithologyValue/basalt					
This version:	http://inspire.ec.europa.eu/co	http://inspire.ec.europa.eu/codelist/Litholog/Value/basalt:1					
Latest version:	http://inspire.ec.europa.eu/co	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt					
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Figure 3. Example of Basalt description

(https://inspire.ec.europa.eu/codelist/LithologyValue/ba salt).

Proceedings of the International Cartographic Association, 4, 2021.

	LithologyValue 🕈	LithologyURI	EventENV	EventENVURI	EventProc	EventProcURI
3962	basalt	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt	terrestrialSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/terrestrialSetting	effusiveEruption	http://inspire.ec.europa.eu/codelist/Eve
3963	basalt	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt	terrestrialSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/terrestrialSetting	effusiveEruption	http://inspire.ec.europa.eu/codelist/Eve
3964	basalt	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt	terrestrialSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/terrestrialSetting	effusiveEruption	http://inspire.ec.europa.eu/codelist/Eve
3965	basalt	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt	terrestrialSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/terrestrialSetting	effusiveEruption	http://inspire.ec.europa.eu/codelist/Eve
3966	basalt	http://inspire.ec.europa.eu/codelist/LithologyValue/basalt	terrestrialSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/terrestrialSetting	effusiveEruption	http://inspire.ec.europa.eu/codelist/Eve
3967	biogenic silica	http://inspire.ec.europa.eu/codelist/LithologyValue/bio	marineSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/marineSetting	organicAccum	http://inspire.ec.europa.eu/codelist/Eve
3968	biogenic silica	http://inspire.ec.europa.eu/codelist/LithologyValue/bio	marineSetting	http://inspire.ec.europa.eu/codelist/EventEnvironmentValue/marineSetting	organicAccum	http://inspire.ec.europa.eu/codelist/Eve
4						•

Figure 4. Attribute table obtained by the Geodatabase. Example of Basalt *LithologyValue* and relative URI is reported. Standard descriptions of other attributes as *Event Process* and *Event Environment* are also available.

In some cases, reference was also made to the GeoSciML standard in order to facilitate the harmonisation process. This is a more complex standard focused on the geological information (http://geosciml.org/). In particular, this standard provides for the description of lithology and foliation, which is missing in the INSPIRE

data model but is important for the geological information.

All the attributes facilitate the realization of different thematic geological maps (Figure 5).

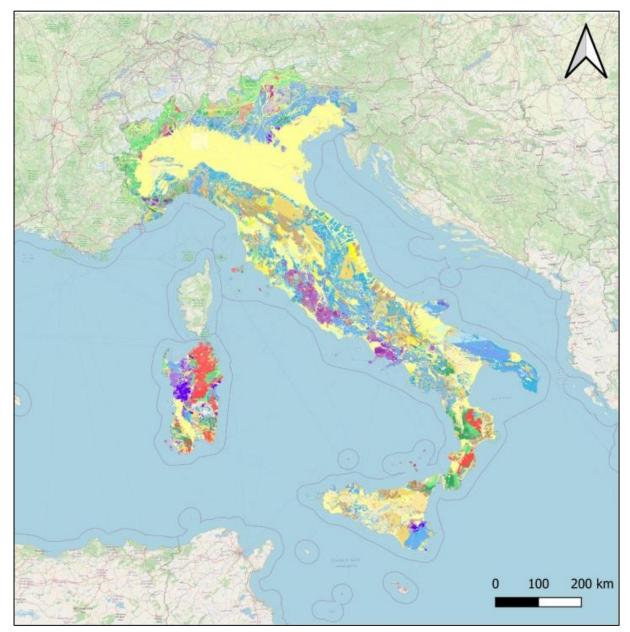


Figure 5. Thematization of the features *LithologyValue1* derived from the harmonized geological map.

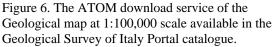
3. Data sharing

It will be possible to download the harmonized data in different formats. For example, the gml format (Geography Markup Language File) is the one provided by the European Commission in order to validate the compliance structure with the standard.

The gml is an XML based encoding standard for geographic information developed by the OpenGIS Consortium (OGC); in addition it is possible to download the data also for more immediate use, for example GeoPackage, an open, standards-based, platformindependent, portable, self-describing, compact format for transferring geospatial information, or compressed shape file download in the ATOM structure (it comprises an XML-based format that describes an ATOM feed and the items of information in it, and a protocol for publishing and editing ATOM feeds).

All these downloads are available within the associated metadata. The metadata file contained in the catalogue of the Portal of the Geological Survey of Italy (SGI) and in the National Directory of Spatial Data (RNDT) is built in accordance with the INSPIRE Directive. In the SGI Portal an example of ATOM download service (Figure 6) available is the Geological map at 1:100,000 scale (https://catalogosgi.isprambiente.it/geoportal2/catalog/sea rch/resource/details.page?uuid=ispra_rm% 3A2020Geolo gica100k_SVD).





Lastly the Portal is harvested every year from the INSPIRE Geoportal to verify the compliance and to show the contents.

All datasets are reusable whit the licence CC BY 4.0 license.

4. Acknowledgements

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5. References

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