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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).

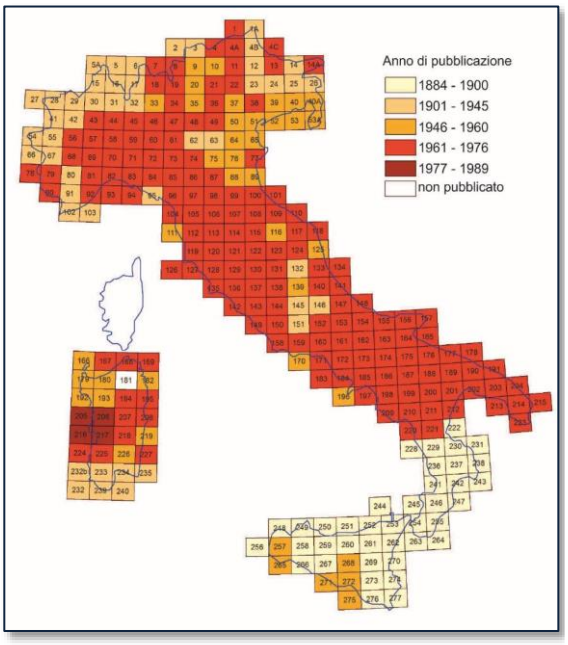

Figure 1. State of realization of the Geological map of Italy 1:100,000 scale.

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 out-of-date geological maps.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

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 32nd 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, high-resolution 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.

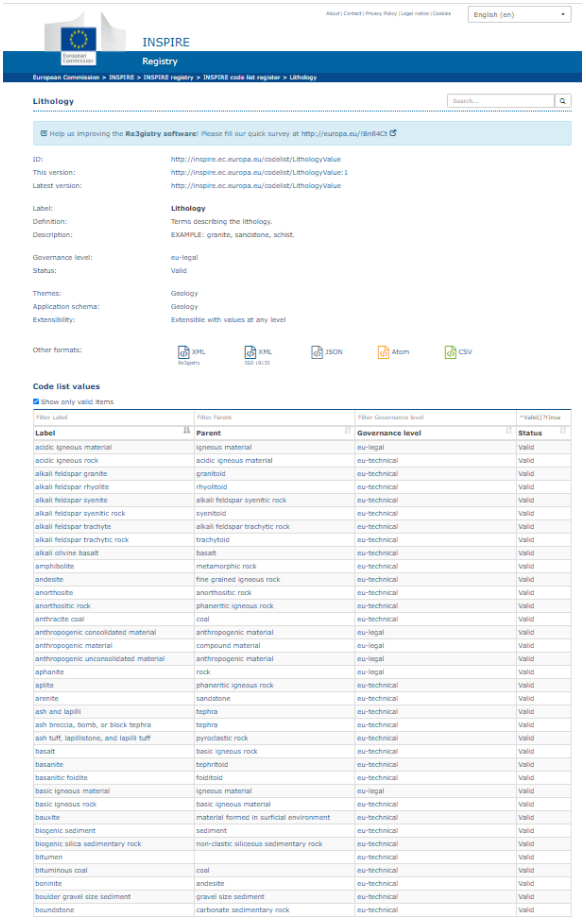

Figure 2. *Example of LithologyValue from the Registry* (https://inspire.ec.europa.eu/codelist/LithologyValue)

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.

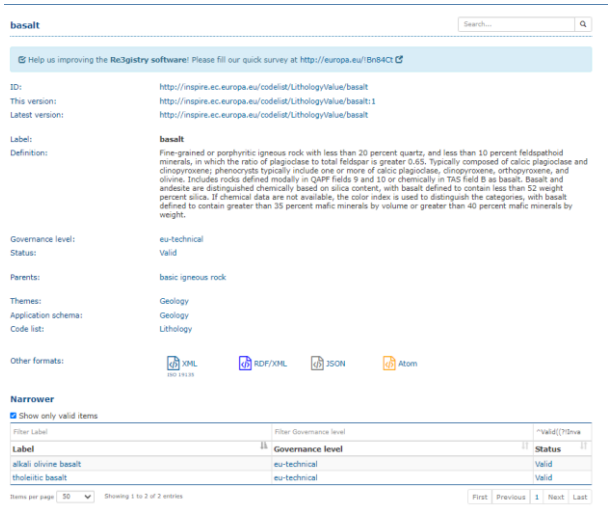

Figure 3. Example of Basalt description (https://inspire.ec.europa.eu/codelist/LithologyValue/basalt).

	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...

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).

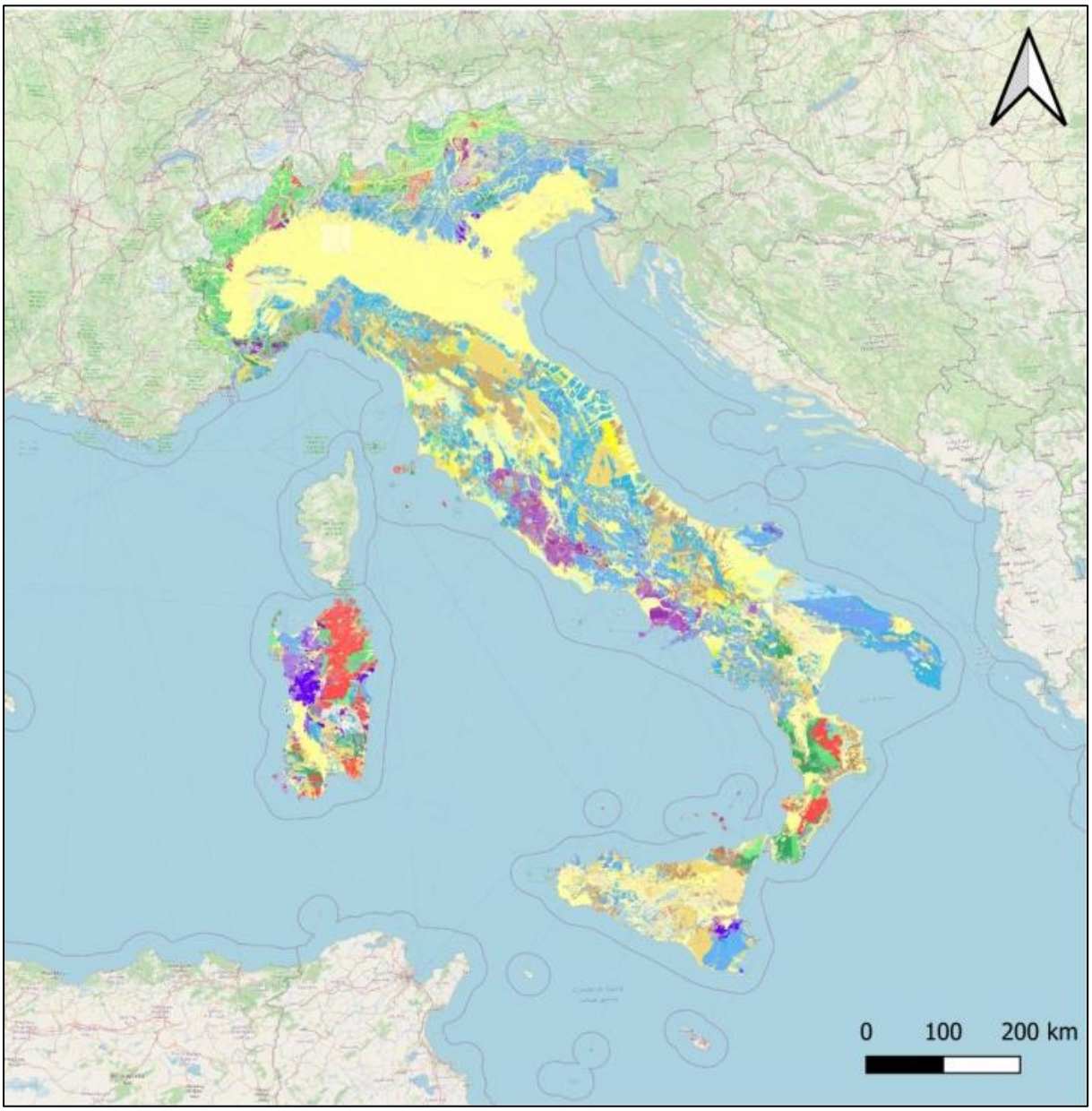

Figure 5. Thematization of the features *LithologyValue1* derived from the harmonized geological map.

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30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-85-2021 | © Author(s) 2021. CC BY 4.0 License.

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, platform-independent, 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/search/resource/details.page?uuid=ispra_rm%3A2020Geologica100k_SVD).

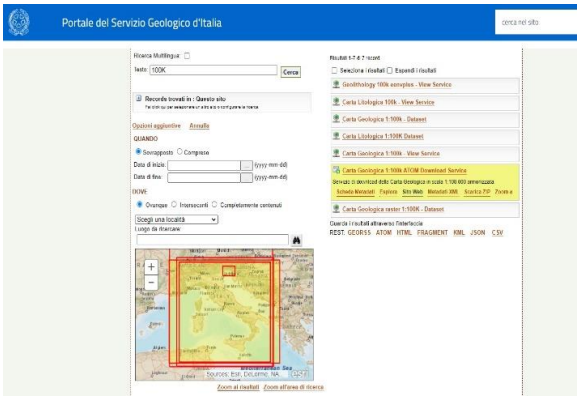

Figure 6. The ATOM download service of the Geological map at 1:100,000 scale available in the Geological Survey of Italy Portal catalogue.

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

Campo, V. and Delogu, D. (2020). Il portale del Servizio Geologico d'Italia: i dati geologici del territorio nazionale alla portata di tutti. Geologia dell'Ambiente, 1/2020, 25-29.

Open Geospatial Consortium (2016). OGC Geoscience Markup Language 4.1 (GeoSciML). Open Geospatial Consortium, 234 pp.

INSPIRE Thematic Working Group Geology (2013). D2.8.II.4 INSPIRE Data Specification on Geology – Technical Guidelines. European Commission Joint Research Centre, 351 pp.

Pantaloni, M., Galluzzo, F. and Marino, M. (2016). Gli aspetti scientifici della Carta geologica d'Italia alla scala 1:100.000. In: Console F., Pantaloni M., Tacchia D. (Eds.). Mem. Descr. Carta Geol. d'It., 100, 106-121.