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How semantics can inform the geological mapping process and support intelligent queries

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The geologic mapping process requires the organization of data according to
the general knowledge about the objects, namely the geologic units, and to
the objectives of a graphic representation of such objects in a map, following an established model of geotectonic evolution.
Semantics can greatly help such a process in two concerns:
the provision of a terminological base to name and classify the objects of the map; on the other, the implementation of a machine-readable encoding of the geologic knowledge base supports the application of reasoning mechanisms and the derivation of novel properties and relations about the objects of the map.

The OntoGeonous initiative has built a terminological base of geological knowledge in a machine-readable format, following the Semantic Web tenets and the Linked Data paradigm.
The major knowledge sources of the OntoGeonous initiative are GeoScience Markup Language schemata and vocabularies (through its last version, GeoSciML 4, 2015, published by the IUGS CGI Commission) and the INSPIRE “Data Specification on Geology” directives (an operative simplification of GeoSciML, published by INSPIRE Thematic Working Group Geology of the European Commission).
The Linked Data paradigm has been exploited by linking (without replicating, to avoid inconsistencies) the already existing machine-readable encoding for some specific domains, such as the lithology domain (vocabulary Simple Lithology) and the geochronologic time scale (ontology "gts").
Finally, for the upper level knowledge, shared across several geologic domains, we have resorted to NASA SWEET ontology.
The OntoGeonous initiative has also produced a wiki that explains how the geologic knowledge has been encoded from shared geoscience vocabularies (https://www.di.unito.it/wikigeo/). In particular, the sections dedicated to axiomatization will support the construction of an appropriate data base schema that can be then filled with the objects of the map.

This contribution will discuss how the formal encoding of the geological knowledge
opens new perspectives for the analysis and representation of the geological systems.
In fact, once that the major concepts are defined, the resulting formal conceptual model of the geologic system can hold across different technical and scientific communities. Furthermore, this would allow for a semi-automatic or automatic classification of the cartographic database, where a significant number of properties (attributes) of the recorded instances could be inferred through computational reasoning.
So, for example, the system can be queried for showing the instances that satisfy some property (e.g., "Retrieve all the lithostratigraphic units composed of clastic sedimentary rock") or for classifying some unit according to the properties holding for that unit (e.g., "What is the class of the geologic unit composed of siltstone material?”).