GEOLOGY ONTOLOGIES AND DATA MINING: CONCEPTUAL MODELS FOR KNOWLEDGE DISCOVERY, INTERPRETATION AND INFORMATION SEARCH

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Non-ambiguous communication between people inside a technical community demands a common, well-defined vocabulary. If the vocabulary is applied to support software development, the terminology requires an explicit semantic definition that can be processed and understood by computers. Ontology is a logical theory accounting for the intended meaning of a formal vocabulary. The theory supports the creation of artifacts (models that can be stored, transferred, or processed) that specifies the key concepts, properties, relationships, and axioms of a given domain and are employed by software systems in several distinct tasks. In the last decades, we were dedicated to developing Geology ontologies in several subareas of the petroleum exploration domain. Some of these ontologies are publicly available under Creative Common License, while others are under industry rights. Here, we describe a catalog of ontologies and applications developed by the research group. Petroledge® is a software application for reservoir, source and seal rock characterization that allows the detailed description of petrographic features that affect the quality of carbonate and siliciclastic reservoir. The 2-thousand terms of Petroledge® ontology define and describe the rock texture and sedimentary structures, the primary and diagenetic rock composition and pore types, grain habits, contact and modifiers, and the paragenetic relations that allow interpretation of diagenetic evolution of the reservoir. The ontology supports several IA methods for automatic geological interpretation, such as the rock classification based on the original and actual composition, burial history, the sediment's provenance, and the diagenetic environment. The ontology-controlled petrography reports allow the application of classical K-Means data mining methods combined with wrapper genetic algorithms for selecting features and grouping clusters related to rock porosity types and quantity. We have also developed a complete ontology of lithologies, structures, textures, and fossil content that supports the Strataledge® application for core and outcrop description, covering all rock classes. The ontology of 1500 terms associates each petrographic vocable to a visual icon used in a visual interface for description, while the formalized terminology supports automatic classification, data mining, and software-generated reports in several graphical and textual formats. The creation of the GeoCore ontology significantly increased the production of geology ontologies. This core ontology contains well-founded definitions of a limited set of very general concepts considered by all geologists in any geology subdomain. Its conceptual framework considers separately a geological object, the substance that constitutes it, the boundaries that limit it, and the rock's internal arrangement inside it. The small set of formally defined concepts specialized from the upper Basic Formal Ontology (BFO) provides a backbone for deriving more specialized geological concepts while establishing a baseline for integrating different existing domain ontologies. Recently, we proposed a conceptual framework for the formalization of processes in geological history modeling. This robust framework has allowed the development of information retrieval, image indexing, and geological interpretation applications. The defined ontologies and ongoing work are accessible on https://github.com/orgs/BDI-UFRGS.

PALAVRAS-CHAVE: ONTOLOGY, GEOLOGY DOMAIN MODEL, INFORMATION INTEGRATION