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Conceptual tools for the management of geological interpretations in GIS databases

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The application of digital methods in earth sciences give rise to new conditions for the representation of geological knowledge. GIS are currently used for storing, processing and sharing geological information according to proper database models that organise the different conceptual, logical and physical components of represented geological objects. GIS databases are therefore able to contain large and complex geological datasets. Nevertheless, these information are not always easily readable and actually sharable between different user communities, because informative systems require rigorously localised and encoded data, often standardised in interoperable formats, but the acquisition of geological knowledge is often characterized by uncertainty and requires flexibility in reasoning. The cognitive and descriptive approach applied in the domain of knowledge of geology is mainly of deductive type, with a large use of mental models (often belonging to geologists' subjectivity and individual experience) that are difficult to communicate in an explicit format (implicit knowledge). Geological settings of given areas are defined by means of different abstraction steps from observation of data to application of proper theoretical principles and representation of geological interpretations: concepts (interpretations) are as important as objects (data) in this approach. Geological GIS applications thus include a whole of heterogeneous information constrained by topological rules but affected by uncertainties and biased by many generalization processes. An effective transfer of geological knowledge in GIS applications thus requires specific methods and tools that allow to give in an explicit format the reasoning and the knowledge paths followed to produce data, as well as the scientific rules that drove the geological interpretations. The formalization of the applied concepts (ontological approach) and the description of specific information about data (metadata approach) are the keys to face this need. Conceptual

methods and digital tools for the production of GIS-based geological maps and compilation of relative databases are here proposed to be used at different operative levels: from knowledge acquisition to knowledge representation. Flexible database models are defined at the beginning of any working project and by means of specific GIS software loaded on portable computer device; although rigorously grounded on a conceptual scheme or ontology, specific for each working project, the database model can be easily modified as work progresses, even directly on the field. Geological information are collected since the beginning in a format suitable for GIS applications and referred to specific “ontological levels”; metainformations can be also added in GIS databases for a better description of the relation between observed features (objects) and interpretations (concepts).