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Geological knowledge as a product of 3D modelling and inversion of geophysical data

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Geological maps at all scale are the most accessible way for earth scientists to collect information about the nature of terrains and their age, paleogeography, structure and metamorphism. Development of GIS enables to attribute infinity of data to georeferenced polygons, lines and points and to combine information extracted from multiple datasets. However, environmental pressure, cost efficiency and conflict of interest on the management of the earth surface and underground raise new challenges. A continuous solid 3D geological model is now required in order to provide access to knowledge and to attribute properties at any point of the 3D space. This revolution that has been accomplished more than 20 years ago by the oil industry through the development of 3D modelling based on 3D seismic surveys, must still be undertaken for inland surveys for general purposes supporting public policies like water resource management, construction of trans-mountainous tunnels, exploration of the geothermal resource, deep geological storageĚIf a significant progress in 3D modelling tools is ongoing, several major issues still hampers 3D geological modelling. Because of the complexity of geological structures and processes and the discontinuous data available, the solution to any request about the presence of an attribute or the evaluation of a parameter will never be unique. Therefore, a geological model is a sample of an infinity of possible solutions taking into account far field conditions like the geological map, drill hole, potential field data (gravity and magnetic). The use of implicit functions for 3D geological modelling and inversion algorithms using Markov's chains provides a methodological background to overpass technical and methodological boundaries. A 3D geometrical model, constructed with available geological information, provide an a priori model. Probabilistic rules are then used to generate many models by forward-inverse modelling of potential field data. For each of the models, the prediction of the

observations is compared with the observations. The models that are kept represent the most general solution of the inverse problem. “A posteriori” samples can then be extracted from this 3D space of solutions with an a posteriori volumetric probability. This methodology is at the base of the concept of generalised litho-inversion and is proposed as a new strategy for delivering geological knowledge. Moreover, any new information and datasets implementing the “a priori” model will better constrain the forward-inverse modelling of potential field data and will consequently improve the resolution of the 3D space of solutions. This methodology could be developed and tested within European Geological Surveys as a companion programme of the TOPO-EUROPE Research programme in which large datasets will be acquired and processed providing a reassessed knowledge of the structure of the European lithosphere.