IGMAS+ a new 3D Gravity, FTG and Magnetic Modeling Software

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Abstract

Modern geophysical interpretation requires an interdisciplinary approach, particularly when considering the available amount of 'state of the art' information contained in comprehensive data bases. A combination of different geophysical surveys employing 3D seismic, gravity and electromagnetic, together with geological and petrological studies, can provide new insights into the structures and tectonic evolution of natural deposits and the lithosphere. Interdisciplinary interpretation is essential for any numerical modeling of these structures and the processes acting on them.

Three-dimensional (3D) interactive modeling with the IGMAS+ software provides means for integrated processing and interpretation of geoid, gravity and magnetic fields, their gradients (full tensor) and invariants, yielding improved geological interpretation. IGMAS+ is an acronym standing for "Interactive Geophysical Modeling Application System". It bases on the existing software IGMAS (http://www.gravity.uni-kiel.de/igmas), a tool developed during the past twenty years for potential field modeling. The new IGMAS+ comprises the advantages of the “old” IGMAS (e.g. flexible geometry concept and fast and stable algorithms) with automated interpretation tools and a modern graphical GUI and thus provides an optimal man machine communication.

IGMAS+ fully three-dimensional models are constructed using triangulated polyhedrons and/or triangulated grids, to which constant density and/or induced and remanent susceptibility are assigned. Interactive modifications and inversion of model parameters (geometry, density, susceptibility, and magnetization), the access to the numerical modeling process, and a direct visualization of calculated and measured potential fields enable the interpreter to design the model as realistically as possible.

IGMAS+ allows easy integration of constraining data into interactive modeling processes, visualization and combination of independent geodata constraints with density/susceptibility models. These visual overlays of different 2D and 3D datasets enables quantitative comparison and adjustment and results in models that are constrained by as much independently derived information as possible.

To avoid ambiguity, the interpretation of potential fields by three-dimensional (3D) modelling requires data from other independent sources. Various geophysical methods are used to interpret geophysical data, yielding an increasing number of models - some 3D, most still two-dimensional (2D), and some even one-dimensional (1D). Examples include seismic 2D-raytracing models, 2D and 3D density modelling, four-dimensional

(4D) (time dependent) stress modelling, and 1D/2D magnetotelluric resistivity modelling. Even geological modelling, which provides a variety of 3D and even 4D models faces limitations. These modeling procedures, and others, are often restricted by single physical parameter interpretation due to limited hard- and software capabilities.

Additionally, these models consist of mostly independently derived information, which must be evaluated to ensure that it is of the highest quality for undertaking complex interpretation. To conduct geophysical modelling, we deal with the following "loop" of knowledge acquisition:

1. Compilation of an initial model that fits both concepts and data.
2. Comparisons with other models or data and, if necessary, depiction contradictions and open questions.
3. Interdisciplinary discussions of inconsistencies.
4. Model improvement by automated algorithms (eg. Sæther, 1997; Alvers, 1998), interactive computer graphics, and incorporation of independent information by visualisation techniques.
5. Return to step 2 until a satisfying model has been found (joint interpretation).

Against this background, we are working towards a 3D interactive software tool which will ease the interpretation of gravity and magnetic data bases. The software is called IGMAS+, an acronym standing for "Interactive Geophysical Modelling Application System". It bases on the existing software IGMAS (http://www.potentialgs.com/, http://www.gravity.uni-kiel.de/igmas), a tool developed during the past twenty years for potential field modelling. The new IGMAS+, however, will comprise the advantages of the “old” IGMAS (e.g. flexible geometry concept and a fast and stable algorithm) with automated interpretation tools and a modern graphical GUI based on leading edge insights from psychological computer graphics research and thus provides optimal man machine communication.

The use of the programming language Java/Java3D will ensure that IGMAS+ is a flexible, platform-independent tool, which, at the same time, can incorporate the interfaces needed for the integration of plug-in and user-defined functions.