INTREPID GEOPHYSICS

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Editeur géologique 3D GeoModeller software

New

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Geology

Stratigraphy

| Sundown |
| Broken Hill |
| Alma |
| Thackaringa |
| Thorndale |
| Clevedale |
| Basement |

3D GeoModeller Model

Plans, Sections

Gocad, FracSIS

Shapes (triangles)

Forward modelling: Magnetics, Gravity, Seismic

Voxels

VRML (Web)

Inversion: Magnetics & Gravity

BH12 3DWEG Model

3D GeoModeller's 'model' is a set of equations – from which any plan or section within the 3D model-space may be rendered. Every plan or section will be fully consistent will all other plans/sections. From the model, shapes can be created (triangulated surfaces), from which further outputs may be generated, such as web-ready VRML 3D models, and industry-standard export files (TSurf files, suitable for import to Gocad, FracSIS). Voxel models can also be created, which form the basis of 3D GeoModeller's inversion process.

Geological inputs into 3D GeoModeller:

3D GeoModeller has a range of input methods for raw data:

- Simple mouse-click and edit attributes in a 2D sectional view
- Registering bit-map images (maps, hand-drawn sections, seismic sections, etc.) in the view
- Importing (e.g. drill-hole data) from a text file

An image of a seismic section interpretation (North Perth Basin) that has been placed in the background of the corresponding section within 3D GeoModeller. Various stratigraphic units and normal faults are being digitised in this view.
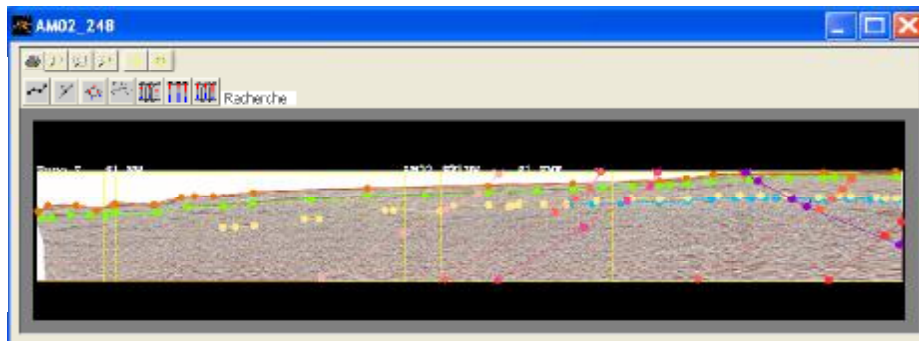

Flyer 0408 GeoModeller 4Page TempFix.doc

3D GeoModeller accepts primary geological observations to build the model:

Geological formations are entered and assembled (youngest to oldest), grouped into **series**, and classified as onlapping or cross-cutting.

Orientation data are entered, given a 3D position and assigned to a formation.

Igneous intrusions and **salt diapirs** can be incorporated in the model by treating their contacts as cross-cutting.
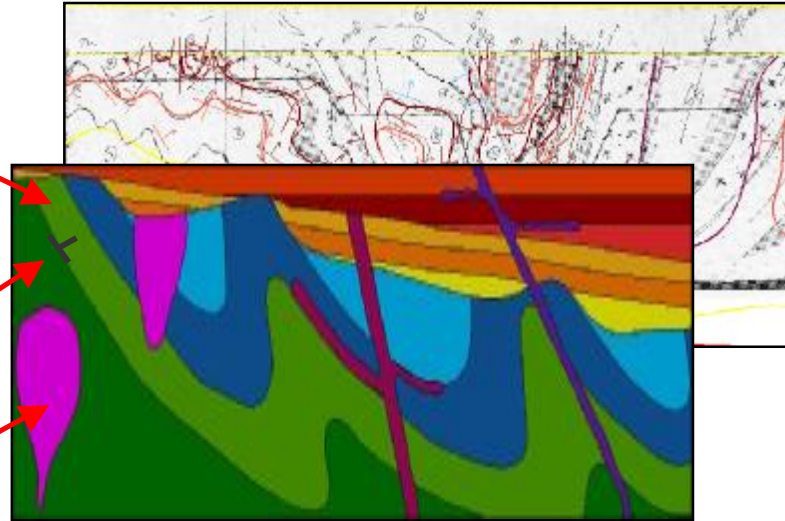
A geological cross-section rendered from 3D GeoModeller (foreground), and a geologist's hand-drawn geological cross-section (background)

Faults are entered with a location and attitude in 3D space, can be limited to certain formations and can have a designated relationship with any other fault in the model.

A 'network of faults' in 3D GeoModeller is managed via a table, wherein each fault can be described in terms of whether it 'stops on' each other fault or not.

Computation and rendering of geological surfaces:

The **computation of a 3D GeoModeller model** is applied to each series independently of all other series; a matrix is constructed using all the geological contacts, and all the orientations (for each formation) of a series. The matrix is solved to define a 3D potential (field) that honours:

- the **geological contacts** – all of the contacts for a given formation lie on an iso-potential of the computed potential field
- the **orientations** – the orientations are treated as gradient-vectors (of the potential), and the computed potential is solved such that the field is always orthogonal to these vectors (gradients).

The **rendering of geological surfaces** onto maps and sections requires repeated interrogation of the computed model in order to calculate the position of contacts between formations, and then drawing these. The interrogation of the model essentially returns 'the *formation* at *point x*', and is based on the computed potentials for each series, coupled with the additional factors of:

- the order of the stratigraphic pile, and
- the onlapping / erosional relationships between series

3D GeoModeller runs from multi-platforms including PC, Linux and Solaris systems.

Outcomes and coherency of the Model:

Following computation of the model, a range of possible **outputs** are available:

- **Maps and sections** - any arbitrary section can be drawn through the model: including non-linear fence-sections, and horizontal slices through the model. Geological maps are simply the intersection of the DEM with the model.
- 3D views in **3D GeoModeller's** '3D viewer'
- **Shapes** (triangulated surfaces) - built for each geological unit, and then exported as T-Surf files (suitable for import and visualisation in Gocad, FracSIS), and VRML files, for visualisation in a web-browser (with a VRML plug-in viewer).
- **Voxels** – a voxel model – with geology assigned to voxels – and exported as Voxet files suitable for import and visualisation in Gocad.

The 3D shapes of geological units – generated as triangulated wire-frame surfaces, can be visualised in 3D GeoModeller's 3D viewer.
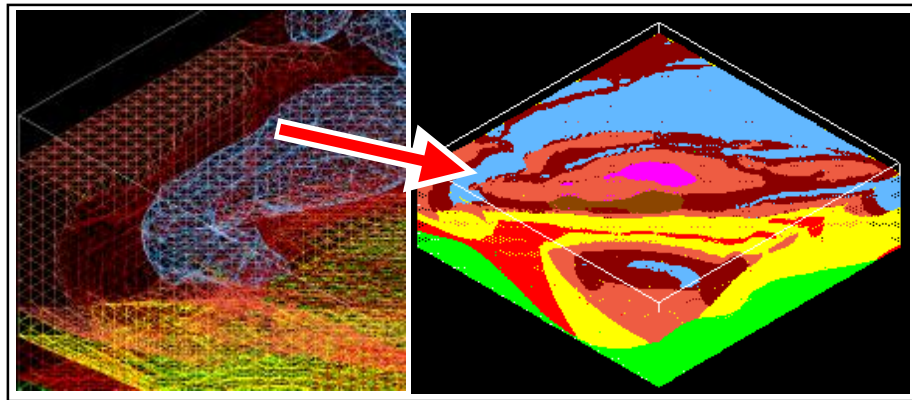

Model building in **3D GeoModeller** guarantees **three-dimensional coherence** between data contained in different sections and/or drill holes of a specific zone. Based on the data entered in sections and maps, a 3D solid model of all the geological formations is constructed automatically using Voronoi diagrams. Starting from a generated set of points issued from the data, this method computes a partition of space according to the nearest neighbour. The constructed solids are *topologically closed* and *share common boundaries*. Since the construction of the solid is automatic, the proposed solution allows iteration of the interpretation and model-construction process until the model is deemed satisfactory.

3D modelling of the Oligocene Alès Basin; an example of the use of the 3D GeoModeller, illustrating the concepts of complete coherency between the different views of a (3D) geological model.
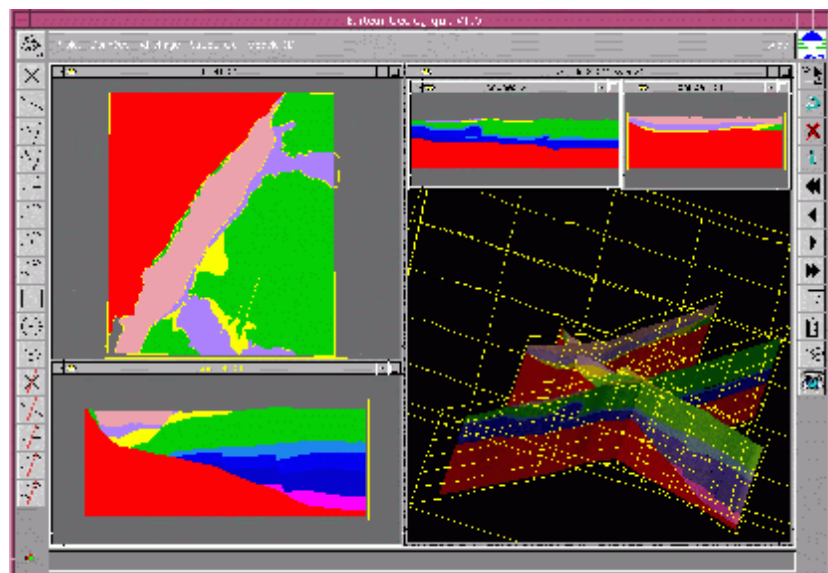
# Inversion of gravity and magnetic data in 3D GeoModeller:

Evolution of the final magnetic anomaly inversion after 5 million iterations
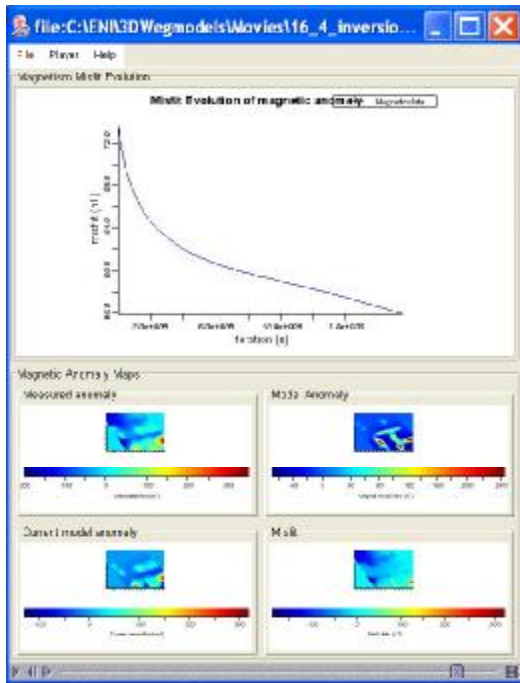
3D GeoModeller inverts gravity and magnetic data by a *radical new approach*. Traditional approaches iteratively adjust the model, each time measuring the error between observed and computed data, until this error is acceptably small, and the iterations are stopped. (This process yields a single solution that is consistent with the observed field data.) Traditional approaches usually stop here, but **3D GeoModeller** continues making adjustments using a Monte Carlo method to manage the adjustments of voxel physical properties (A voxel-model is initially generated from the current 3D model, for use as the *starting model*.)

3D GeoModeller explores *a set of possible solutions*, all of which can explain the geophysical signature. Thus the output is not just 'an adjusted model' - rather the results are presented in terms of <u>probabilities</u>. In this way, 3D GeoModeller presents inversion results *with a measure of uncertainty*, leaving the interpretation of those uncertainties with the geologist.

Image of 'most probable geology' for depth-slice (–250 to 0) m. Exported from 3D GeoModeller in Voxet-file format, and imported into Gocad for visualisation and analysis.
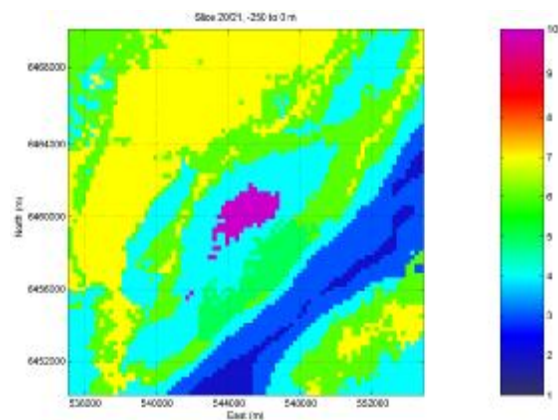
Forward modeling of seismic data:

3D GeoModeller can currently forward model seismic data and render it back to the model for verification. (Future software development envisages inversion of seismic data, in the same way as currently possible for gravity and magnetic data.)

Ongoing R & D of 3D GeoModeller:

Intrepid Geophysics and **BRGM** are currently undertaking a major R & D initiative on behalf of a consortium of Australian government geological organisations. The broad objectives of this research are to develop the **3D GeoModeller** software to enhance its capability to integrate geology and geophysics. Also, to tailor some aspects of the software's functionality to deal with specific challenges to exploration which occur in the Australian onshore environment (e.g., 'seeing through' Australia's deeply weathered cover).

Ask us about opportunities for YOUR company to be involved in 3D GeoModeller's further development and commercialisation …
Also, see our website: http://3dweg.brgm.fr for further information, case studies and interactive displays