GEOSOFT
Oasis montaj

# GM-SYS 3D Modelling

## montaj Extension developed by Geosoft

GM-SYS 3D® provides you with the ability to build layered earth models using gravity and magnetic data. Fully integrated with Oasis montaj™, you are able to model complex three dimensional subsurface structures at any scale, and integrate them with seismic data. GM-SYS 3D provides a user-friendly interface that makes it easy to build, visualize, edit, and add constraints to create complete earth models. Effective collaboration between gravity and magnetics and seismic interpretation teams is enabled by an efficient inversion workflow and rapid, iterative process for the best possible integrated models and sharing.

GM-SYS 3D leverages Geosoft's unique hybrid approach to modelling, incorporating grids, geosurfaces, and 3D voxels to allow for more accurate representation of salt geometry and sub-salt density distributions versus traditional modeling methods.

GM-SYS 3D, which requires MAGMAP Filtering™, utilises frequency domain calculations based on Parker's algorithm (Parker, 1972 and Blakely, 1996). The software's efficient calculations and superior memory management within Oasis montaj mean there is no limit to the size or number of layers used in GM-SYS 3D models.

The GM-SYS 3D model structure is defined by one or more stacked horizon grids. Each horizon grid defines the top of a layer, while each layer-parameter (density, susceptibility, or remanent magnetisation) may be specified by a constant or a laterally-varying, or a 3D voxel. Models may include a vertical depth-density relationship relative to one of the model horizons, which may be applied to any layer in lieu of a constant density or laterally-varying grid. GM-SYS 3D can also calculate the gravity and magnetic response of models represented by 3D voxel grids.

### Use GM-SYS 3D to:

- Calculate the gravity and magnetic response grid for a layered-earth model. Gravity and magnetic calculations automatically generate response and error grids, instantaneously highlighting discrepancies. The model is then edited until the response grids match the measured grids.

- Remove the gravity effect of top layer/known geology to highlight the gravity response of deeper structures (gravity stripping).

- Edit models to your exact specifications. Editing features enable user to create any number of irregular layers. View models in 3D from any angle and from any position both inside and outside the model. Thoroughly examine any portion of the model, and intelligently direct the modelling process.

### VALEM for GM-SYS 3D (Voxel Assisted Layered Earth Modelling)

VALEM is an on-demand 3D inversion service offered as an integral part of Geosoft's well-established GM-SYS 3D workflow. VALEM harnesses the power of our most advanced 3D inversion technology deployed in a high performance computing (HPC) cloud.

VALEM resolves the base of salt from gravity data bound by the constraints of seismic modelling, leveraging a unique hybrid approach that incorporates grids, geosurfaces, and 3D voxels for more accurate representation of salt geometry and sub-salt density distributions versus traditional modelling methods. This leads to improved velocity models and seismic interpretations.

Geosoft's high performance computing approach is critical for solving large problems quickly, allowing an interpretation team to iterate through different constraining scenarios and thus maximize the value of gravity data to obtain the best possible integrated models.

## GM-SYS 3D in Action

Integrating GM-SYS 3D into the Oasis montaj environment encourages a multifaceted approach to modelling and visualisation. Models may be constrained by well data, 2D/3D data, outcrop maps, density-depth relationships, etc. This example shows a relatively simple 3D "salt" model including wellbore, a 2D seismic section, and an upper layer with a vertical density distribution in the Oasis montaj 3D Viewer. Two dimensional visualisation techniques include plan maps of horizons and anomalies, a linked GM-SYS Profile model (corresponding to the vertical density section), and a 2D Profile map revealing the vertical density gradient in the sediments and lateral density variation in the basement.
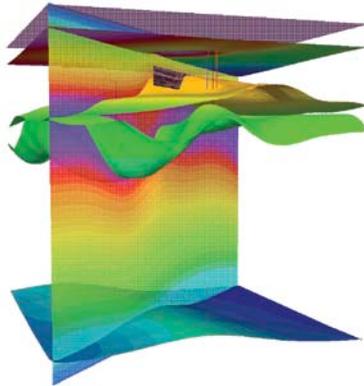
A 3D visualisation of the Silent Canyon caldera region, Nevada. The model is modified from Blakely et al., 2000. The model includes an existing density-depth profile from earlier studies. The basement horizon is constrained using digital geology, multiple seismic reflection lines, hydrocarbon and geothermal exploration wells, and groundwater well logs.
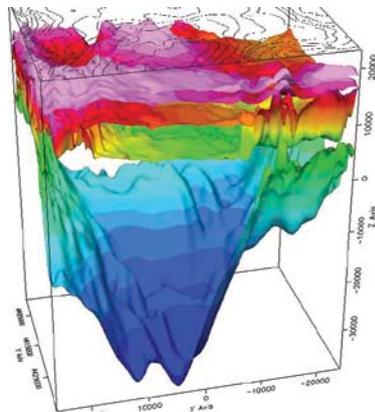
**Technical References:**

Parker, R.L., 1972, The rapid calculation of potential anomalies: Geophysical Journal of the Royal Astronomical Society, v.42:315-334.

Blakely, R.J., Langenheim, V.E., and Ponce, D.A., 2000, Summary Of Geophysical Investigations Of The Death Valley Regional Water-flow Modelling Project, Nevada and California: U.S. Geological Survey Open-File Report 00-189.

## GM-SYS Profile Modelling compatibility

You may extract GM-SYS Profile® models seamlessly from within GM-SYS 3D. Select a 2D map on which you wish to draw the profile. Select the "Extract GM-SYS Profile Model" option from the Display menu. The dialog will automatically be populated with the correct anomaly and structure grid names. Define your start and end coordinates and your model will be opened in GM-SYS with the appropriate layer names, layer parameters, and a linked cursor.
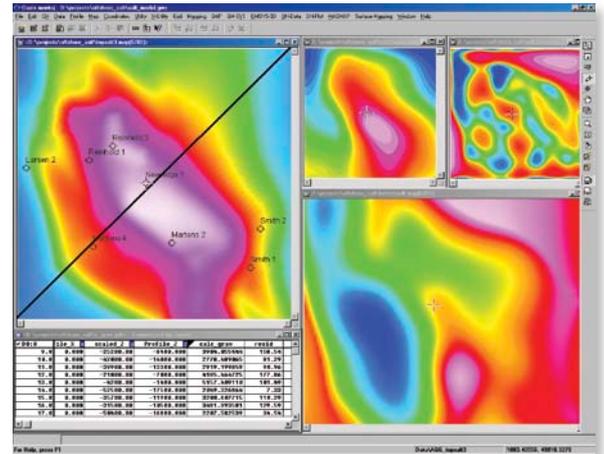


Oasis montaj workspace showing 2D representations of the "salt" model, including constraining wells and 2D Profile model locations plotted on the" top of salt" horizon, and the inverted "base of salt" horizon.

### Key Functionality

- Forward and inverse gravity and magnetic calculation routines.

- Ability to display models as individual 2D horizon maps, arbitrary 2D profiles, and dynamic 3D visualisations.

- Interactive grid editing tools, and a toolbar for quick access to the most commonly used GM-SYS 3D functions.

- Build a "Time" model using seismically-derived time horizons and velocities, then convert this directly to a "Depth" model.

- Load cross section grids of density and susceptibility values directly into 3D views. Users can export GM-SYS 3D properties to Geosoft voxels, UBC or GOCAD formats.

- Rapid and reliable cloud-based gravity inversion from your desktop with VALEM.

- In addition, GM-SYS 3D users have access to the full suite of Oasis montaj plotting, projection, grid manipulation and filtering routines. Inversion options include structural relief, lateral parameter variation, and (constant) parameter optimisation, utilizing constraints from wells, outcrop, seismic horizon, and other sources.
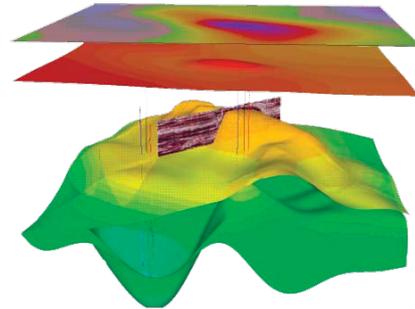
*The montaj GM-SYS 3D Modelling extension requires Geosoft Oasis montaj.

# Which modelling solution is right for you?

## A quick overview of GM-SYS Profile and GM-SYS 3D Modelling
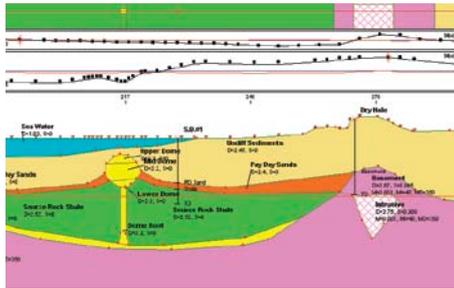


### GM-SYS Profile
Superior gravity and magnetics modelling solution



### GM-SYS 3D
3D gravity and magnetic modelling

| Overview | |
|---|---|
| GM-SYS Profile Modelling is a user friendly and feature rich interactive gravity and magnetic mapping program. Using the Oasis montaj platform, it provides a range of gravity and magnetic mapping, modelling and interpretation solutions. | GM-SYS 3D is 3D gravity and magnetic modelling software for layer-earth models, developed as an extension for Oasis montaj. The extension, which requires MAGMAP, enables explorers to model complicated three dimensional subsurface structures of any size or scale. |

| Key Benefits | |
|---|---|
| Geosoft's Oasis montaj earth mapping platform combined with GM-SY Profile gravity and magnetic modelling software: | Geosoft's Oasis montaj earth mapping platform combined with GM-SYS 3D: |

**GM-SYS Profile Key Benefits:**

- Creates an integrated 2D visualisation and modelling solution for Oil and Gas explorers identifying and characterizing potential reservoirs.
- Provides an optimal environment for integrating, viewing and comparing large volume geophysical, geochemical and geological data including well data in LAS format.
- Accelerates data analysis to support effective interpretation and target selection in daily decision making.
- Maximises the accuracy of final interpretations, thus helping to improve the potential for successful discoveries, reduce risk and minimise costs.

**GM-SYS 3D Key Benefits:**

- Creates an integrated 3D visualisation and modelling solution for Oil and Gas explorers identifying and characterizing potential reservoirs.
- Easily create realistic models: layer properties may be constant, vary laterally or vary with depth or defined via a 3D voxel.
- Helps improve the potential for successful discoveries, reduce risks and keep costs down.
- Provides an optimal environment for integrating, viewing and comparing large volume geophysical, geochemical and geological data.
- Accelerates data analysis to support effective interpretation and target selection in daily decision making.
- Maximises the accuracy of final interpretations and optimise the more expensive aspects of their exploration program such as seismic acquisition or drilling.
- Unique hybrid approach to modelling, incorporating grids, geosurfaces, and 3D voxels for improved velocity models and seismic interpretations.

|  | • Resolve base of salt from gravity bound by constraints of seismic modelling with more accurate representation of salt geometry and sub-salt density distributions. |
|---|---|

## Key Features

| | |
|---|---|
| • Rapid model creation with the "starting model wizard". <br><br> • Access Velocity/Density conversion tools. <br><br> • Flexible and robust model structure. <br><br> • Interactive model editing. <br><br> • Comprehensive model response. <br><br> • Time to depth conversion. <br><br> • Calculate the Geomagnetic Reference Field for a specific location and date. <br><br> • Enhanced Block Spreadsheet. <br><br> • Advanced and Intermediate Options available. <br><br> • Convert to/from other modelling software formats. | • Full Tensor Gravity Gradient Joint Inversion. <br><br> • Edit models to exactly your specifications, using inversion and other tools. <br><br> • Easily create realistic model structure – no limit to the number of layers or size of models. <br><br> • Thoroughly examine models – view model from any vantage point from both inside and outside the model. <br><br> • Convert from time model to depth model. <br><br> • Speed the modelling process and help to constrain variables, using a variety of import and export features. <br><br> • Sophisticated model response including gravity stripping. <br><br> • Power and speed of cloud computing from your desktop with VALEM 3D gravity inversion service. <br><br> • Integrates with other software. |

## Options

| | |
|---|---|
| **Intermediate option includes:** <br><br> • 2¾D modelling. <br><br> • Joint Inversion. <br><br> • Seismic Bitmap. <br><br> **Advanced option includes:** <br><br> • SEG-Y Reader. <br><br> • Gravity & magnetic gradient calculations. <br><br> • High-resolution modelling. <br><br> • Grid response. | • VALEM on-demand, cloud-based inversion service, offered as an addition to the GM-SYS 3D extension for Oasis montaj. |

## Differences

| | |
|---|---|
| • Suitable for modelling 2D or 2½ D (pseudo- 3D) structures. <br><br> • Real-time calculation feedback as model is edited. | • Model complex 3D environments. <br><br> • Multiple inversion algorithms to optimise model. <br><br> • Full 3D visualisation. |

## Requirements

| | |
|---|---|
| • Software requirements: Geosoft Oasis montaj. <br><br> • Hardware requirements are available on the Geosoft web site. | • Software requirements: Geosoft Oasis montaj + MAGMAP Filtering Extension. <br><br> • Hardware requirements are available on the Geosoft web site. |

## Price

| | |
|---|---|
| • Contact a Geosoft Solution Advisor. | • Contact a Geosoft Solution Advisor. |

**GEOSOFT.**
freedom to explore

**Geosoft Inc.**
+1 (416) 369-0111
www.geosoft.com