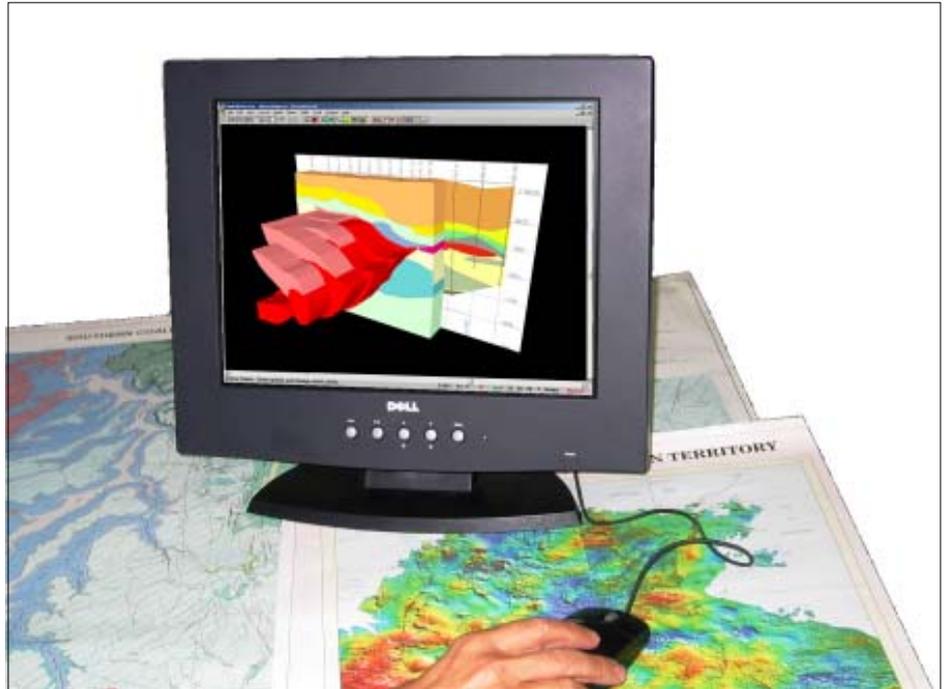




# Encom ModelVision Pro 7.0

## Advanced 3D Magnetic and Gravity Interpretation



## The industry standard for integrated 3D magnetic and gravity interpretation

Encom ModelVision Pro provides a solution for every 3D potential field problem. Whether you work in mineral exploration, diamond exploration, petroleum exploration, environmental geophysics, engineering, unexploded ordnance or underground hazard assessment, ModelVision Pro can provide you with a complete interpretation environment. Designed by geophysical interpreters for geophysical interpreters, ModelVision Pro is the most advanced general purpose model-based interpretation system available.

### A Total Modelling Application

Magnetic and gravity geophysical methods are applicable to solving problems in a wide range of disciplines including mineral exploration for base metals, gold and iron ore, diamond exploration, petroleum exploration, coal hazard assessment, environmental, engineering and unexploded ordnance.

Every problem is different in some way and Encom ModelVision Pro has the versatile tools that you need to solve these problems. Whether you need to look at micro-magnetic signature of joint zones or basement signatures in petroleum basins, ModelVision Pro can be applied to find a solution.

The tools have been progressively refined over 20 years by professional interpreters working on routine to advanced geophysical applications. You receive the benefit of this experience in one package.

### Leading Edge Technology

Encom's research team is continually responding to industry challenges to provide new features and integration with other industry software products.

Full 3D tensor modelling of gravity and magnetic gradiometer systems has been available for several years, allowing our clients to test the benefits of this new technology to their own exploration problems. With ModelVision Pro, you can model a survey or simulate one over a target geology of your design.

Model single profiles or complete anomalies depending on the problem you need to solve. Link this to constrained 3D inversion methods so that you can quickly test and refine your geological models.

Model gravity and magnetic data simultaneously to reduce the geological ambiguity of your interpretation.

### More than Modelling

Your data rarely comes ready for modelling and you will need a comprehensive set of tools to analyse and isolate the data that you need to study.

ModelVision Pro provides you with a wide range of import and export formats, utilities for gridding, filtering and numerical manipulation.

There are tools for survey simulation so that you can plan and predict the field specifications for gravity and magnetic surveys. You can create an airborne survey from a digital terrain grid or create a set of synthetic drillholes in a simulated geological model.

Create outputs for other programs or document your report directly from ModelVision Pro using the layout tool to compose your presentation.

## Solutions

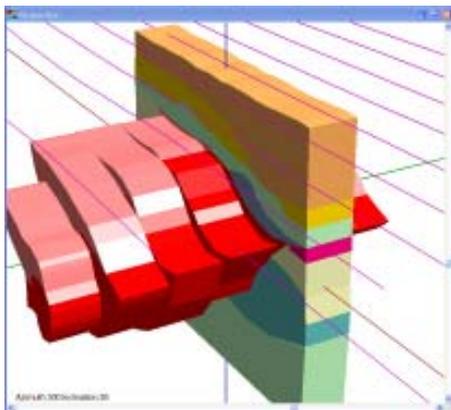
Gravity and magnetic surveying is commonly used in most geoscience applications including mineral, petroleum and diamond exploration, coal mine hazard assessment, groundwater studies, unexploded ordnance, environmental and engineering applications.

### Mineral Exploration

The magnetic and gravity methods are used widely in exploration for base metals, gold and other precious metals, diamonds and mineral sands.

#### Base metal exploration

Encom ModelVision Pro is used by mineral exploration companies in most parts of the world because it has the ability to model complex geological shapes in three dimensions with a minimum of effort. The combined use of gravity and magnetic methods makes it possible to deduce many geological factors about a potential deposit prior to drilling.



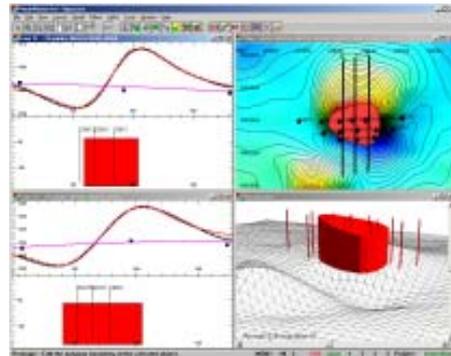
Example of a ModelVision Pro model of the gravity response of the San Nicolas polymetallic (Zn, Cu, Au, Ag) deposit in Mexico. The central section is shown in full and cut away on the adjacent sections to expose the resource model.

#### Diamond exploration

Modelvision Pro is used by diamond explorers to model magnetic targets believed to be associated with kimberlite pipes.

Gravity data is often used with the magnetic method and simultaneous modelling of gravity and magnetic data helps geologists to design an optimized drilling program. ModelVision Pro's

drillhole simulator allows you to create drilling programs and see where the holes are expected to intersect the target.



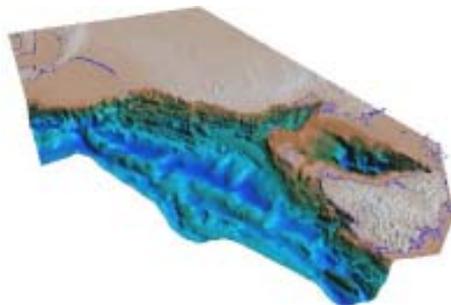
Example model for the Seppelt kimberlite diamond pipe showing two cross-sections, an image map and a 3D view of the model with a drilling program simulation.

### Petroleum Exploration

Encom ModelVision Pro is used for depth to crystalline basement studies, the study of salt diapirs, seismic controlled layered sequences and the analysis of micromagnetic features which may be magnetic hydrocarbon indicators.

#### Depth to crystalline basement

Gravity and magnetic surveys are used in many parts of the world to help understand under-explored petroleum basins. Even in mature basins, magnetic data is being used to re-evaluate basement structural controls that may have influenced the evolution of the sedimentary section.

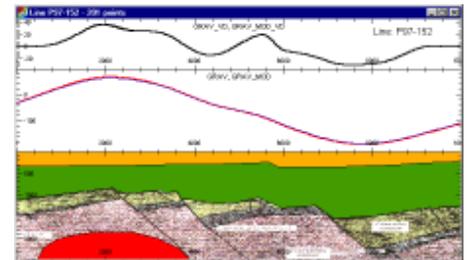


SEEBASE™ example of a depth to crystalline basement model

SEEBASE is a trademark of SRK Consulting and provides a good example of using magnetic and gravity data to enhance sparse seismic control using structural geological principles. SRK uses the results from ModelVision Pro to build geological models of petroleum basins.

### Seismic horizon integration

You can use depth-converted images of seismic data as backdrops in your section to constrain your interpretation or import seismic horizon data as horizon grids or horizon sections.



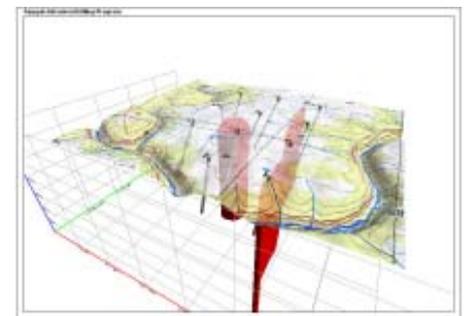
Example of a depth converted bitmap of a seismic section with a ModelVision Pro gravity and magnetic model superimposed.

Full section modelling using the polygroup body makes it easy to perform joint modelling of the magnetic and gravity data.

By modelling a square of seismic section you can model salt domes, half grabens and intrusions. If you can export your 3D seismic models as 3D DXF bodies, then they can be modelled in ModelVision to help explain anomalous gravity or magnetic data.

### Hazard Assessment

Intrusions within coal mines can cause major disruption to coal production and degrade coal quality. Early detection through the use of magnetic data can save millions of dollars in lost production.

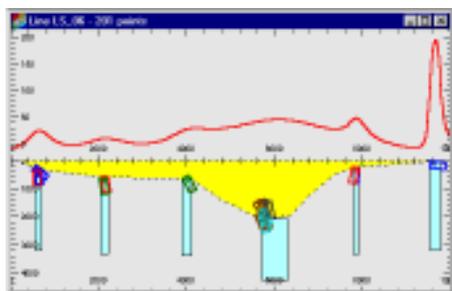


Example of intrusive pipes modelled in ModelVision Pro and a test drilling program designed to assess the impact on sub-surface coal measures. Visualisation in Profile Analyst

ModelVision Pro is used to assess intrusive dykes, sills, plugs and diatremes.

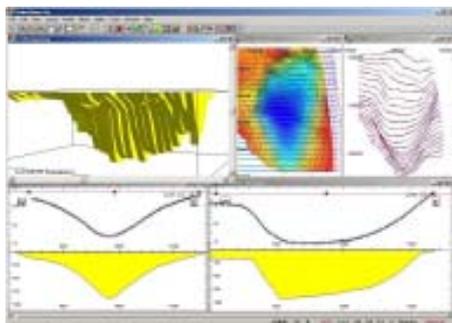
## Groundwater

There are many aspects of groundwater research and management that can utilise magnetic and gravity modelling. Gravity may be used to map the location of buried channels and the magnetic method can detect the depth of cover where the channels are sitting on a magnetic basement.



*AutoMag example used to determine the depth of steeply dipping magnetic units in magnetic basement*

Use both gravity and magnetic modelling with inversion to build a 3D model of buried river channels, deep leads and groundwater basins.



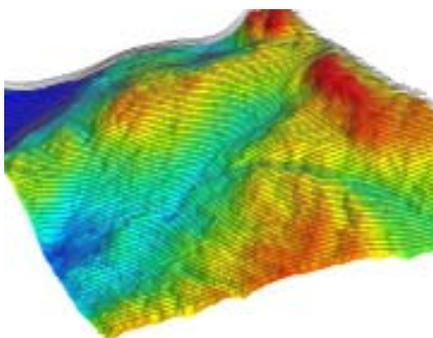
*3D interpretation of the Banting Tertiary Basin in Malaysia*

## Survey planning & research

ModelVision Pro can model gravity and magnetic data for any 3D model at any x,y,z spatial location including the ground surface, airborne surveys and drillholes. ModelVision Pro is renowned for its ability to interpret 3D potential field data and you can use it to simulate a survey for a wide range of geological models and a wide range of survey types.

ModelVision Pro has a synthetic line and dillhole calculator that creates predetermined sample locations for modelling. In the case of an airborne survey, you can use an existing digital

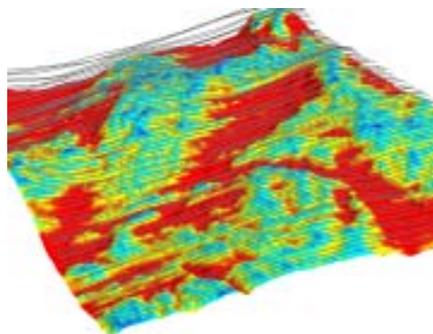
terrain model to derive the local elevation along the line and offset it vertically to create the necessary terrain clearance. You can apply a damping filter to the clearance to simulate the characteristics of the



aircraft.

*Simulation of an airborne survey flight line set over rugged terrain in PNG*

Around the world, geoscience organizations use ModelVision Pro to research issues from processing through to the detectability of subtle buried targets. It is used in research and teaching for introductory training in geophysics through to the solution of advanced research problems. When combined with the synthetic survey capability almost any geoscience interpretation problem can be simulated.



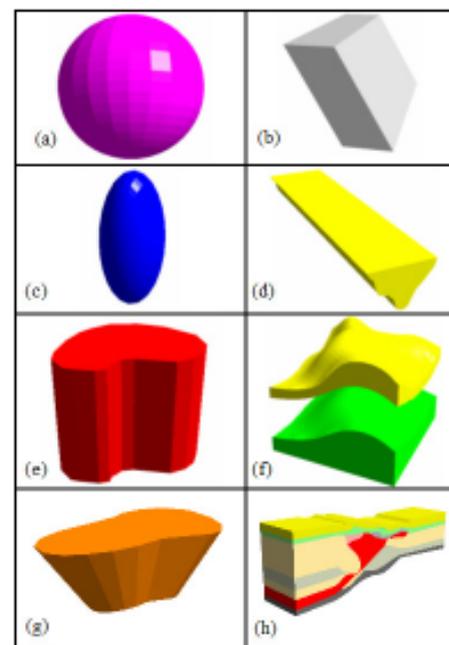
*Actual survey flight path over rugged terrain in PNG with colour coding of terrain clearance*

Airborne contractors and QC personnel use ModelVision Pro to analyse daily results and simulate the expected responses from detailed surveys with 50m line spacing to regional surveys with 1km line spacing. ModelVision Pro is packed with features designed to solve the great diversity of geological investigations that are suited to magnetic and gravity investigations.

## Features

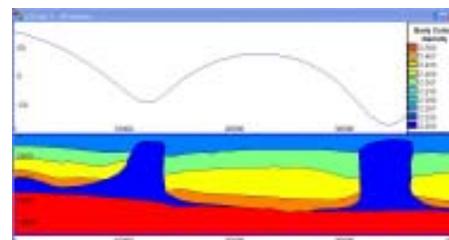
### 2D/3D modelling

ModelVision Pro performs all modelling in 3D but provides the operational efficiency of 2D modelling by providing optimised cross-sections.

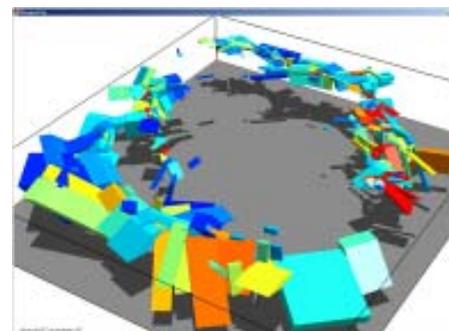


*View of different 3D model shapes, sphere (a), tabular (b), ellipsoid (c), polygon (d), plunging prism (e), polyhedron (f) and frustum (g), polygroup with linked polygons (h).*

The polygroup body links polygons to make it easy to create complex models that are easy to reshape.



*Cross-section through a 3D model allows editing in the section view*

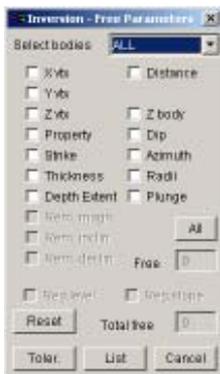


*Tanami district 3D model of magnetic features surrounding a large granitic pluton*

## Features cont'd

### Guided 3D inversion

ModelVision Pro guided inversion supports your geological modelling by allowing you to select individual parameters for refinement.



*ModelVision Pro inversion control panel provides access to any body parameters in any and all bodies in the model*

ModelVision Pro supports single profile inversion for isolated cross-sections and full 3D inversion of multiple lines of data. With modern GPS surveying you can invert on data collected along multiple lines with computations made at the elevations of the sample locations. This feature allows you to do precision modelling in rugged terrain or for data collected in drillholes.

Active Point mode allows you to select a subset region in a map or cross-section. This means that you can model part of a large survey without having to model every data point. You can perform multi-body inversion with control over individual parameters such as body position, physical property, vertex position, dip, strike, remanence vector etc.

### Gravity and magnetic gradiometer simulation

ModelVision Pro models the full gravity tensor so you can model data collected by the BHP Billiton Falcon™ or Bell Geospace airborne gravity gradiometer systems.

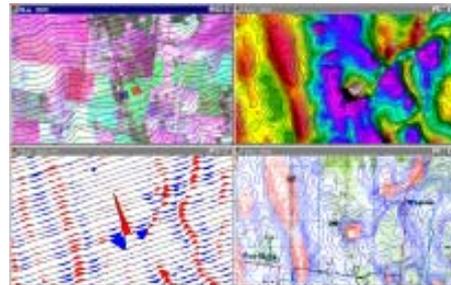
$$G_{ij} = \begin{bmatrix} G_{xx} & G_{xy} & G_{xz} \\ G_{yx} & G_{yy} & G_{yz} \\ G_{zx} & G_{zy} & G_{zz} \end{bmatrix}$$

You can simulate total field magnetic gradiometer surveys for the next generation of SQUID magnetometers that measure the full magnetic field tensor.

You can analyse the model components, the vertical gradient or full tensor. The 3D visualisation assists with understanding the relationship between the model and the tensor direction. The 3D colour modulated ribbon allows you to colour code the ribbon by another channel such as terrain clearance.

### Mapping & imaging

ModelVision Pro supports a variety of mapping methods and allows you to superimpose the plan view of your model in the map view



*An example of stacked profiles over a Landsat image, colour image with contours, variable area stacked profiles and colour contours over a scanned map image is shown.*

### Processing & utilities

ModelVision Pro is packed with useful utilities such as minimum curvature gridding, grid filtering, line filtering and a calculator that operates on lines, points, drill holes and grids.

The line and grid filters include a comprehensive suite of FFT and convolution operators. You can use the output from the first vertical derivative FFT filter as an input for modelling and inversion.

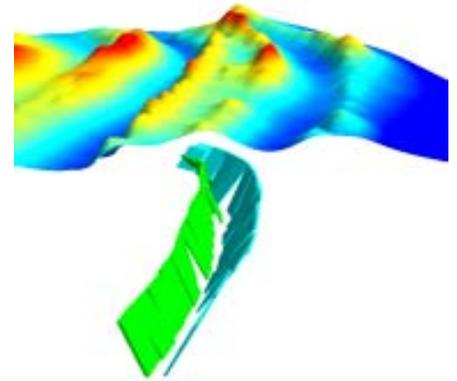
The utilities include a survey simulator and a drillhole simulator that can be tagged to a topographic surface and viewed in 3D.

ModelVision Pro is integrated with other products and extensions designed to optimise the benefits derived from advanced interpretation of magnetic and gravity data.

## Optional Features

### Encom AutoMag

Encom AutoMag is an advanced implementation of Dr Zhiqun Shi's Naudy method for automatic location and inversion of magnetic anomalies. It is integrated with ModelVision Pro to provide confirmation of automated solutions in a way that cannot be achieved by conventional automated methods.



*AutoMag solutions along a syncline converted to ModelVision Pro tabular bodies*

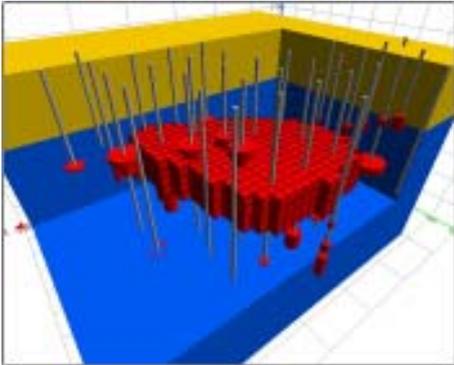
Any solution from AutoMag can be converted to a ModelVision Pro model body and the forward model response compared with the original data.

A suite of QC tools allow you to prioritise the responses, apply strike corrections and use inversion to refine the initial models. The tools are used to obtain rapid estimation of depth of cover for petroleum, mineral and groundwater applications.

### UBC – GIF voxel model creation and inversion

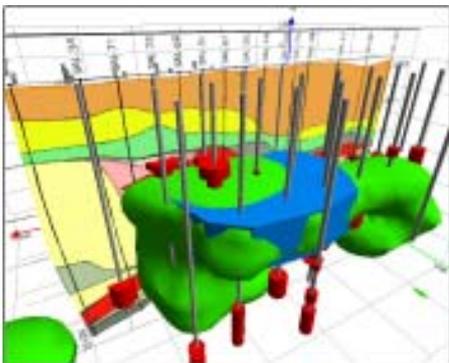
Encom has developed an optional extension for ModelVision Pro that makes it easy to prepare and run UBC-GIF, GRAV3D and MAG3D smooth inversions.

Use ModelVision Pro to generate the initial model for the inversion along with the associated data and constraint files. The solid models in ModelVision Pro are converted to mesh models by assigning properties to each mesh cell that falls inside a body. The density and susceptibility of that body are assigned to each cell.



*A UBC-GIF constraint voxel model created by ModelVision Pro and visualised in Profile Analyst*

You can use the standard UBC tools to visualise the results of the smooth inversion or Profile Analyst's rich range of visualisation options to integrate the inversion results with other models and data sets.



*A Profile Analyst iso-surface view of the UBC inversion results superimposed on the ModelVision Pro seed model*

The benefits of using ModelVision Pro with the UBC GIF programs include:

- Easy connection to industry data formats
- Prepares topographic model
- Prepares data files
- Removal of the regional field
- Prepare a starting model
- Prepares a bounds file (GRAV3D)
- Runs the UBC-GIF programs
- Visualise the results with UBC viewer
- Visualise the model in Profile Analyst.

ModelVision Pro allows you to integrate geological controls into the UBC-GIF smooth inversion. ModelVision Pro can create and populate the entire model with physical properties based on geological modelling with limited controls.

You can add an unconformity layer to minimise the leakage of high density or susceptibility values into a low contrast domain. This forces the properties to be distributed below the unconformity and subsequently produces more realistic geological solutions.

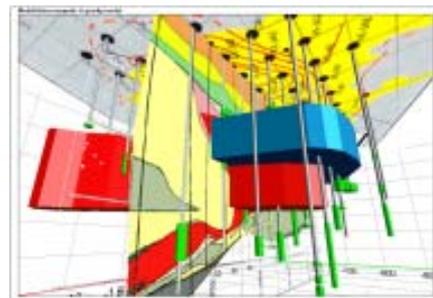
A comparison of the ModelVision Pro model and UBC Inversion results in Profile Analyst allows you to assign confidence zones to the UBC inversion.

## Related Products

### Encom Profile Analyst

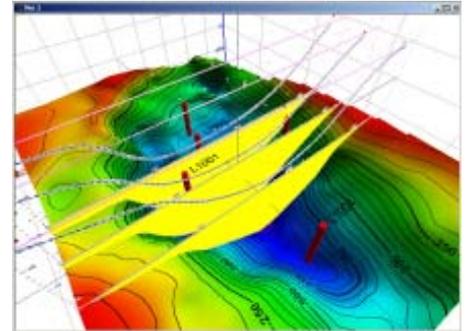
Encom Profile Analyst is Encom's premier model and data integration tool for 1D, 2D and 3D geoscience information. It connects to other Encom products and many other industry geoscience products such as Oasis montaj™, Intrepid and ER Mapper. ModelVision Pro provides direct support for the following information types:

- 3D models
- 3D cross-sections
- Model computations for lines, points, drill holes & grids.
- Synthetic drillholes



*ModelVision Pro gravity and magnetic models for the San Nicolás deposit integrated with drillhole assay data and geological section*

Use Profile Analyst to compare your results with other information sources such as drillhole data, outcrop mapping, models from other geophysical packages.



*ModelVision Pro gravity interpretation cross-sections visualised in the context of the basin container*

### Encom QuickMag Pro

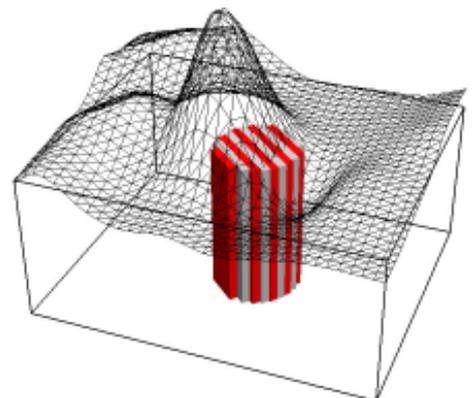
Encom QuickMag Pro provides a rapid method of 3D modelling of magnetic targets and can export its models in ModelVision Pro tabular block or polyhedral format.

QuickMag Pro is used to map the distribution of magnetic sources on an unconformity surface. This includes dykes, steeply dipping and folded volcanic units and intrusive plugs.

QuickMag Pro includes an expert system for auto-identification of 2D magnetic anomalies and an advanced inversion technology that allows you to match the inversions for different geological styles.

QuickMag Pro segments a complex geological target into a set of linked tabular blocks whose properties can vary in a controlled manner along the axis of the model.

Use the results from QuickMag Pro to guide your interpretation in ModelVision Pro.



*Example of a QuickMag Pro pipe showing each of the tabular blocks used to build a model for an intrusive pipe*

# Specifications

## Import

ModelVision Pro supports a wide range of industry standard line, point, grid and image data formats.

### Lines

- General ASCII import wizard
- ASEG-GDF2
- Geosoft Oasis montaj (.GDB)
- Geosoft multi-line (.XYZ)
- Geosoft single line (.DAT)
- Oasis multi-line (.XYZ)
- Simple XYZ format (.LIN)
- Multi-file single line (.DAT)
- Separate header and data (.HDR + .LIN)
- ER Mapper 4,5 (.ASC) (.TXT)
- AMIRA (.TEM)
- TOOLKIT (.TK)
- External Data Link (User defined)

### Grids

- ER Mapper (.ERS)
- Geosoft uncompressed (.GRD)
- ASEG-GXF
- USGS (.USG)
- Geopak (.GRD)
- Encom (.GRD)

### Drillholes

- Geosoft Oasis montaj (.GDB)
- Simple XYZ (.LIN)

### Points

- Geosoft Oasis montaj (.GDB)
- Simple XYZ (.PTS)
- Geosoft single Line (.DAT)
- ER Mapper 4 ASCII Profile (>ASC)
- Toolkit format (.TK)
- AutoMag solutions

## Images

Images can be imported as Microsoft BMP files and geo-referenced for inclusion in cross-sections or map views. Depth-converted seismic sections or scanned geological sections can be used as backdrops on model sections

### Vectors

- ESRI Shape files (.SHP)
- MapInfo interchange (.MIF)
- AutoCad 2D (.DXF)
- ER Mapper vector (.ERV)

### Models

- ModelVision & Toolkit (.TKM)
- External links
- 3D DXF

## Export

You have access to a wide range of export facilities for both models and data created within Modelvision Pro.

### Lines

- ASEG-GDF2
- Geosoft Oasis montaj (.GDB)
- Geosoft multi-line (.XYZ)
- Geosoft single line (.DAT)
- Simple XYZ format (.LIN)
- TOOLKIT format (.TK)
- AMIRA format (.TEM)
- External Links (User defined)

### Grids

- ER Mapper (.ERS)
- ASEG-GXF
- Geosoft (.GRD)
- USGS (.USG)
- Geopak (.GRD)
- Encom (.GRD)

### Drillholes

- Geosoft Oasis montaj (.GDB)
- Simple XYZ (.LIN)

### Points

- Geosoft (Oasis montaj (.GDB)
- Simple XYZ (.PTS)
- AutoMag solutions

### Models

- ModelVision Pro (.TKM)
- ModelVision SE (.TKM)
- TOOLKIT (.TK)
- AutoCAD 3D (.DXF)
- UBC mesh model
- External link (user defined)
- Profile Analyst geocoded sections (.EGB)
- GoCAD (tsurf)

## Encom Profile Analyst

ModelVision Pro provides support for Profile Analyst in a variety of methods including:

- Grid (.ERS)
- Lines (.GDB)
- Holes (.GDB)
- Points (.GDB)
- Models (.3D .DXF)
- Sections (.EGB)
- UBC-GIF voxel model

You can save nearly all data, grids and models in a format that is immediately available for visualisation in Profile Analyst.

## Images

Most graphic windows support the creation of high-resolution bitmaps (BMP) as an export option. These images are suitable for inclusion in reports.

## Filters

### Line Convolution

- Low/high/band pass
- 1st/2nd horizontal derivative
- 1st vertical derivative
- Analytic signal
- Moving average
- Median
- Fourth difference
- Upward continuation
- AGC
- Noise generator

### Line FFT

- Low/high/band pass
- 1st horizontal derivative
- 1st vertical derivative
- Upward/downward continuation
- Reduction to the pole
- Pseudo-gravity
- Band limited noise genertor

### Grid Convolution Filters

- Average
- Gaussian
- Low/high/band pass
- Laplace
- Sharpen
- Sobel
- Illumination
- Noise generator

### FFT Grid Filters

The research capabilities of ModelVision Pro have been extended with the introduction of a comprehensive range of 2D FFT filters that include the following:

- High/low/band pass
- x, y, z component transforms
- Upward/downward continuation
- 1st, 2nd vertical derivative
- fractional derivatives
- x, y horizontal derivatives
- reduction to equator
- reduction to pole
- pseudo-gravity transform
- pseudo-magnetic transform

## Model types

ModelVision Pro models are designed to provide convenient methods for creating and editing a range of simple to complex geological shapes.

- Polygonal polygroup
- Polygonal horizontal cross-section
  - > dip
  - > azimuth
- Inclined upper surface
- Frustum
- Dipping tabular block
- Ellipsoid
- Sphere
- Horizontal elliptic cylinder

Combinations of these basic building blocks can reproduce almost any geological environment.

## Modelling methods

### Section (3D)

Create, select and edit models in a single section or multiple geological sections with all the advantages of 2D modelling in a 3D volume. Graphical access to body-specific spatial attributes such as polygon vertices or body location.

### Map (3D)

Create, select and edit models in a map view. Graphical access to body specific spatial attributes such as polygon vertices or body location. Use the body property to access spatial, physical property and visual attributes.

### Field Components

Gravity modelling supports the total gravitation attraction  $G_x$ ,  $G_y$ ,  $G_z$  and the full gravity tensor  $G_{zz}$ ,  $G_{xx}$ ,  $G_{yy}$ ,  $G_{xy}$ ,  $G_{xz}$ ,  $G_{yz}$  and some derived components such as the analytic signal.

Magnetic modelling supports the total magnetic intensity  $B_x$ ,  $B_y$ ,  $B_z$  components and full magnetic tensor  $B_{zz}$ ,  $B_{xx}$ ,  $B_{yy}$ ,  $B_{xy}$ ,  $B_{xz}$ ,  $B_{yz}$ . The along-line component can be used for the axial drillhole component.

### Active data zones

ModelVision Pro can work with a complete survey by activating segments of the survey for modelling. This may be a single line, multiple lines or segments of one or more lines. In this way, it is possible

to reduce the large computational overhead of modelling large data sets by focusing on anomalous data regions.

### Manual/immediate/compression

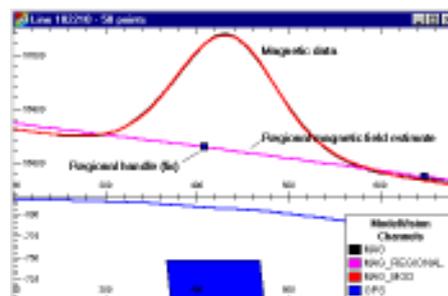
You can model using compute-on-demand or immediate (real-time) computing modes. If you are working with large data sets and complex models, you can speed up the computation process using a data compression option.

### In-line filters

You can turn on an active filter that allows you to view your model and field data through the same filter. Use a first vertical derivative filter to improve depth precision or an upward continuation filter for noise affected data.

### Regional 1D/ 2D

Manipulate 1D and 2D regional gravity and magnetic fields depending upon the modelling mode. Auto-compute a starting regional and then use manual editing methods to adjust the shape.



1D regional manipulation in a cross-section view

### 3D visualisation

- Models
- Flight path/profiles
- Drillholes
- Points
- 3D Grids with colour drape
- AutoMag points
- Vectors

### Map visualisation

- Model
- Stacked profiles
- Contours
- Grid profiles
- Vector files
- Drill holes
- Images

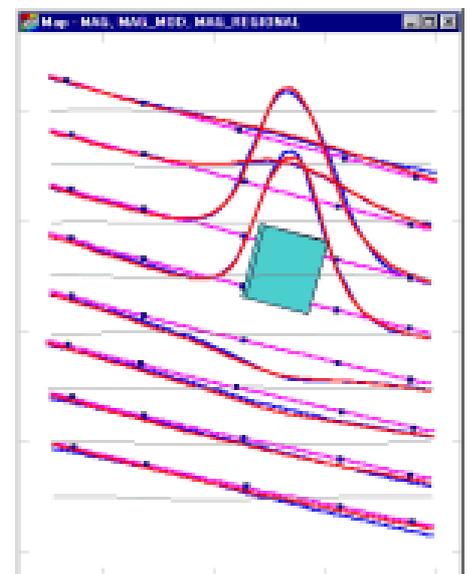
- Bitmaps
- Points/symbols
- AutoMag solutions
- Profile vectors
- Base lines
- Flight path
- Legend
- North arrow
- Coordinate grid

### Section visualisation

- Model (colour modulation)
- Gravity & magnetic data
- Computed magnetic & gravity data
- Regional gravity & magnetic field
- In-line filters
- Auxiliary curves
- Vectors
- Terrain
- Data collection path
- Drillholes
- AutoMag solutions
- Similarity coefficients
- Bitmap sections (geocoded)
- Titles & legends
- Next line function

### Inversion methods

The guided inversion method allows you to free parameters from one or more bodies at a time. Parameter ranges can also be fixed to ensure that they do not move outside reasonable bounds.



Comparison of field data and model data in a multi-line 3D inversion

