Tensor Research

ModelVision
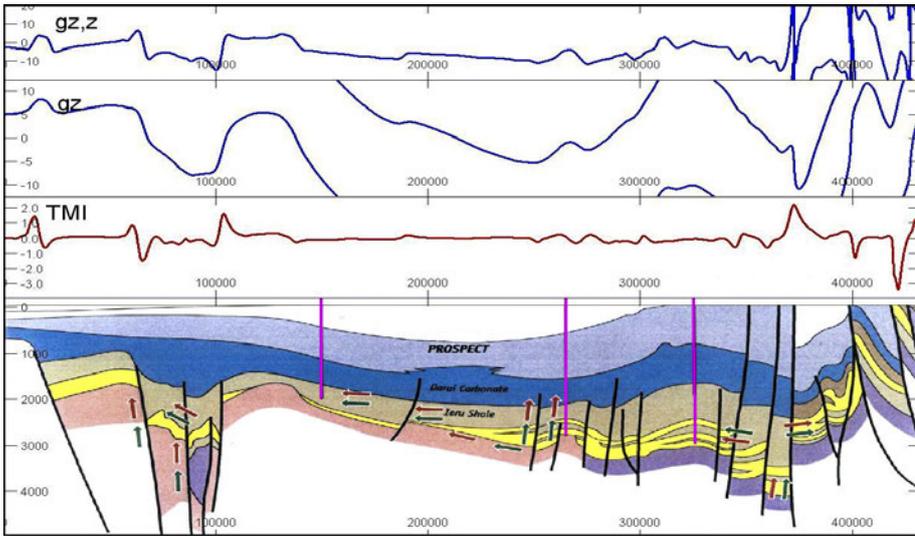
Magnetic & Gravity Interpretation System
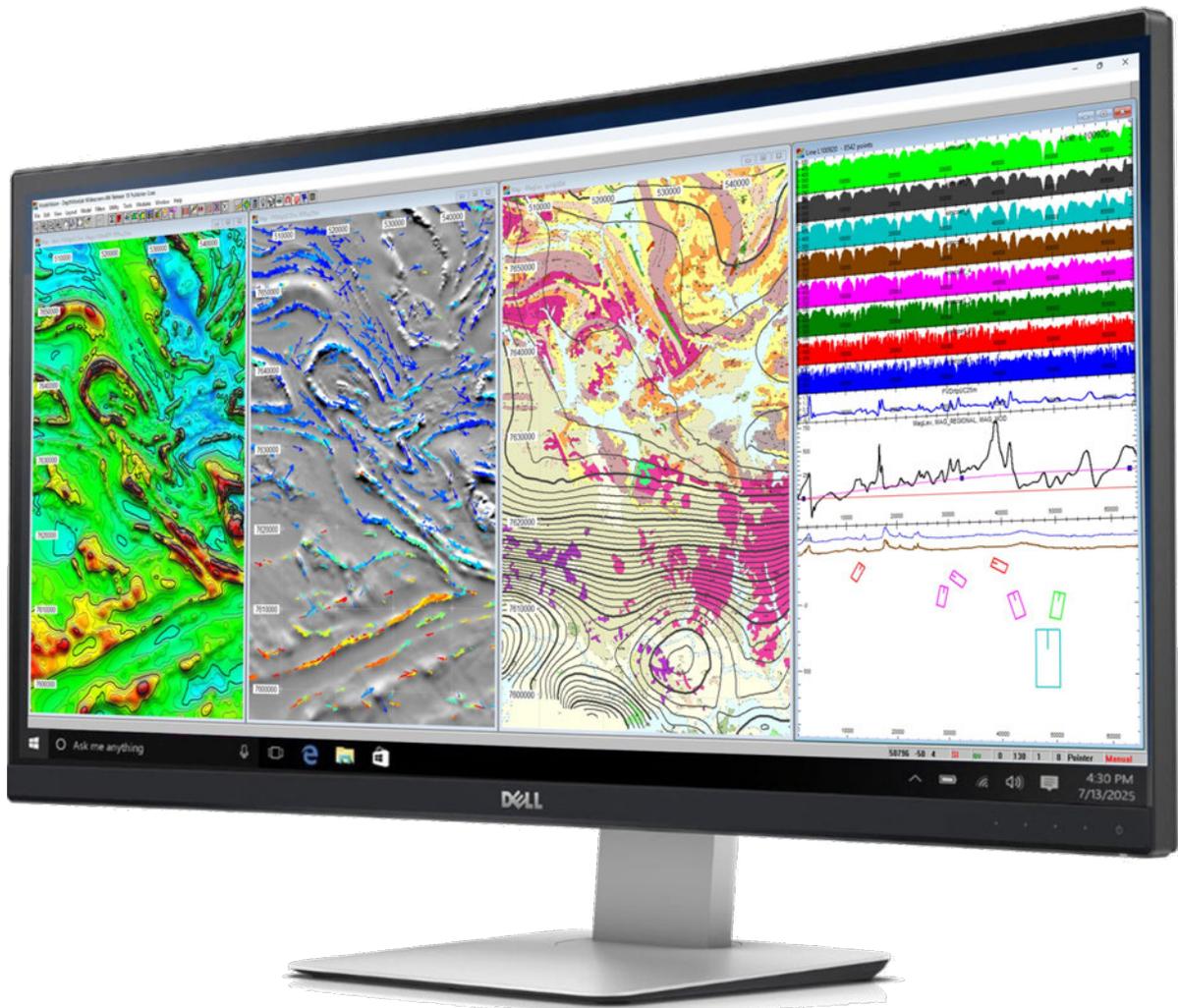
A Complete Solution

All sensors	**Minerals**
FFT filters	**Petroleum**
3D modelling	**Near Surface**
3D inversion	**Government**
Visualisation	**Contracting**
Processing	**Consulting**
Utilities	**Education**

www.tensor-research.com.au

Basin Studies

ModelVision is used globally by geological surveys and petroleum exploration groups to investigate sedimentary basins and the basement that lies beneath. It is used for complex geological section modelling, for aeromagnetic, airborne gravity and airborne gravity gradiometer survey interpretation.

You can use georeferenced bitmaps from seismic processing as backdrops to constrain your interpretation. Magnetic and gravity data can be modelled simultaneously and cooperatively inverted for precision interpretations.
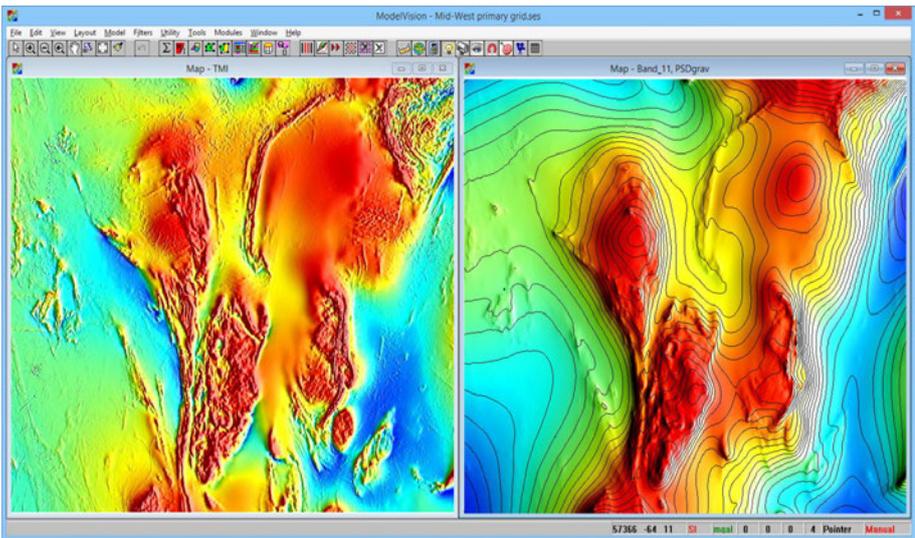
Regional Enhancement

ModelVision provides an advanced suite of processing and filter tools to complement the interpretation of magnetic and gravity data. The example here is part of a regional geological study where a pseudo-gravity transformation has been used to see deeper into the magnetic property distribution beneath the surface.

The pseudo-gravity FFT transformation has the added bonus that it can be modelled jointly with magnetic data over the same area or compared with the measured gravity response.
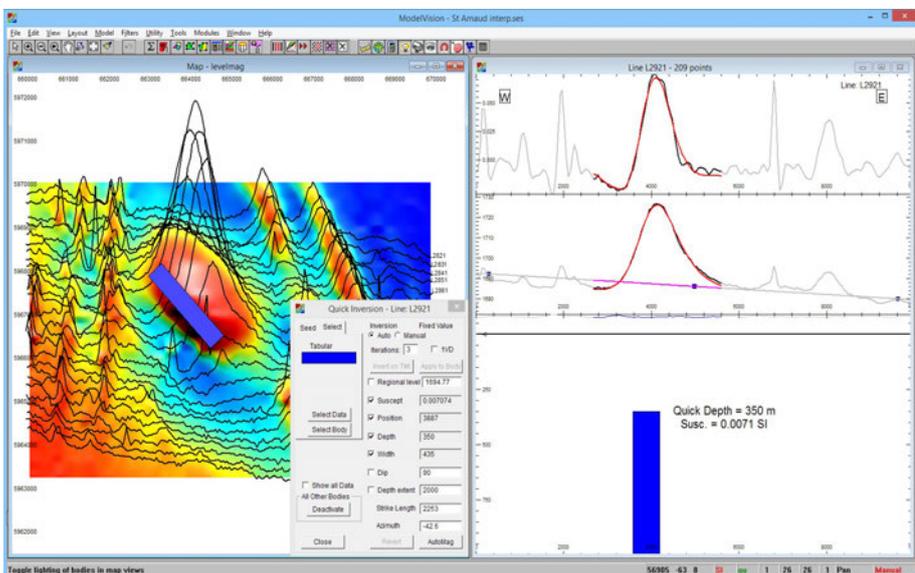
Depth Estimation

Used widely in mineral exploration, environmental, groundwater and engineering studies. ModelVision offers great flexibility with sensor combinations, presentation styles, model types, inversion, advanced processing and helpful wizards such as QuickInvert and the Target Wizard.

Use magnetic data for estimating changes in depth to an unconformity surface where variable shaped pipes and linear features can be modelled with high precision. Use gravity data for modelling basin shapes with constraints provided by magnetic depth interpretations and cooperative inversion.
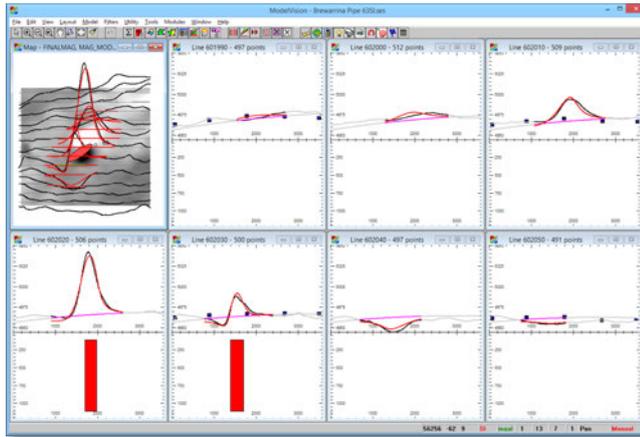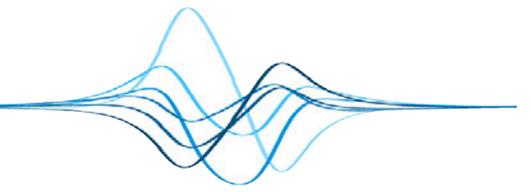
Target Wizard

The Target Wizard streamlines the process of setting up the regional, activating the data points, opening the windows, tiling the windows and computing the initial response. When you finish the modelling of the target, the new bodies are appended to the master model and control is returned to the master session. You can work systematically through large surveys with ease.
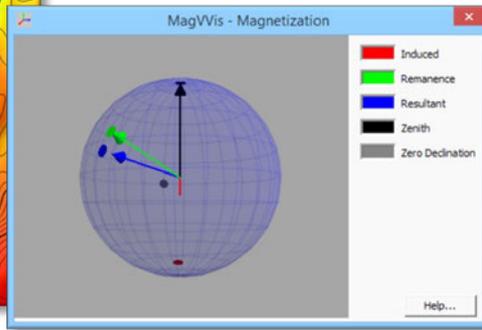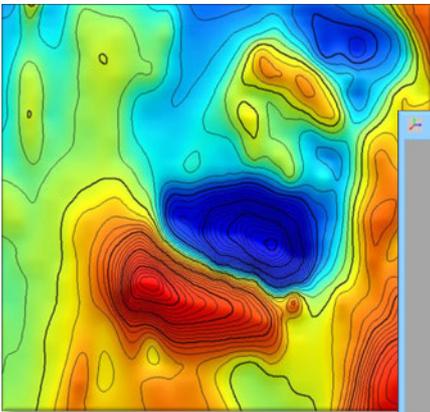

Remanence Methods

ModelVision has been a leader in its class for the study of magnetic remanence with a range of tools for obtaining quantitative measures. Inversion for magnetic remanence and resultant magnetisation is an important tool for quantitative evaluation of specific anomalies or groups of anomalies. The Resultant Deconstruction wizard provides different ways for estimating remanence and susceptibility from resultant magnetisation.
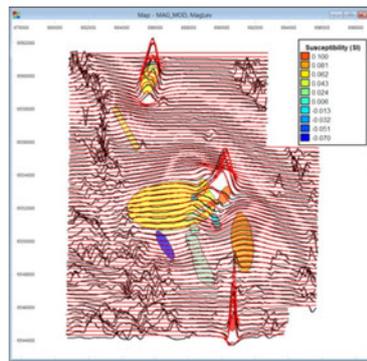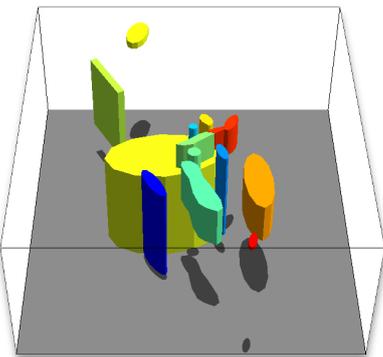
Inversion

Parametric constrained inversion is supported for all body types with standard inversion and joint inversion is available for multi channel magnetic gradient and gravity gradiometer data. ModelVision inversion returns numeric information on physical properties and geometry that you can apply to a broad range of exploration problems such as depth mapping, geological boundary location, density & susceptibility.
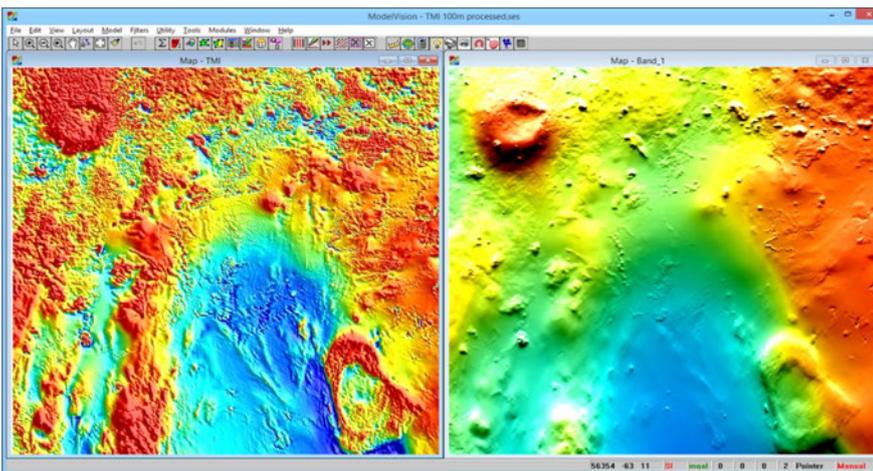
FFT Grid Processor

ModelVision has an advanced FFT processing suite for conventional and extended magnetic and gravity interpretation. RTP, 1VD, Continuation, Band-pass, Micro-levelling and Pseudo-gravity are ideal for standard interpretations. But there is much more to explore, including the general phase transformations, fractional derivatives, integration, components, tensors, and normalised source strength.
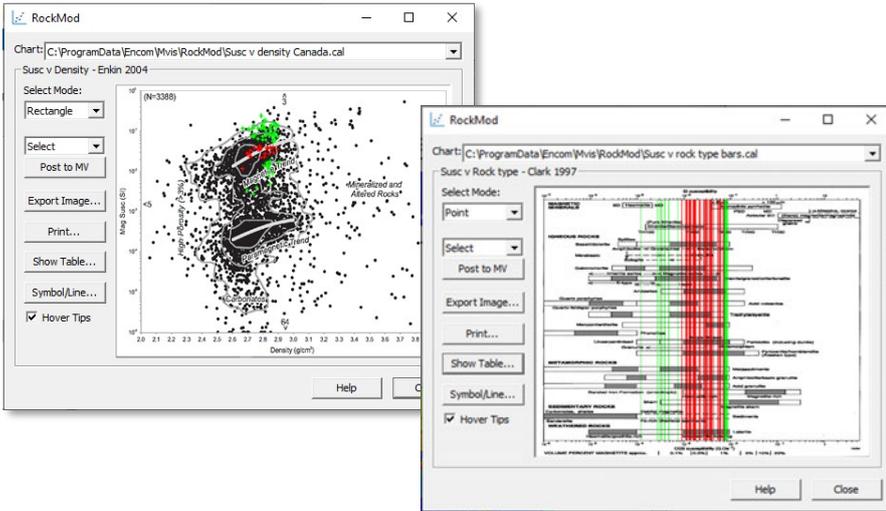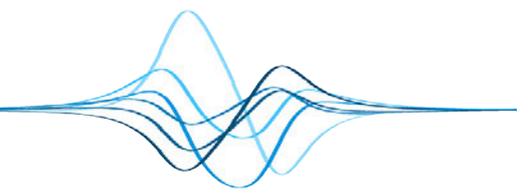
Rock Properties

RockMod is a rock properties plugin that allows you to analyse magnetic, remanence and density properties in a range of standard rock property charts. ModelVision inversion produces compact rock properties that can be compared with standard charts or your own suite of measurements.. This means that you can make geological inferences from your inversion data that will help you prioritise targets.

Point Display

ModelVision has been a leader in its class for the study of magnetic remanence with a range of tools for obtaining quantitative measures. Inversion for magnetic remanence and resultant magnetisation is an important tool for quantitative evaluation of specific anomalies or groups of anomalies. The Resultant Deconstruction wizard provides different ways for estimating remanence and susceptibility from resultant magnetisation.
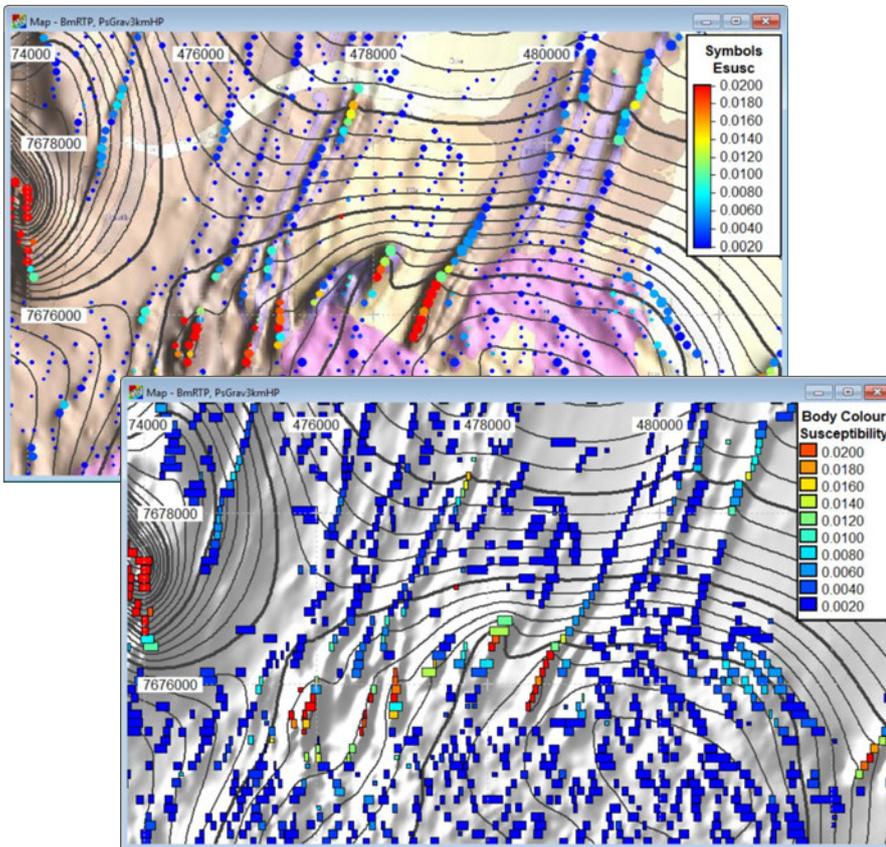

Point Data to Models

For researchers interested in studying large scale models, the point to body conversion tool supports conversion to tabular, spheres, ellipsoids, circular and elliptical pipe body shapes. Use survey simulations to test your survey specifications before you fly or simulate near surface maghaemite using randomly distributed ellipsoids or spheres along with your target model.

Drilholes

Drillholes have their own View type and presented as vertical logs. It shows curves of your measured and model data along with solid sections where the drillhole intersects any of the bodies in the model. Intersecting bodies are selected and moved up and down the hole. The drag and drops logs behaves in the same way as the Multitrack views along with curve attribute controls. Updates in the hole are reflected in section, map and 3D perspectives.
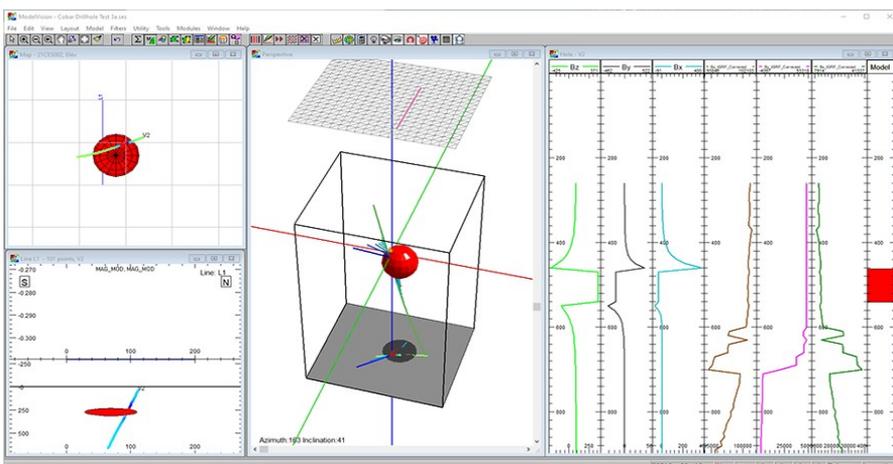
Applications & Industries

The magnetic and gravity methods are fundamental to the study of the subsurface and are used widely by many industries to resolve a broad range of geological problems. ModelVision's quantitative tools provide direct guidance on the location, shape, volume, depth and physical properties of model bodies and puts you in control of the geology.

| Application	Minerals		Oil/Gas		Diamonds		Coal		Eng/Env.		UXO		Survey		Consult		Research	
Precision depth of cover	M	G	M	G	M	G	M		M	G	M		M	G	M	G	M	G
Automated depth of cover	M		M		M				M		M		M		M		M	
Intrusive pipe interpretation	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Properties susc/dens	M	G	M	G	M	G	M		M	G	M		M	G	M	G	M	G
Target shape	M	G	M	G	M	G	M		M	G	M		M	G	M	G	M	G
Target dip	M	G	M	G	M		M				M		M	G	M	G	M	G
Sedimentary basin shape	M	G	M	G			M	G		G			M	G	M	G	M	G
Basin layers & structure	M	G	M	G			M	G		G			M	G	M	G	M	G
Mine planning sections	M	G			M	G							M	G	M	G	M	G
Voxel model geological controls	M	G	M	G	M	G							M	G	M	G	M	G
Cavity/cave		G		G						G				G		G		G
Drill hole design	M		M		M	G	M		M	G			M	G	M	G	M	G
Survey & target simulation	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Instrument simulation	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Survey planning	M	G	M	G	M	G	M	G	M	G	M	G	M	G	M	G	M	G
Survey quality control	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Data enhancement	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Micro-levelling	M		M		M		M		M		M		M		M		M	
Line & grid FFT filtering	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
Terrain correction	M	G	M	G	M	G	M	G	M	G	M		M	G	M	G	M	G
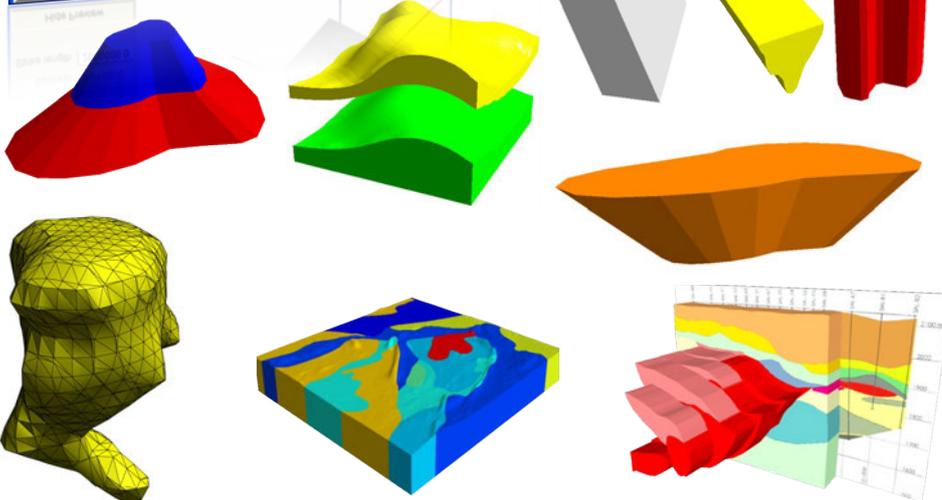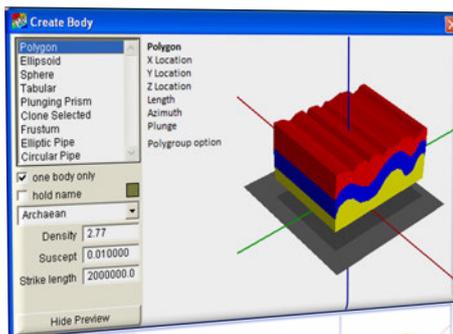
ModelVision Models

ModelVision has a flexible geological modelling environment that provides quick solutions for simple problems, yet has the depth to model mine plans or sedimentary basins to answer fundamental geological modelling questions or locate buried resources.

Body shapes include tabular, sphere, ellipsoid, polygroup, elliptic pipe, frustum, plunging prism and general polyhedron. These shapes are combined to build more complex geological models such as folds, mine plans, mapping and layered sedimentary basins.

You can compute the standard magnetic and gravity responses of any combination of bodies, but in addition, you can simulate virtually any field system in operation including gravity and magnetic full tensor gradiometers
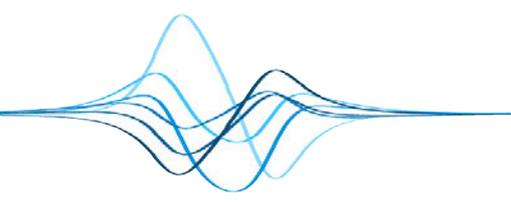
Depth Modules - AutoMag

The optional Depth Module includes the AutoMag and QuickDepth applications where AutoMag focuses on automated depth, dip estimation over large areas and QuickDepth is a fast method for obtaining depth estimates of selected magnetic anomalies.

AutoMag is the best geologically focused automated magnetic depth interpretation system available with many productivity tools and cross-checks that enable you to interpret a full survey in a short period of time. An initial tuning phase is followed by multi-line processing and then interactive global filtering of the solutions to high grade the results by filtering low quality results and extreme attributes.
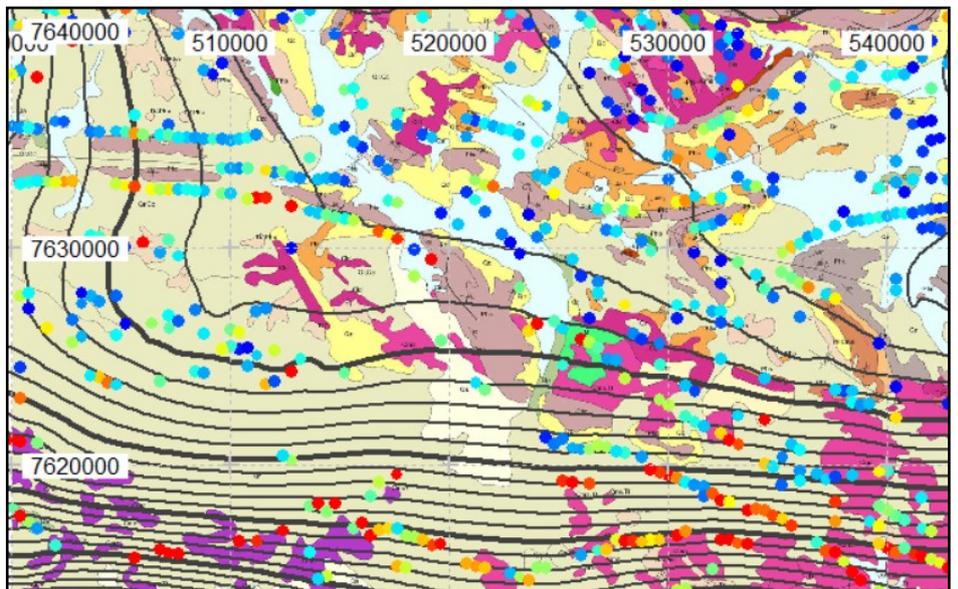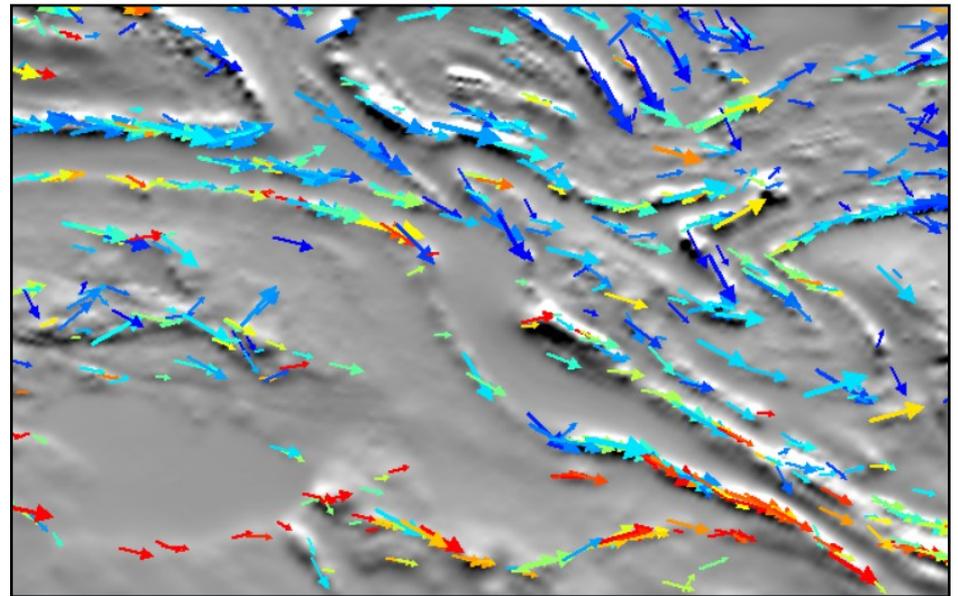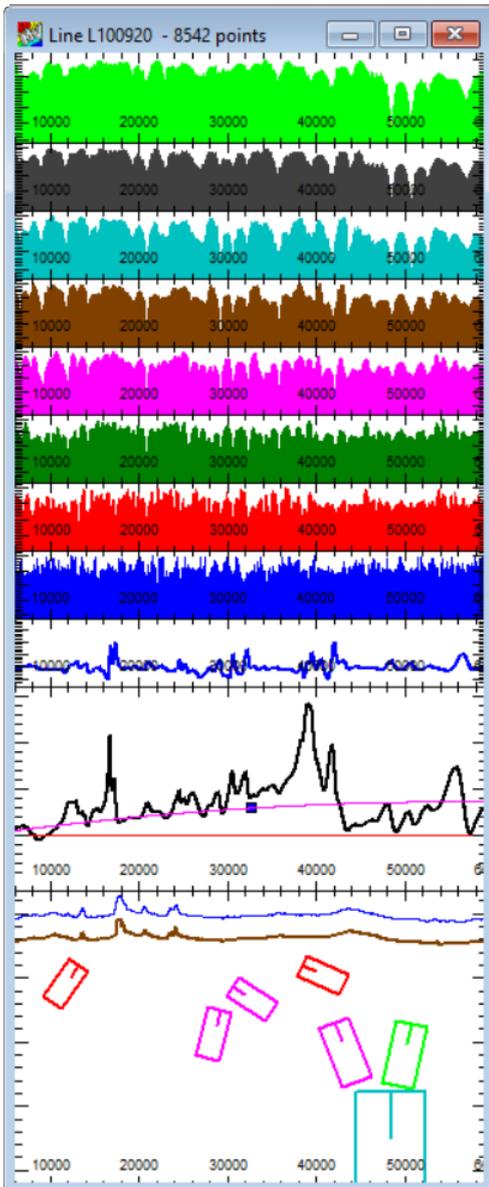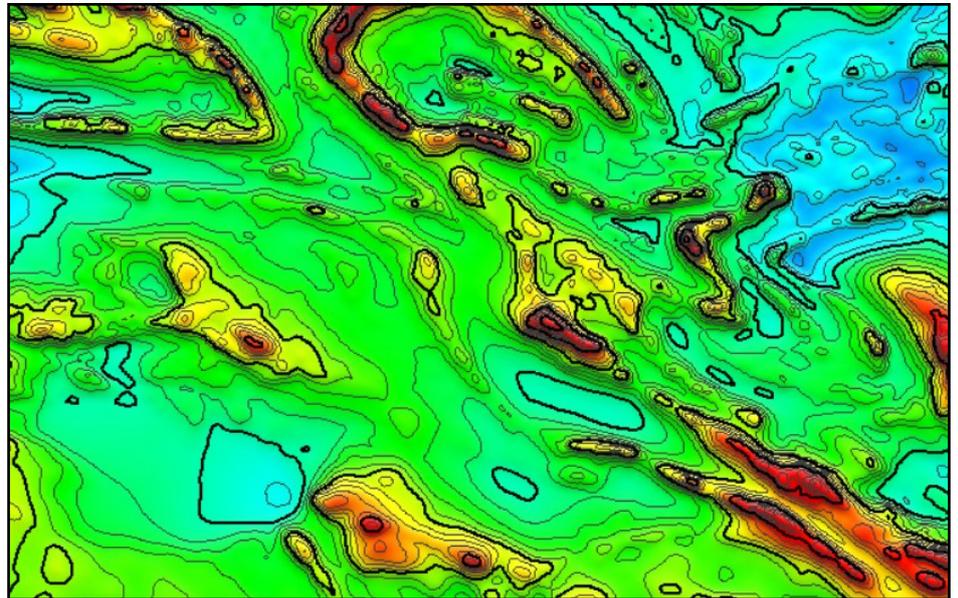
Depth Module - QuickDepth

QuickDepth applies AI principles to the estimation of depth, magnetic properties and geological style from magnetic data. AI speeds up the interpretation process, and puts you in control of the geological interpretation. It uses both the line data for the highest possible depth precision and the associated grids to gather intelligence on the shape characteristics of each anomaly. This knowledge is also used to estimate depth quality or confidence.

The magnetic gradient tensor is used to derive geological characteristics such as strike direction, body type, centre of magnetisation and depth to the top of the magnetic unit. This information is used to constrain and improve the precision of the following depth estimation methods:

- **Tensor**
- **Euler 2D**
- **Peters' Length**
- **Werner Deconvolution**
- **Tilt Depth**
- **Euler 3D**

ModelVision uses the peak of the normalised source strength (NSS) from Clark (2014) to define the horizontal (X, Y) location of the centre of magnetisation which simplifies the calculations of depth and the azimuth is computed from the peak tensor.

Data preparation phase

The line and grid data is pre-processed in a once-off run to prepare all the data you need to automatically analyse each anomaly. You will also retain tensor, gradient and RTP line and grid data.

Depth interpretation phase

You simply select an anomaly in a cross-section view and QuickDepth uses the AI engine to analyse the shape characteristics to infer the geological style which is relevant to the depth precision. Styles are include intrusive pipes, sheets, dykes, edges, sills and ellipsoids. Most of the time the inferred geological style will be correct, but you can override the selection if you think another style is more appropriate.
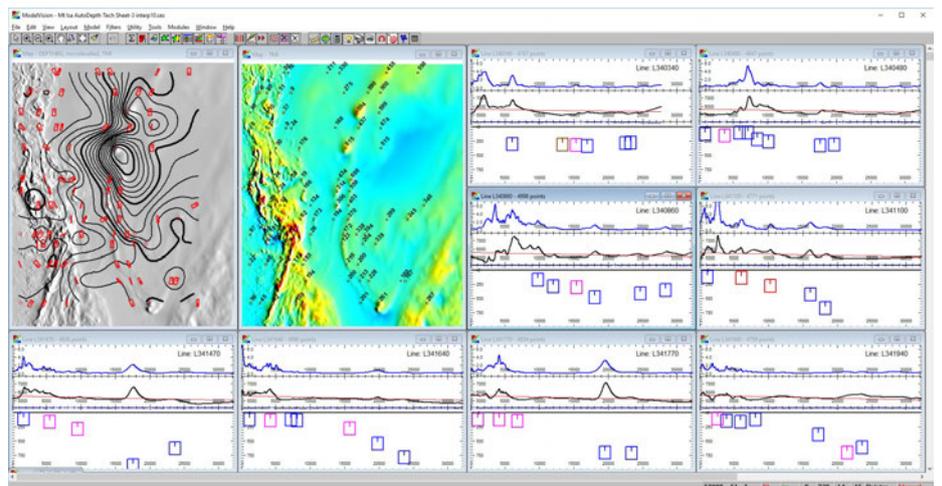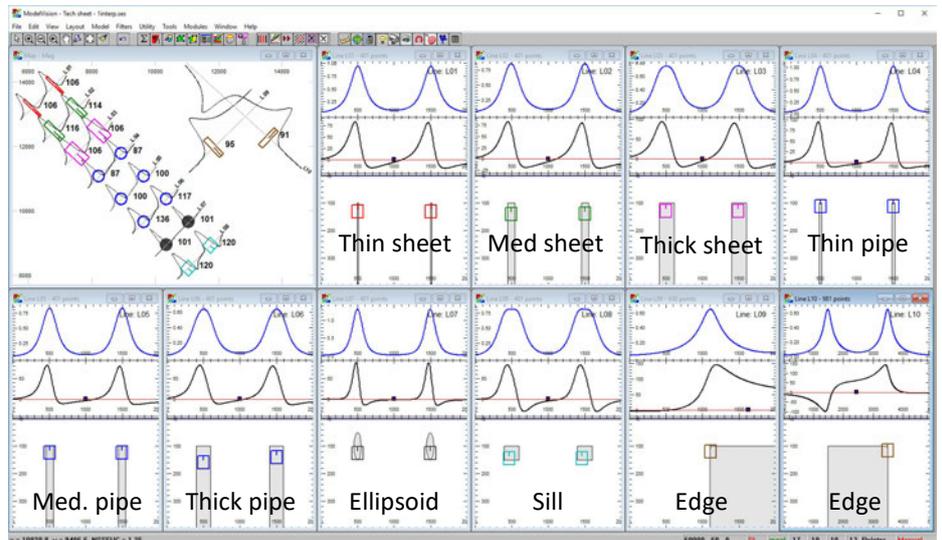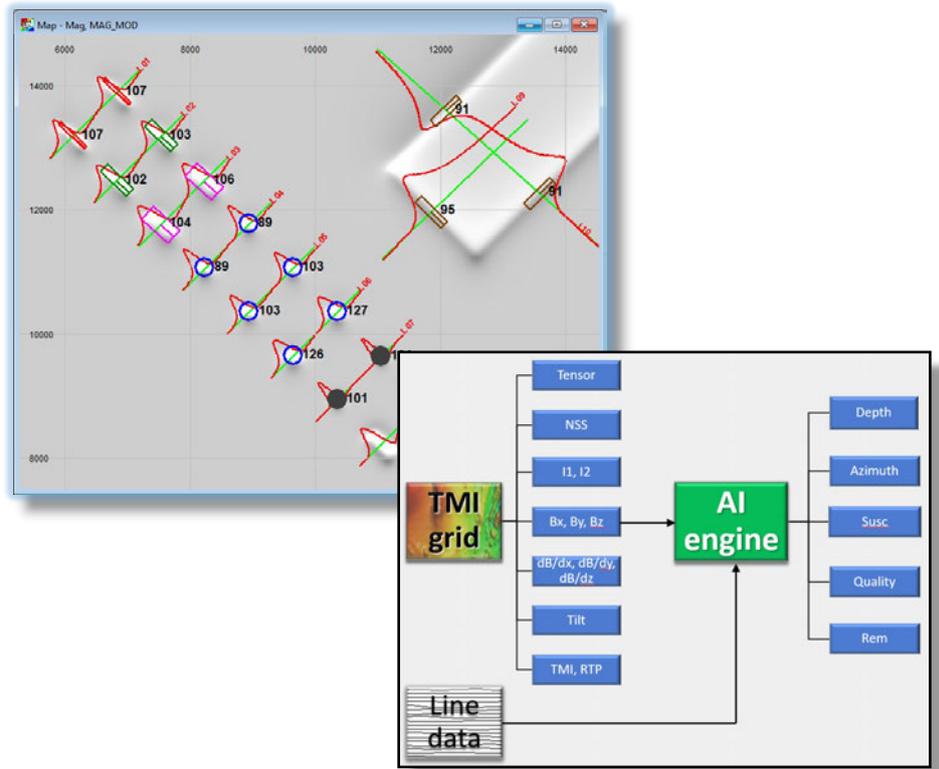
UBC Mesh designer

Create constrained UBC magnetic and gravity voxel models including model mesh, property constraints mesh, data files and control files.

The UBC programs GRAV3D and MAG3D are popular for developing large scale voxel inversions for gravity and magnetic datasets. This ModelVision option gives you a geologically meaningful method for embedding constraints into the control files prior to running the inversion. ModelVision models, that have been developed through modelling or the direct import of external models, are populated with magnetic or density properties and bounds on the property range. You can generate different mesh specifications from the same model allowing you to run quick trials before committing to full runs.

In this example we have converted a geological map from a GIS file to a solid model using the 3D Extrusion Wizard and then populated the 3D UBC mesh from the properties in the solid geology model. You can also import other 3D models using the Topology Checker tool to create ModelVision models and then export it to a UBC mesh.
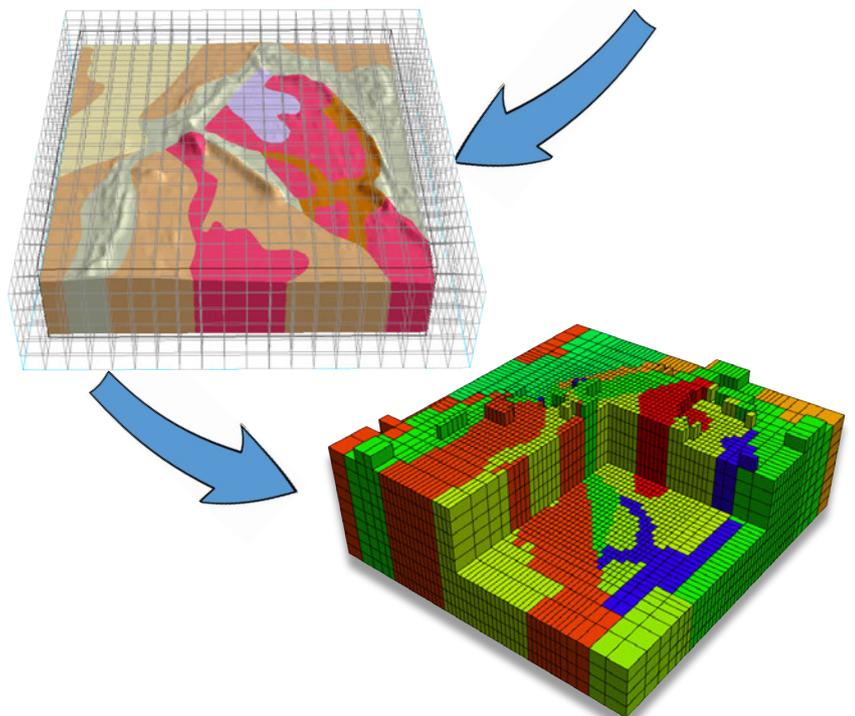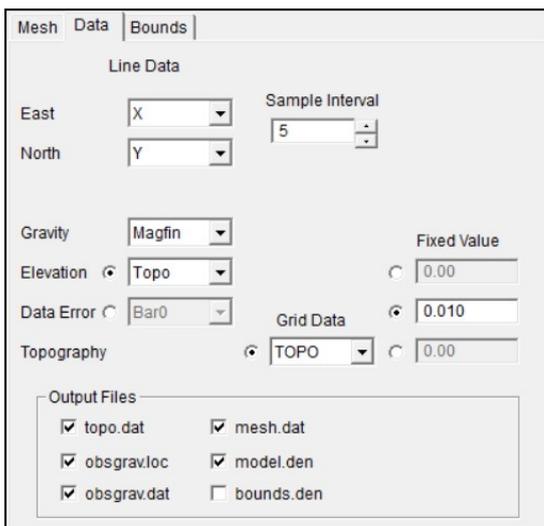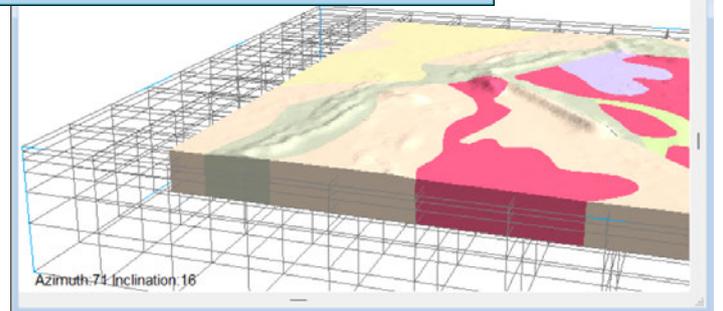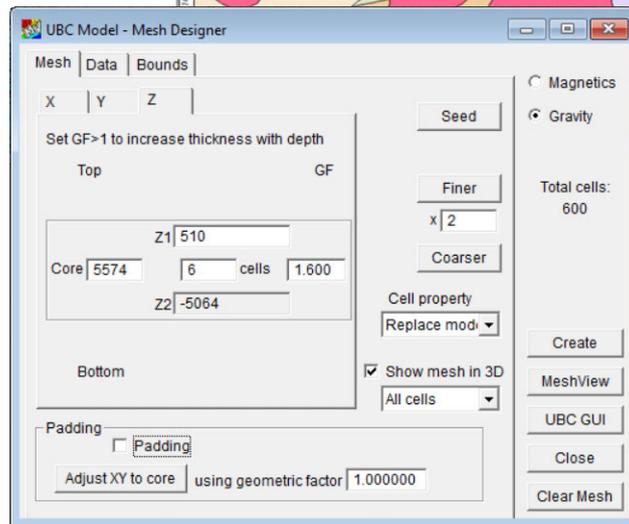
The UBC input files for the mesh definition, topographic data, observed gravity locations, observed gravity data, model density and density bounds are controlled from the multi-tabbed dialog. In addition, the line data and grid data are selected from grids in memory. When data is not available, a constant value can be is assigned.

ModelVision Functionality Table

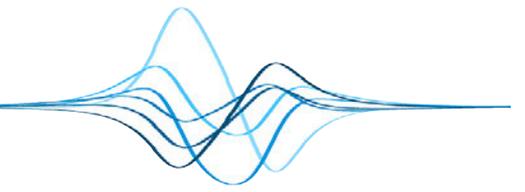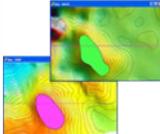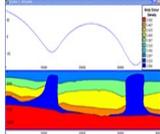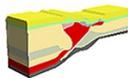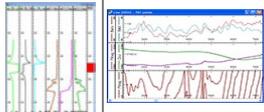| OPTIONAL MODULES	Advanced Capability Extensions	
Depth Module • AutoMag • QuickDepth	AutoMag is an extended version of the Naudy method for estimating the depth, dip and properties of extended strike tabular bodies. Automatic strike correction is available when combined with the FFT Trend filter. All solutions can be converted into bodies and modelled to check the parameter integrity.	
UBC Model Builder	Builds UBC model meshes, property distributions and constraints from a ModelVision model. The user has full control over the generation of the mesh for trial runs and full runs of the UBC MAG3D and GRAV3D codes.	
TOOLS & WIZARDS	**Productivity & advanced application**	
Target	Automatically prepares a suite of cross-sections over a target anomaly complex, sets the active data points, computes a starting regional and sorts the sections ready for full 3D modelling. Simplifies workflows to reduce modelling and inversion times.	
QuickInvert	Provides a cut-down inversion tool to match tabular bodies to selected anomalies. The user just selects the data to be modelled and QuickInvert prepares the data, regional, starting model and inversion parameters.	
Terrain correction	This tool uses three different resolution terrain grids to calculate the terrain correction for a survey. It can be used for ground surveys and airborne gravity gradiometer surveys.	
Remanence calculator	Estimate the resultant magnetisation direction using the Helbig magnetic moment method.	
Resultant	Deconstruct resultant magnetisation into susceptibility, Q or remanent magnetisation.	
Publish	Set live update (export) of models and sections for immediate viewing in other products such as Discover for MapInfo and PA Explorer.	
3D Model Generator	Build 3D models from hand drawn polygons or imported GIS map files. This tool can build a single body or populate a complete geological map in 3D.	
Create Strata	Create formations in section or maps from data fields or grid surfaces.	
Topology Checker	Imports models from other software applications and allows you to assign properties and detect problems. Supports 3D dxf, Gemcom BT2, ESRI TIN, GoCAD .ts, Datamine, Vulcan, 3D Studio	
Polygon splitter	Split a complex polygon section into two polygons.	
Property table	Manipulate multiple bodies via a spreadsheet table.	
Points to models	Convert point datasets to tabular bodies by mapping channel names to body attributes. Supports Tabular, Circular pipe, Elliptic pipe, Sphere & Ellipsoid definitions. Properties: Susceptibility, Density and Remanence.	
ASCII import	Powerful and flexible ASCII import for point and line data types. Supports Geosoft xyz, csv, txt, asc, data, ldt, lin formats.	
Create new line	Draw a line on a map and sample grid values onto the new line.	
Create next	Automatically opens a cross section for the next line in sequence.	
Active line & point selector	Select multiple lines in a map for modelling and inversion. The active points tool lets you select or deselect points in section or map mode.	
Polygon clip	Draw polygon and null grid values outside the polygon.	
Clip project	Clip a project data set to a user drawn rectangular area.	
Measure	Measure distances and azimuths interactively.	
StatWatch	Monitor stats for line data channels.	
Movie Mode	Capture a sequence of model edits and inversion and then play back the process	
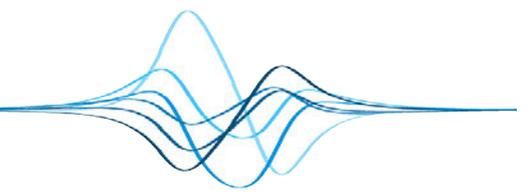
MODEL FEATURES	Field Components, Inversion Styles, Data Types & Body Operations	
Body types	Polygonal section, sphere, ellipsoid, tabular, plunging polygonal prism, frustum, elliptic pipe, circular pipe, general polyhedron. Simulate dykes, plutons, solid geology, terrain, layers, formations, folds, faults, basement, cavities, overburden.	
Body properties	Density, susceptibility, remanence, anisotropy, demagnetisation, resultant magnetisation.	
Line data	Sequential data on one or more lines with x, y, z, fields values.	
Grid data	Grid points based on x, y, field values plus an elevation.	
Drillhole data	Sequential data on one or more holes with x, y, z, field values.	
Point data	Random point data with x, y, z, field values.	
Regional	Polynomial in 1D or 2D or designated regional bodies	
IGRF	Computes the IGRF value for a lat, lon, z, year.	
Magnetic	TMI (Bm), Bx, By, Bz, Bxx, Bxy, Bxz, Byy, Byz, Bzz, dT/dx, dT/dy, dT/dz, dT/dH TAS, Bp, BH, BAS, NSS, Phi, Lamda2.	
Gravity	gz, gx, gy, Gxx, Gxy, Gxz, Gyy, Gyz, Gzz, Guv, GH, aH, GC, aC, I1, I2, Gaa, Gcc, Gza, Gzc.	
Terrain correction	Variable density grids, triangulated surface, triangulated surface geology, strata model builder.	
Model import	tkm, 3D dxf, Gemcom BT2, ESRI TIN, GoCAD .ts, Datamine, Vulcan, 3D Studio.	
Model export	tkm, 3D dxf, GoCAD .ts, csv, UBC mesh.	
Body operations	Create body, reshape, split polygon, create strata, 3D model generator.	
Quick inversion	Simplified anomaly inversion of profiles using tabular bodies and data selection.	
Standard inversion	Single field data value inversion of model using the Marquardt non-linear inversion method. Invert on a single channel of magnetic data for spatial and physical properties. Parameter range constraints with spreadsheet table.	
Joint inversion	Multi-parameter model non-linear inversion of multi-channel field data using Tikhonov regularisation and singular value decomposition. Ideally suited to full tensor gravity and magnetic data, cross-wing horizontal gradiometers and 3 component fluxgate sensors.	
Cooperative inversion	Model gravity and magnetic data simultaneously and invert on either parameter in a co-operative sequential procedure.	
LINE FILTERS	**Line Filter Types Convolution & FFT**	
Convolution	Low pass, high pass, band pass, 1st & 2nd horizontal derivatives, sq root of 1st derivative, log of 2nd derivative, 1st vertical derivative, analytic signal, averaging, median, fourth difference, upward continuation, AGC, noise generator.	
FFT	Low pass, high pass, band pass, 1st, 2nd & 3rd horizontal derivatives, 1st, 2nd & 3rd vertical derivative, upward & downward continuation, reduction to pole, reduction to equator, pseudo gravity, band limited noise generator.	
In-line	Include an in-line filter for line and model data for depth and noise sensitivity.	
GRID FILTERS	**Grid Filter Types Convolution & FFT**	
Convolution	Sun angle(8), standard(16), smoothing (10), seismic(3), geophysics (20), gaussian(4), enhancement(14), average(10) plus user definable. ER Mapper format definitions.	
Component	TMI to components and general directional transform.	
Derivative	Vertical derivative, advanced derivative, integration.	
General	Analytic signal, band pass, Butterworth, continuation, directional cosine, high pass, low pass, directional pie-slice.	
Tensor	Gz to gravity gradient tensor, TMI to magnetic gradient tensor, gravity tensor to field components, magnetic tensor to field components.	
Transform	TMI pseudo gravity, Gz to pseudo magnetic field, reduction to equator, reduction to pole, low latitude reduction to pole, general phase transformation.	
Special	Normalised Source Strength (NSS), Phi, Lamda2 from eigenvector decomposition of the magnetic gradient tensor.	
Other	Fill holes, noise generator.	

VIEWS	Window Types & Special Controls	
Map	Layers for models, body labels, georeferenced RGB images, vector graphic files, grid images, grid contours, drillholes, regionals, points, flight lines, stacked profiles, vectors, legends, north arrows, AutoMag points, AutoMag labels, title blocks, graticule, geographics, cursor x,y and grid value status, zoom, pan, zoom fit, refresh, active line, active point. Linked cursor to section view.	
Section	Layers for models, body labels, multi-track field & model data curves, in-line filters, georeferenced RGB images, drillholes, regionals, legends, orientation labels, AutoMag Similarity Coefficients, AutoMag points, AutoMag labels, title blocks, graticule, geographics, context sensitive cursor x,y and value status, zoom, pan, zoom fit, refresh, active point, scale controls, style controls.	
3D	3D zoom, pan, rotate, bodies, flightlines, drillholes, surfaces, points, AutoMag solutions, profile vectors.	
Multitrack & Drillhole logs	Multi-track graphics with easy scaling, zoom, pan and line/drillhole selection. Reference track and spreadsheet for data interrogation. Drillhole logs show vertical data tracks and model intersections.	
Layout	Layout and drawing window for compositing and aligning different windows onto a single printer page. Add text and drawing objects for report quality presentations.	
Custom Tiling	Multi-section modelling uses special tiling of window types to simplify large scale multi-body modelling.	
UTILITIES	**Powerful Utilities for Routine Data Management Procedures**	
Calculator	Supports line, grid, point and drillholes with special functions and logical IF.	
Interpolation	Resample line or drillhole data to a regular spacing.	
Synthetic survey	Generate synthetic line, grid and drillhole datasets for simulations.	
Gridding	Minimum curvature gridding of line and point data.	
Grid to line	Sample one or more grids onto existing line or point data.	
Grid utilities	Clip, clip grid to grid, merge, resample, reproject, trend, azimuth plus more	
Statistics	Supports line, grid, point and drillholes plus reports.	
Maintenance	Manage line, grid, point, drillholes, polygon features and projects.	
LUT editor	Colour lookup table builder supports ER Mapper, Geosoft and MapInfo	
FILE MENU	**Project Management, Printing, Import & Export**	
Projects	A project covers multiple sessions and common parameters such as the IGRF	
Sessions	Contains a single file copy of all data, models and parameters	
Import/export	Lines data, grids, points and drillholes. Geosoft grids and databases and a range of industry formats including ASEG-GDF2.	
Setup	Set system default values	
Project Properties	Global parameters Datum, projection, IGRF, units, background density & susc.	
Print	Scaled printing of maps and sections	