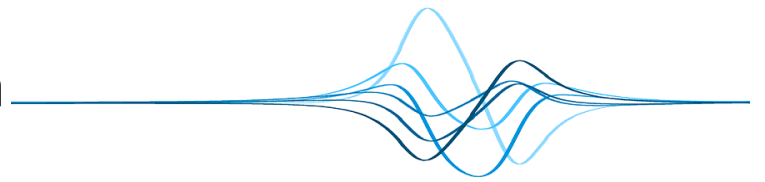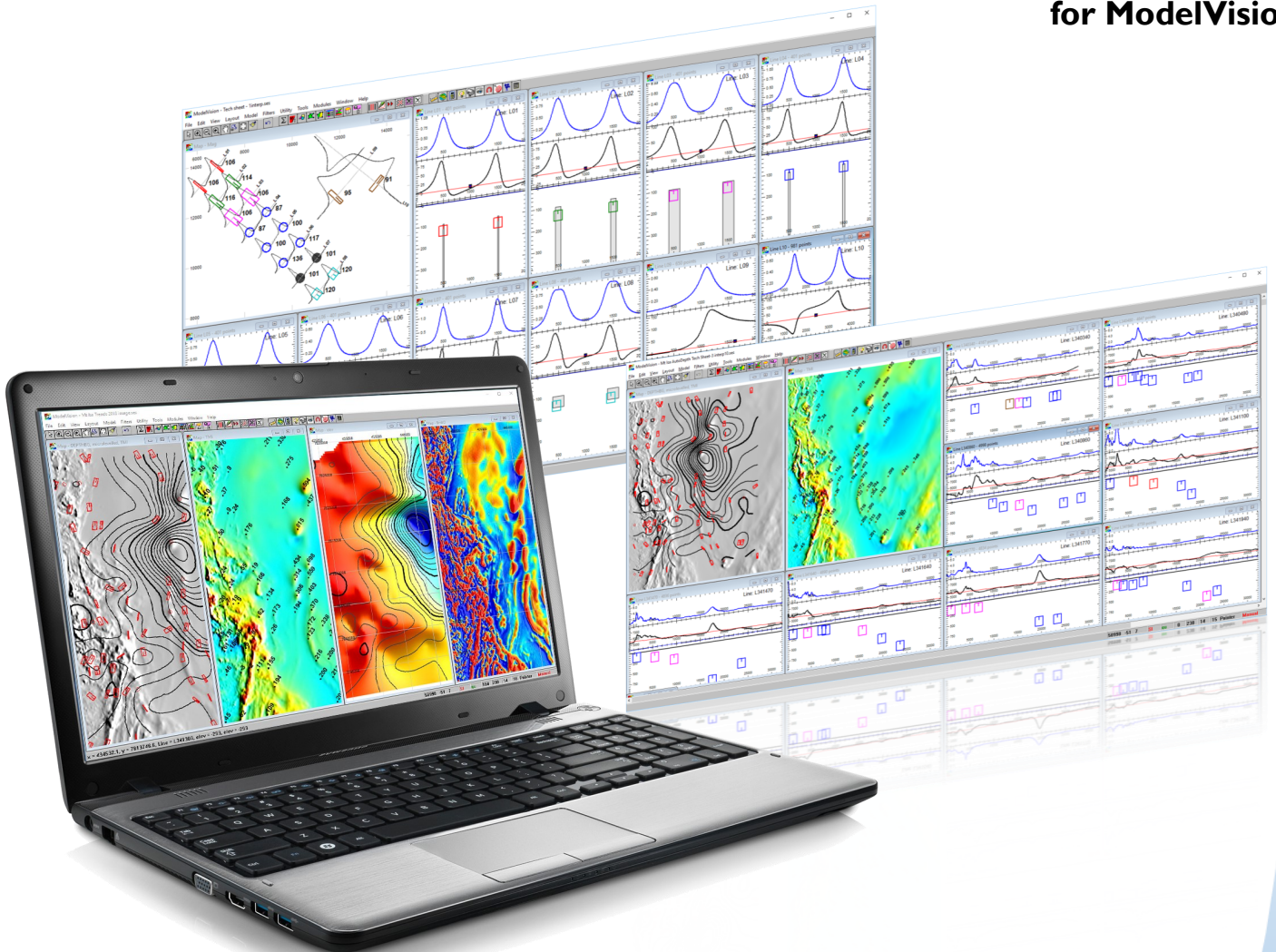# Tensor Research

QuickDepth

for ModelVision

An AI approach to rapid depth estimation from magnetic line and grid data

QuickDepth

QuickDepth applies AI principles to the estimation of depth, magnetic properties and geological style from magnetic data. Not only does AI speed up the interpretation process it leaves the interpreter 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 intelligence is also used to estimate interference from overlapping anomalies to help in the assessment of depth quality or confidence.

Information extraction phase

By extracting all the information that influences the depth, shape, and physical property estimation we have been able to pre-train the system against a wide range of models. This avoids the need for the end-user to train a complex system on each new survey.

The information extraction phase must be run prior to starting the depth interpretation and the results are then available for the current and future sessions. The total magnetic intensity grid is used to derive the 2D estimates of the magnetic tensor, tensor invariants, normalised source strength, magnetic field components, total field gradients and reduction to pole of the total magnetic field.. The 3D attributes of the full magnetic tensor implicitly carries a lot of shape information such as elongation or dimensionality and strike direction.
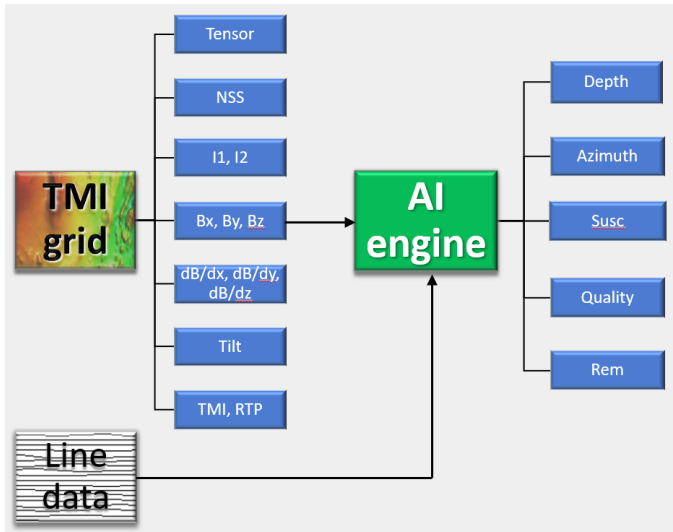
Depth interpretation phase

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. Geological styles are defined in terms of 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.

The accuracy of magnetic depth interpretation is highly dependent on the selection of the correct anomaly style as the target shape has a large influence on the anomaly characteristics and depth estimate. The AI engine uses the pre-conditioned data to estimate the shape and then uses one or more depth estimation methods to obtain a depth value for the selected shape.

The process is repeated for each anomaly with the following steps:

1) Select a data range across the target anomaly in a cross-section view.
2) Compute the depths.
3) Select the most appropriate (best) method.
4) Adjust the auto-detected body type (if required).
5) Save the depth solution.

Estimation Methods

The magnetic tensor measures the curvature of the magnetic field and consequently contains significant 3D information and just one measurement can tell you the direction to the magnetic source. Add more readings and you can resolve the distance, body shape information, azimuth and properties.

The tensor of the total magnetic field is used to derive geological characteristics such as strike direction, body type, centre of magnetization 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 magnetization which simplifies the calculations of depth for the Euler 2D, Werner and Tilt Depth methods. The strike direction of the anomaly (Pederson & Rasmussen, 1990) is used to correct the depth estimates for the Tensor, Peters' Length, Werner Deconvolution and Tilt Depth methods.

Tensor analysis also provides a dimensionality index which automatically differentiates between pipe-like magnetic sources and linear magnetic formations or dykes. This allows for different depth correction techniques to be applied according to the geology. The tensor provides some information about the width of the magnetic source and classifies it as thin, intermediate or thick.

A quality estimator is presented as a guide only and is based on principles that rely heavily on interference estimation and robustness of the tensor method. The user is able to overrule the best method if the interpreted geology matches a different method and body type.

The best method option determines which body will be included in the QuickDepth point data set which preserves the best outcome based on your interpretation of the geology. You can export the best results for each depth method if required, but in general it is best to preserve your preferred interpretation because you have invested time interpreting the probable geology at that anomaly location.

As you interpret each anomaly and save the solution, a symbol representing the top centre of the target (excluding the ellipsoid) is posted in the cross-section. In the case of the sphere or ellipsoid, only the centre of magnetization can be estimated.

You can export the solutions as a point dataset to a Geosoft GDB database or CSV file for use in other applications. The data can be imported into ModelVision using the Convert Point to Body option for display of bodies in cross-section and map views.
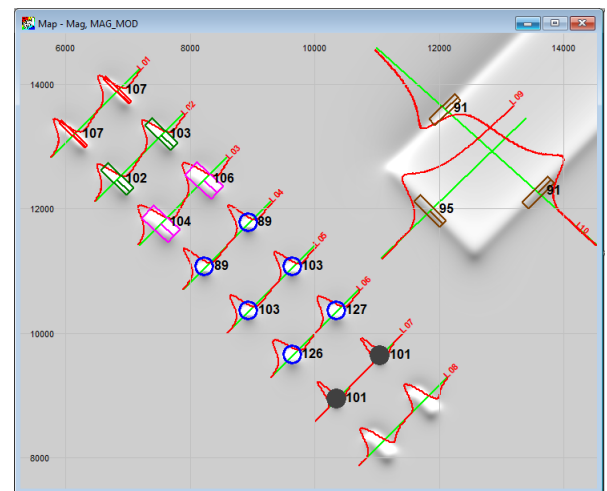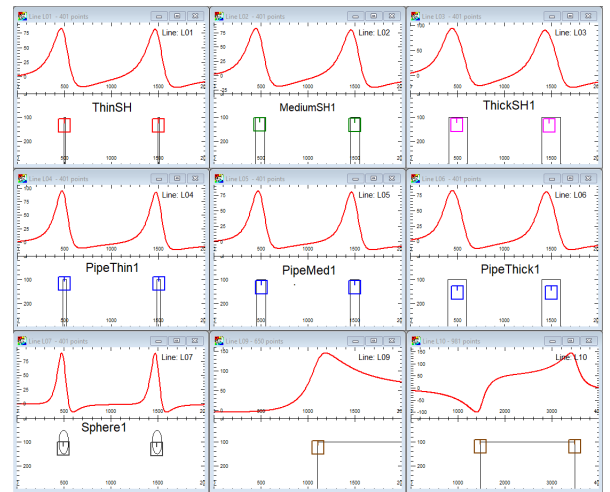
DEPTHBG	QDELEV	SUSC	DIPAZIM	STRIKEAZIM	THICKNESS
106	-106	0.00134	224	134	150
106	-106	0.00134	224	134	150
116	-116	0.00139	224	134	191
114	-114	0.00138	224	134	191
106	-106	0.00124	223	133	303
106	-106	0.00124	223	133	303
87	-87	0.00158	181	91	143
87	-87	0.00160	182	92	142
100	-100	0.00142	181	91	170
100	-100	0.00142	181	91	169
136	-136	0.00143	182	92	267
117	-117	0.00122	181	91	268
101	-101	0.0			
101	-101	0.0			
120	-120	0.0			
120	-120	0.0			
95	-95	0.0			
91	-91	0.0			

REM	DPTHXTNT	SI	DI	QUAL	DBGAV	DBGSD
2	1065	1	0.07	92	96	9.6
2	1063	1	0.07	93	97	9.1
2	1252	1	0.09	92	116	0.0
2	1228	1	0.09	92	114	0.0
2	1289	1	0.26	88	106	0.0
2	1289	1	0.26	88	106	0.0
2	941	2	0.99	95	111	28.1
2	939	2	0.99	96	112	30.5
2	1079	2	0.99	95	125	31.9
2	1077	2	0.99	95	127	35.4
2	1460	2	0.99	92	169	49.1
2	1260	2	0.99	92	167	58.3
2	695	3	1.00	90	120	29.5
2	694	3	1.00	90	101	0.0
2	935	2	0.13	69	143	25.7
2	1136	2	0.14	90	172	40.4
2	1612	0.5	0.13	85	102	10.2
0	1603	0.5	0.08	85	97	5.5

Examples

Experimental Survey

ModelVision provides tools that allow you to create experimental surveys over any geological model. This example shows a geological model composed of all the body shapes that can be supported by QuickDepth with lines that are at 45 degrees and elongate bodies that are perpendicular to the line direction.

In this example, the true depth is within 5 to 15% of the true depth when the correct body type is selected. In cases where there is no appropriate model from the original AI training such as the thick pipe, you can expect an overestimation of the depth. The strike direction is estimated within two degrees of the true direction.
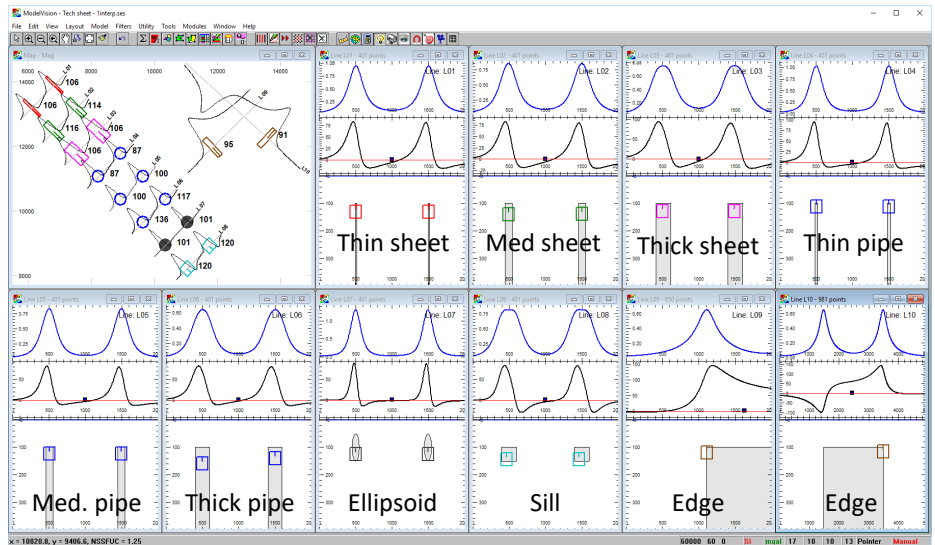
Mt Isa Region Example

QuickDepth was applied to the magnetic data in the Mt Isa-Cloncurry region of western Queensland where the sedimentary cover dips below cover to the north-east. A subset of the lines was selected for depth interpretation to provide a quick indication of depths across the survey area.
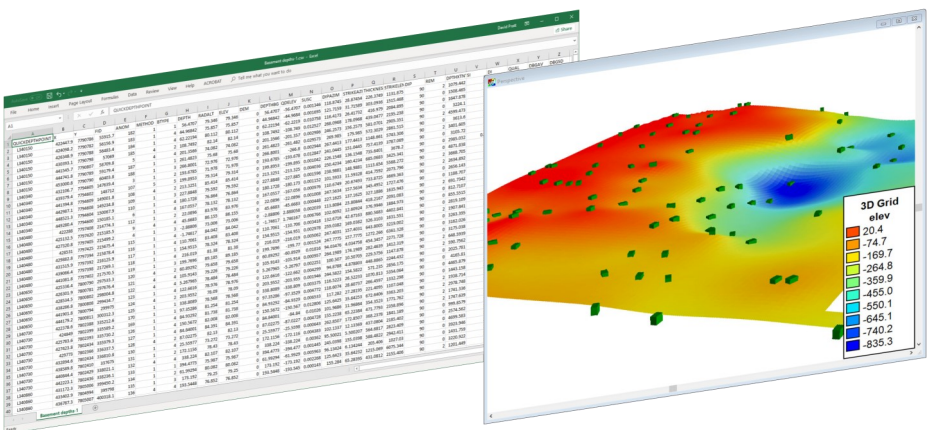
Depth below ground values were then gridded and contoured to show regions more prospective for exploration drilling.
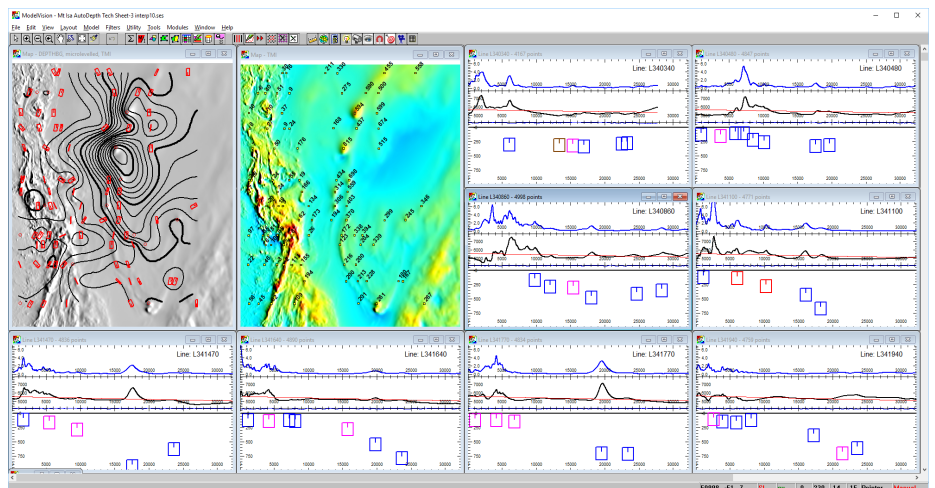
Visualisation & Export

There are many ways to visualise the result of your QuickDepth interpretation sessions. The solutions are automatically displayed in your depth sections and easy to add to a map view. Explore the use of other parameters such as magnetic susceptibility, azimuth, dimensionality and structural index (SI).

It is simple to export your depth points as a spreadsheet or GDB file for use in other products.