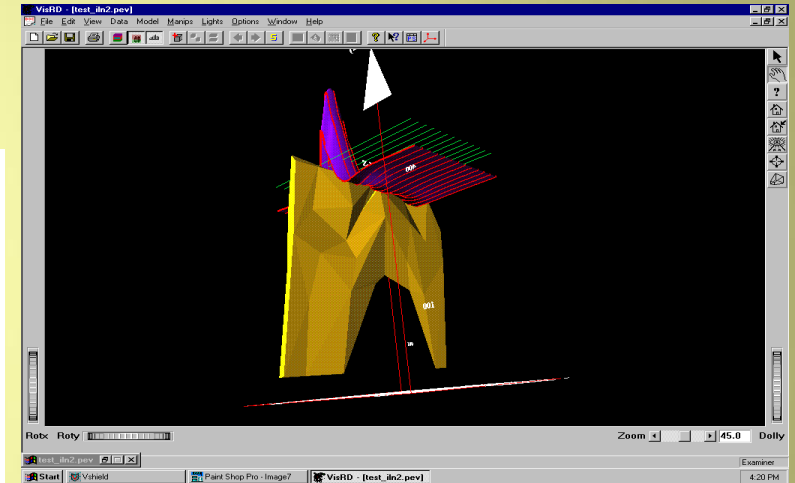
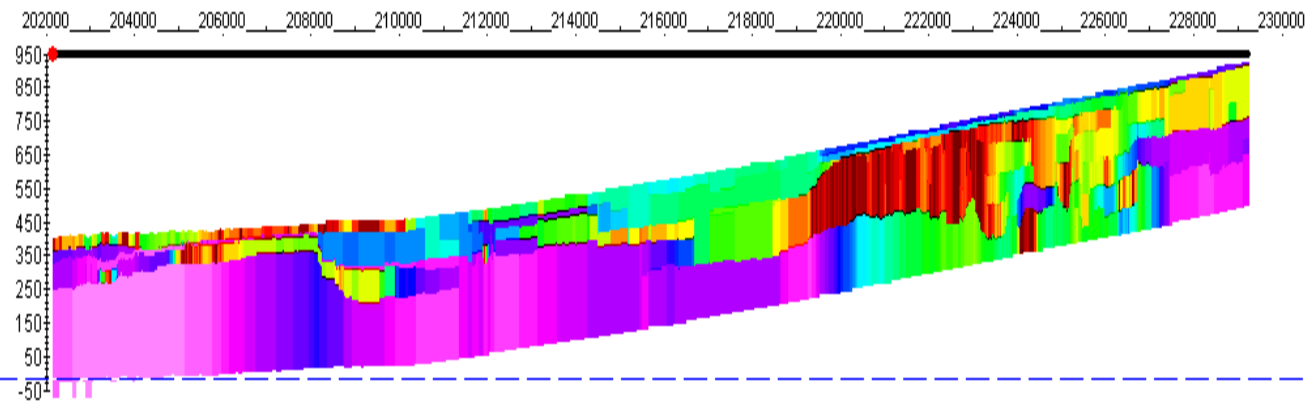


Eikon Technologies (Earth Imaging)

Software for Detection, Delineation, Exploration, Education and Quality Control

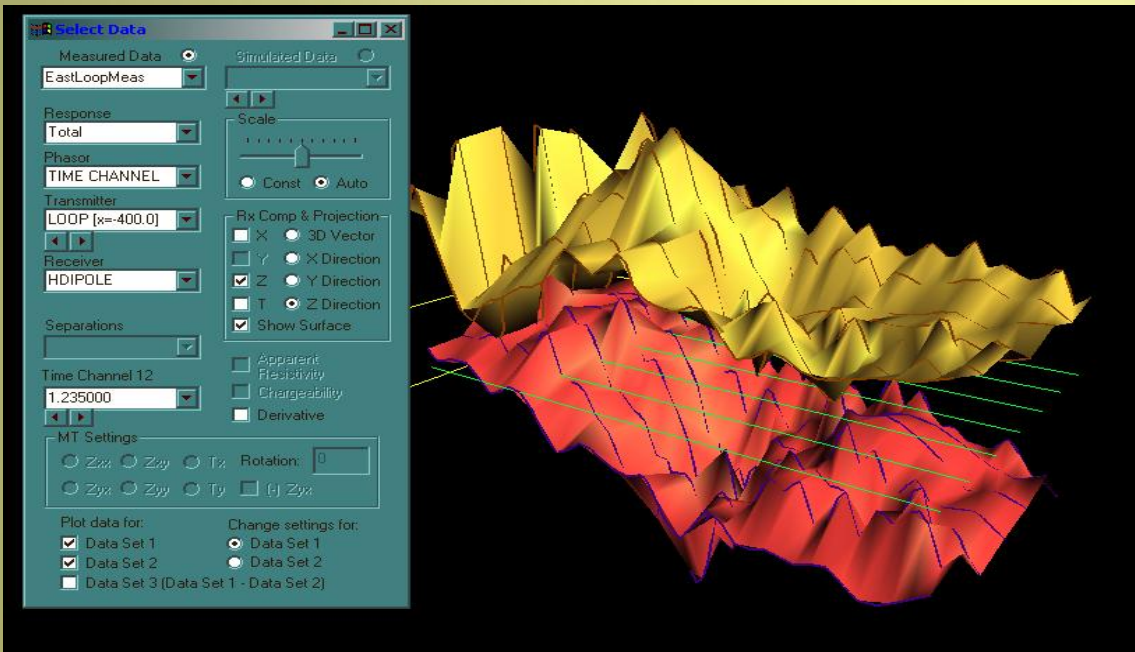
Aquifer study



Ni/Zn Deposit

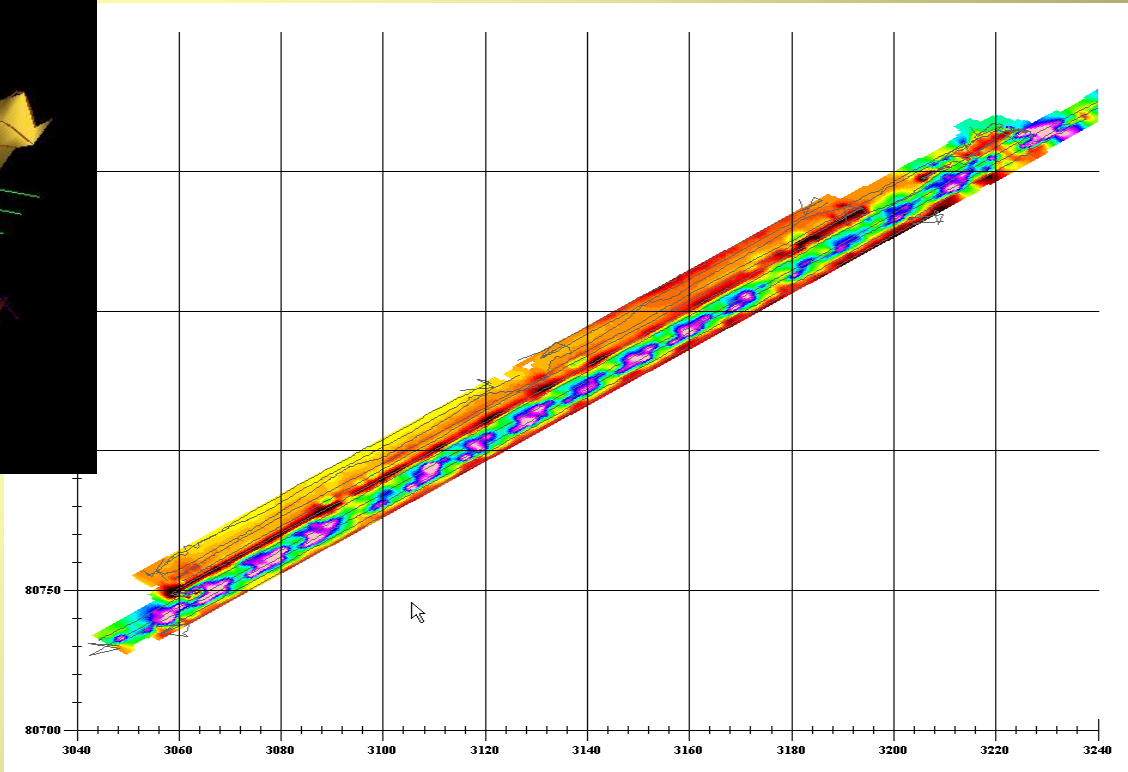


Developing Software for Interpretation of Geophysical Data Since 1994



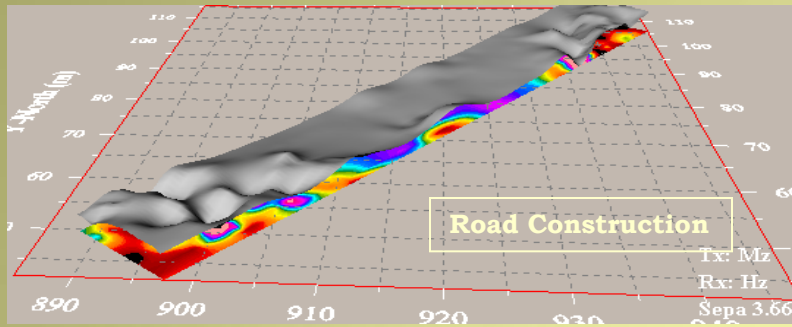
Uranium Exploration

Urban Hazards



Modelling, Inversion, Data Analyses, Research

Applications



TEM

FEM

MAGNETICS

AEM

HEM

CSAMT/CSEM

IP

RESISTIVITY

GRAVITY

MT

MMR

VLF

BOREHOLE

SURFACE

AIRBORNE

CROSSHOLE

✓ Mining Exploration and Delineation

✓ Environmental Detection and Monitoring

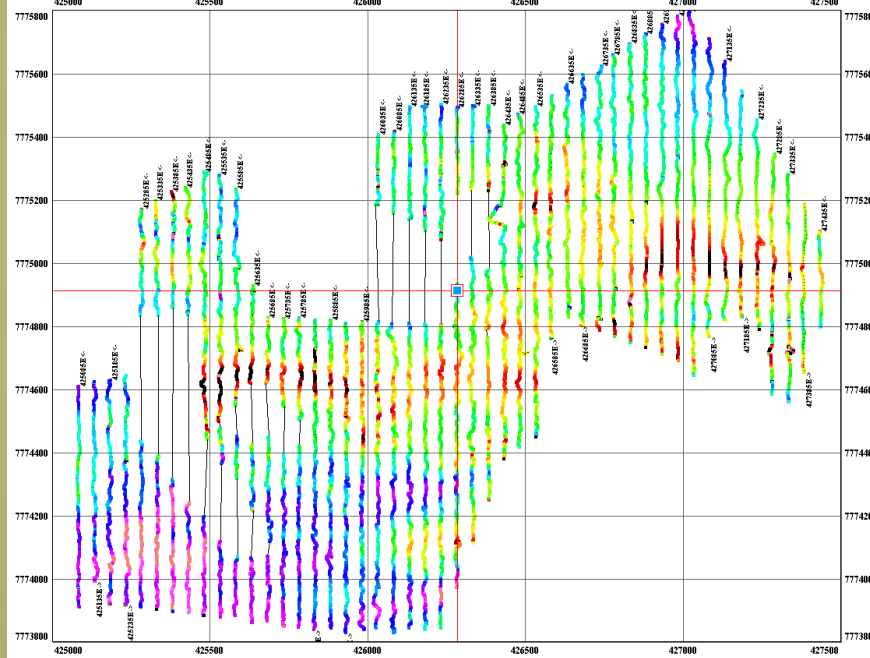
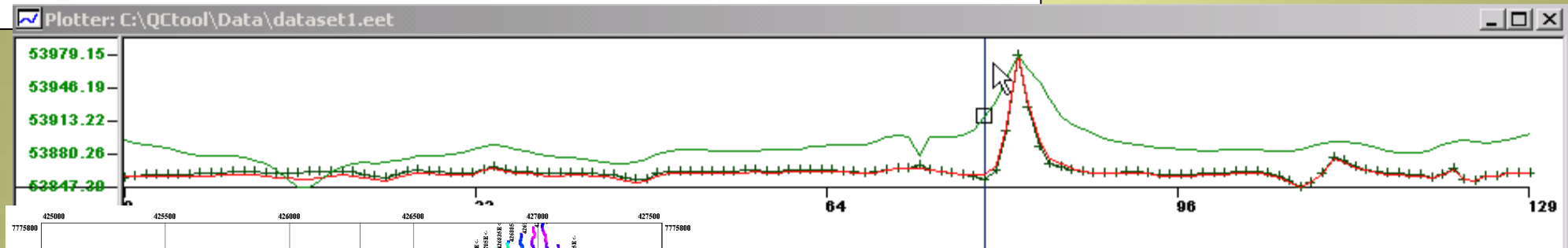
✓ Geotechnical Investigations

✓ Oil and Gas Exploration

✓ UXO

- ✓ detect, delineate
- ✓ depth determination, spatial resolution
- ✓ survey design
- ✓ characterisation, evaluation
- ✓ research

QCTool

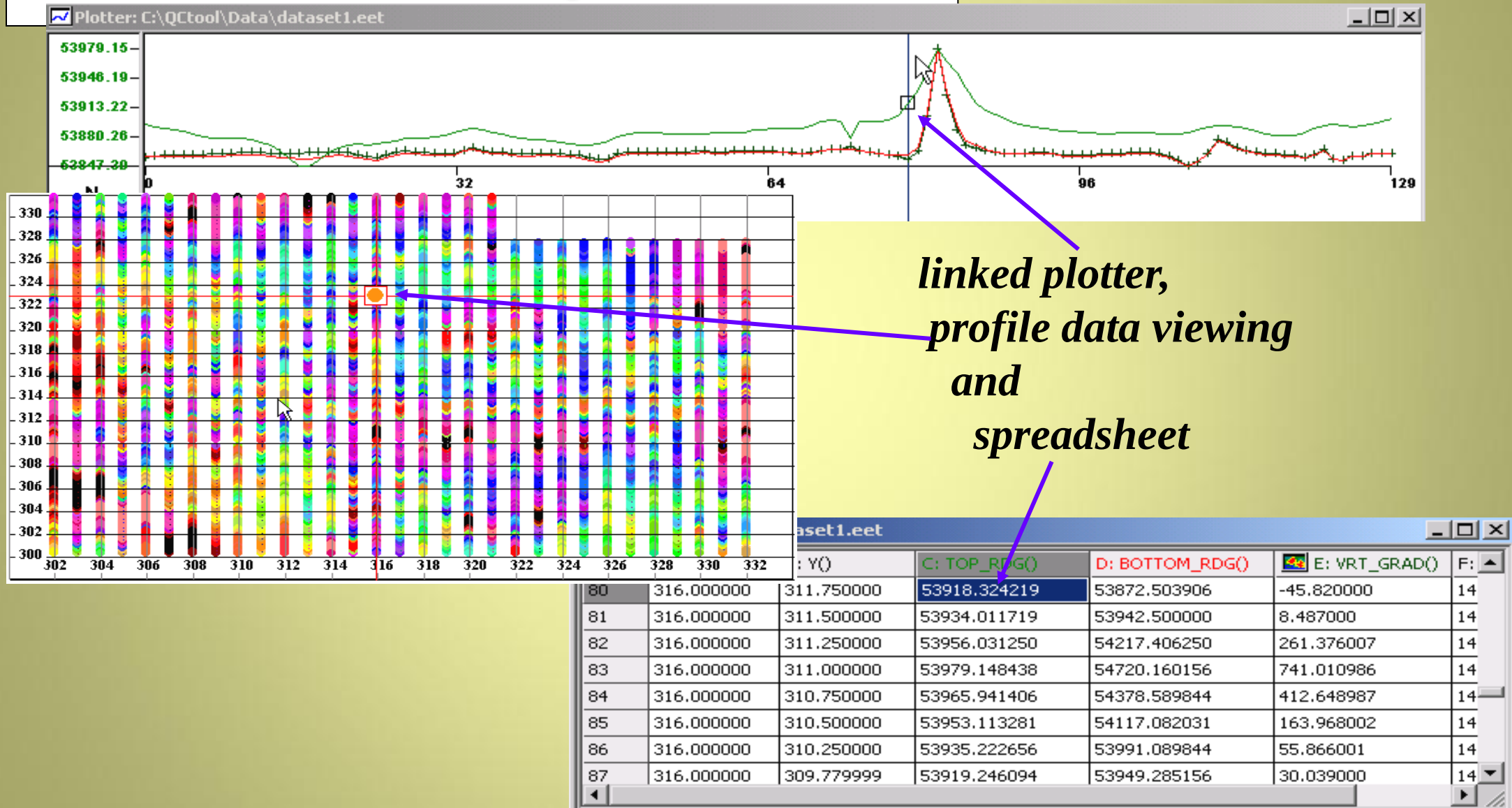


*for data Quality Control
editing, plotting, gridding,
mapping, processing and
and filtering*

ol\Data\dataset1.eet					
X()	B: Y()	C: TOP_RDG()	D: BOTTOM_RDG()	 E: VRT_GRAD()	F: ▲
5.000000	311.750000	53918.324219	53872.503906	-45.820000	14
5.000000	311.500000	53934.011719	53942.500000	8.487000	14
5.000000	311.250000	53956.031250	54217.406250	261.376007	14
16.000000	311.000000	53979.148438	54720.160156	741.010986	14
16.000000	310.750000	53965.941406	54378.589844	412.648987	14
16.000000	310.500000	53953.113281	54117.082031	163.968002	14
16.000000	310.250000	53935.222656	53991.089844	55.866001	14
16.000000	309.779999	53919.246094	53949.285156	30.039000	14

Ground Magnetics – Gold Exploration

QCTool₂



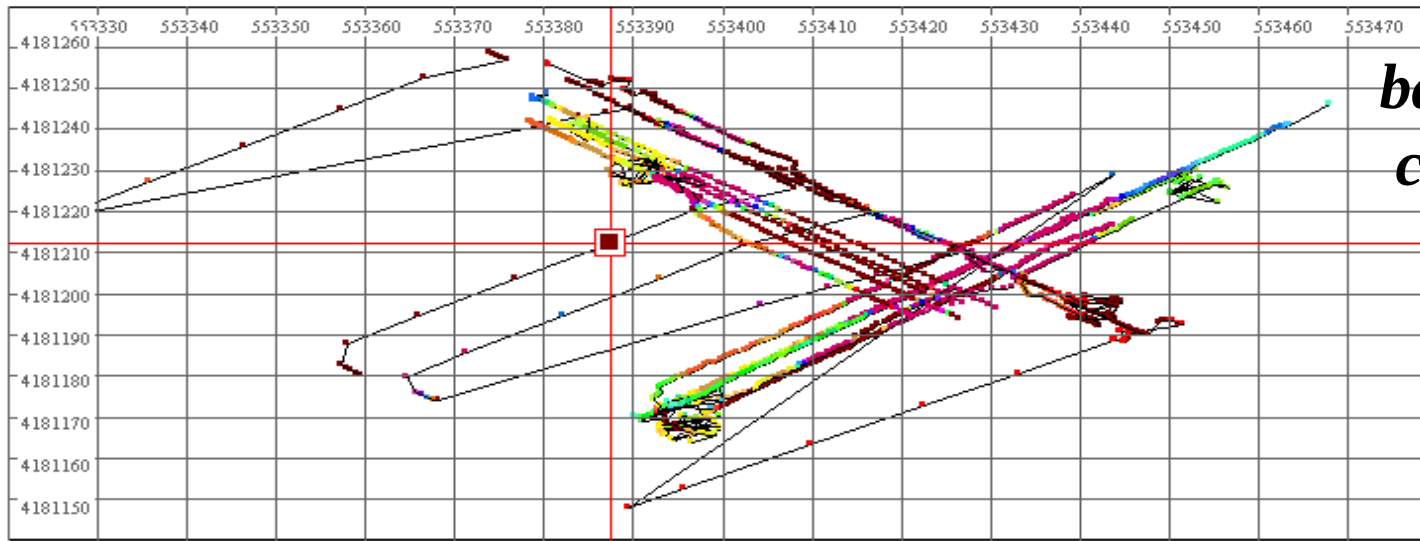
QCTool₃

E: CPQ980...	F: CPI9800S2Q	G: CPQ9800S3Q	H: CPI9800S3Q	I: FIDS3Q	J: reducedQ
-8.750000	20.478001	-195.750000	-20.469999	2015.979980	*
-183.750000	20.	Formula Calculator Result: J Formula: log(a)*sqrt(d)/d^3 Save Load Clear Check Formula Formula result Row: 1 0.003026 Rows ☒ All Rows ☐ All Lines From: 1 To: 51 Functions sin arcsin x^2 ln cos arccos x^3 log tan arctan 10^x sqrt int abs exp PI Numeric 7 8 9 () 4 5 6 - / 1 2 3 + * 0 . ^ Backspace Delete ☐ Degree ☒ Radians Columns: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Apply Exit			
-292.250000	20.				
-127.500000	20.				
-118.500000	20.				
-162.250000	20.				
-0.750000	20.				
-308.500000	20.				
-361.500000	20.				
61.250000	20.				
188.250000	20.				
190.500000	20.				
160.500000	20.				
157.250000	20.				
163.250000	20.				
163.500000	20.				
110.000000	20.				
102.250000	20.				
145.250000	20.				
160.250000	20.				
176.750000	20.				
227.750000	20.				
229.500000	20.				
45.250000	20.478001	101.250000	20.478001	2020.589966	*

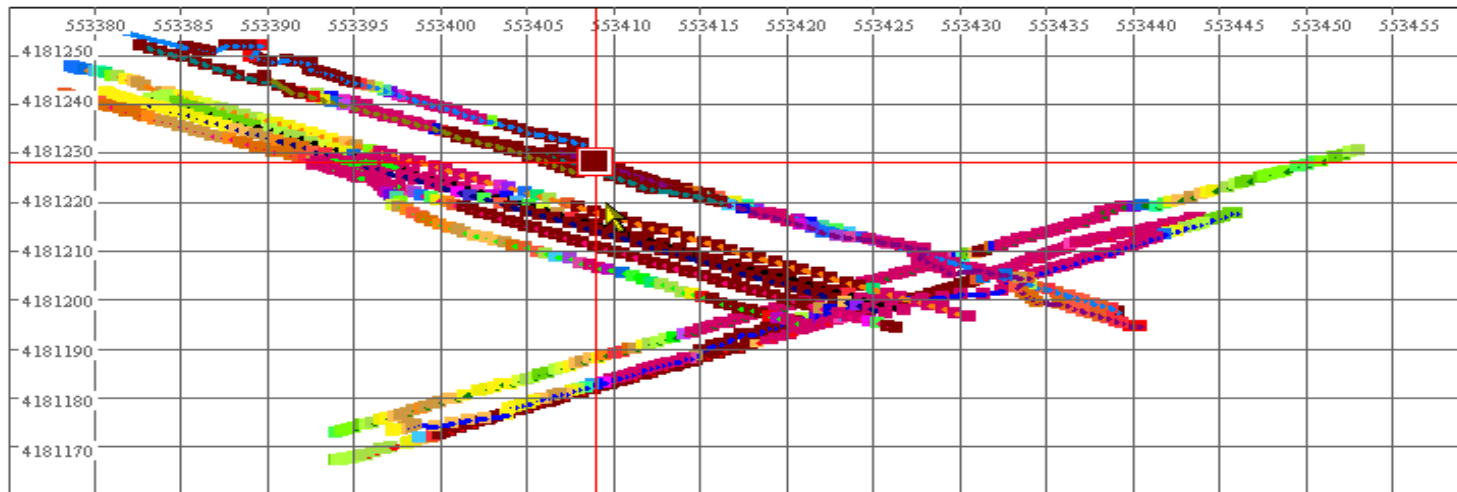
*Spreadsheet functions,
new channels calculator*

QCTool 4

Survey Cleaning



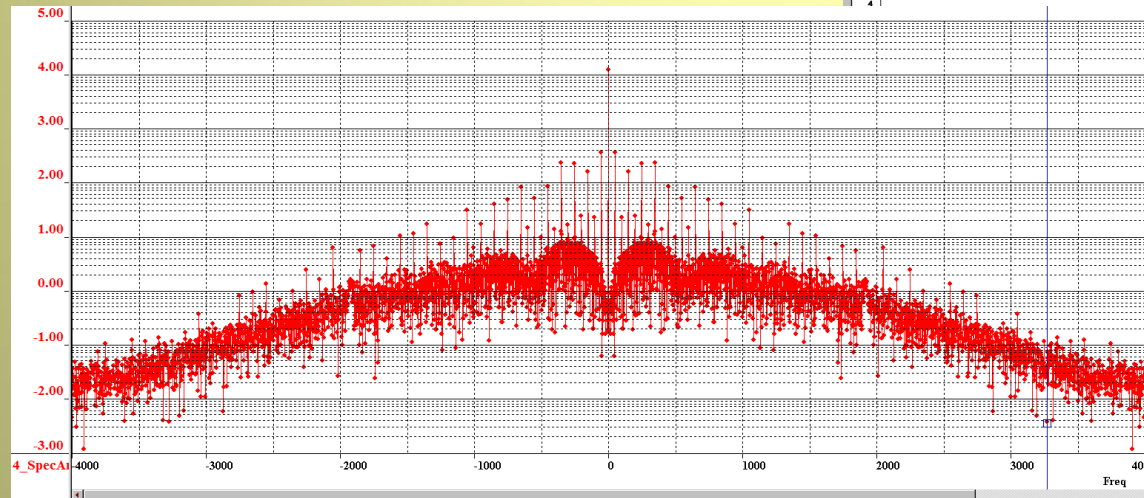
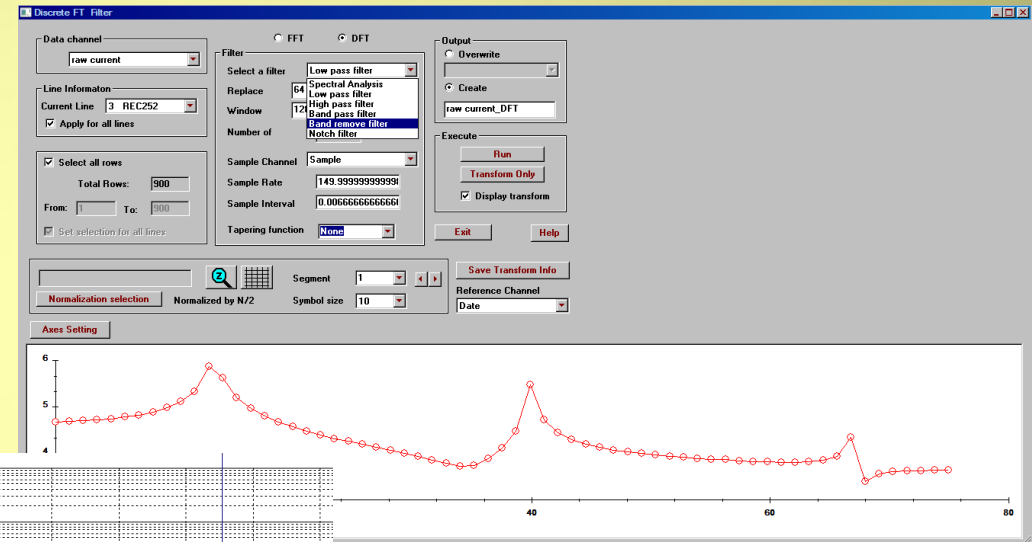
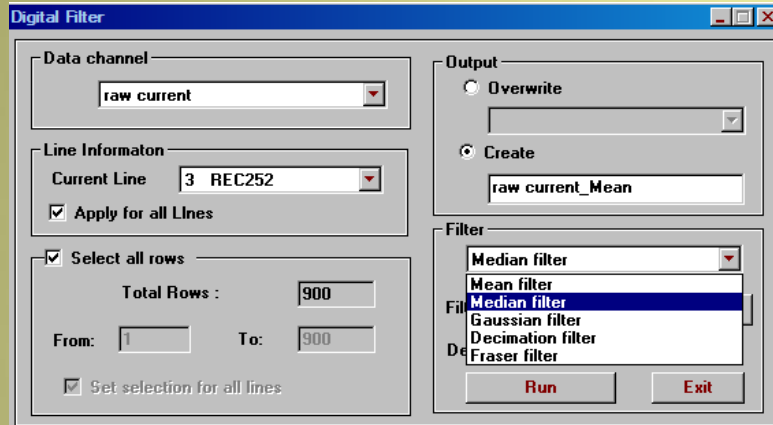
*bad data location editing
coloured data displays*



Munitions Testing Site ground FDEM

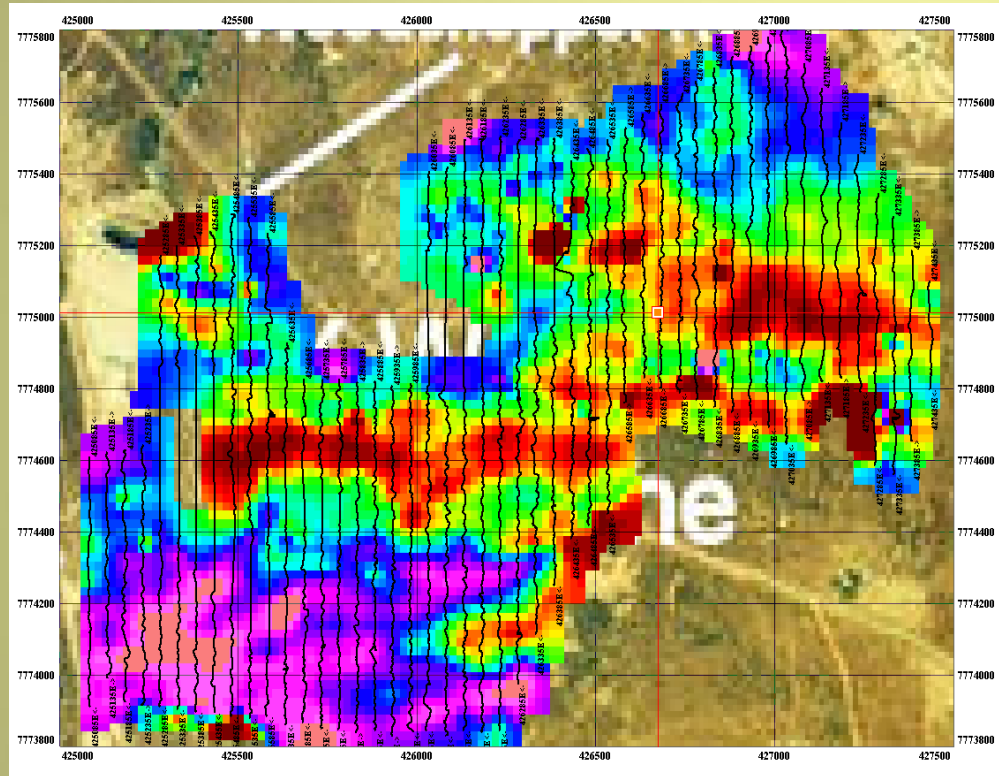
QCTool 5

*Data Filtering
Spectrum Filtering
and Analyses – FFT,DFT
Raw vs filtered overlays*



QCTool₆

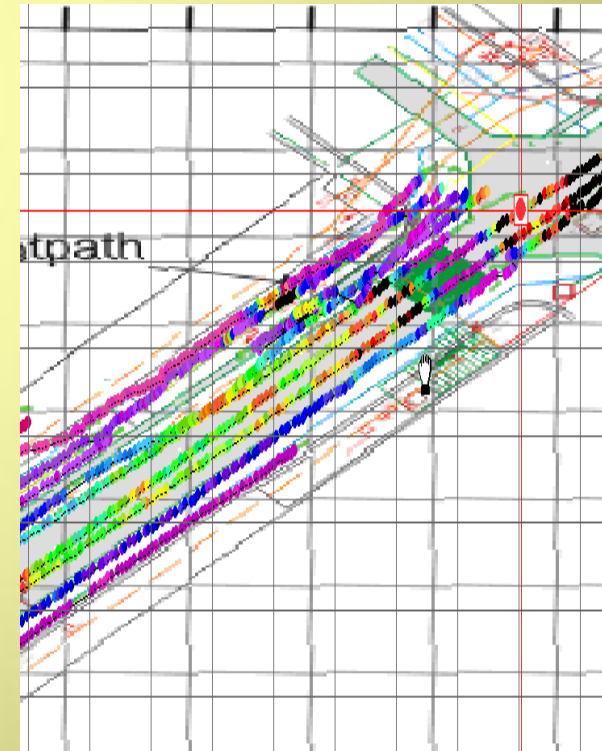
Mapping



Ground Magnetics – Gold Exploration

Fuel Dump contamination – EM31-3

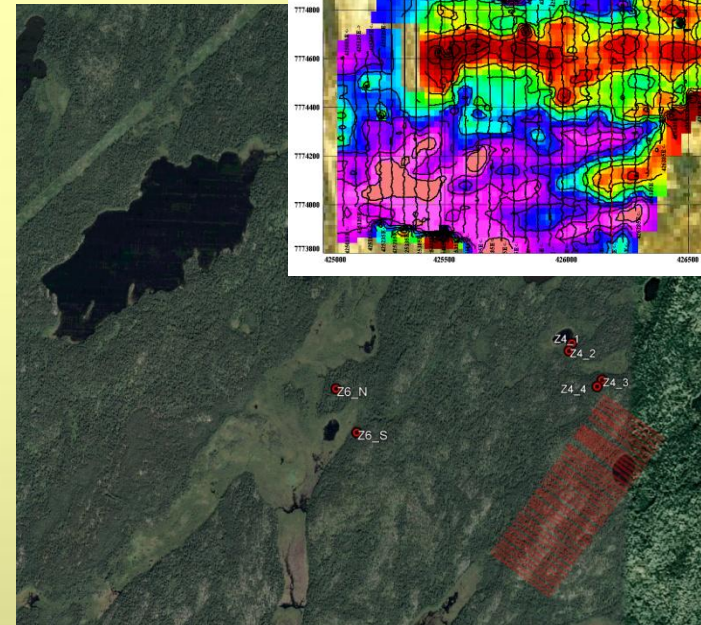
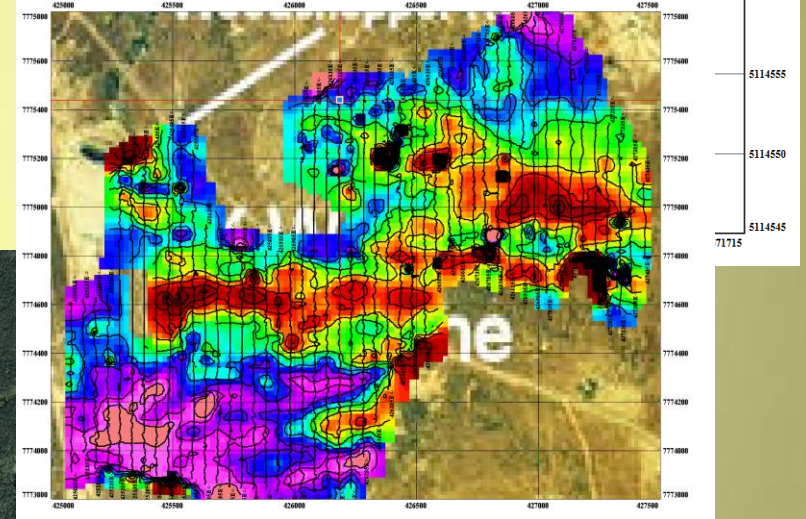
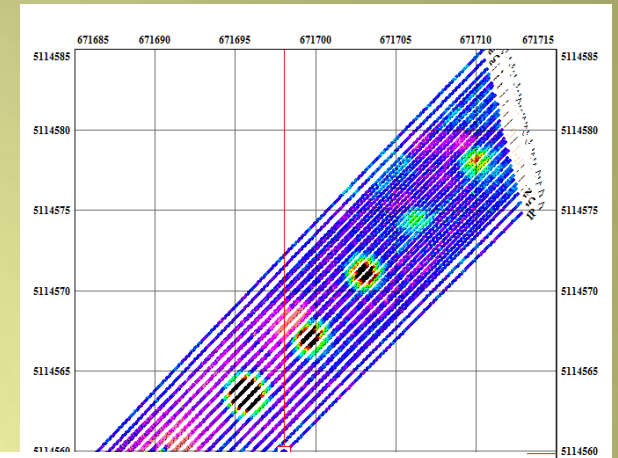
*non-convex local contouring,
rectangular grid cells,
map underlays*



QCTool 6

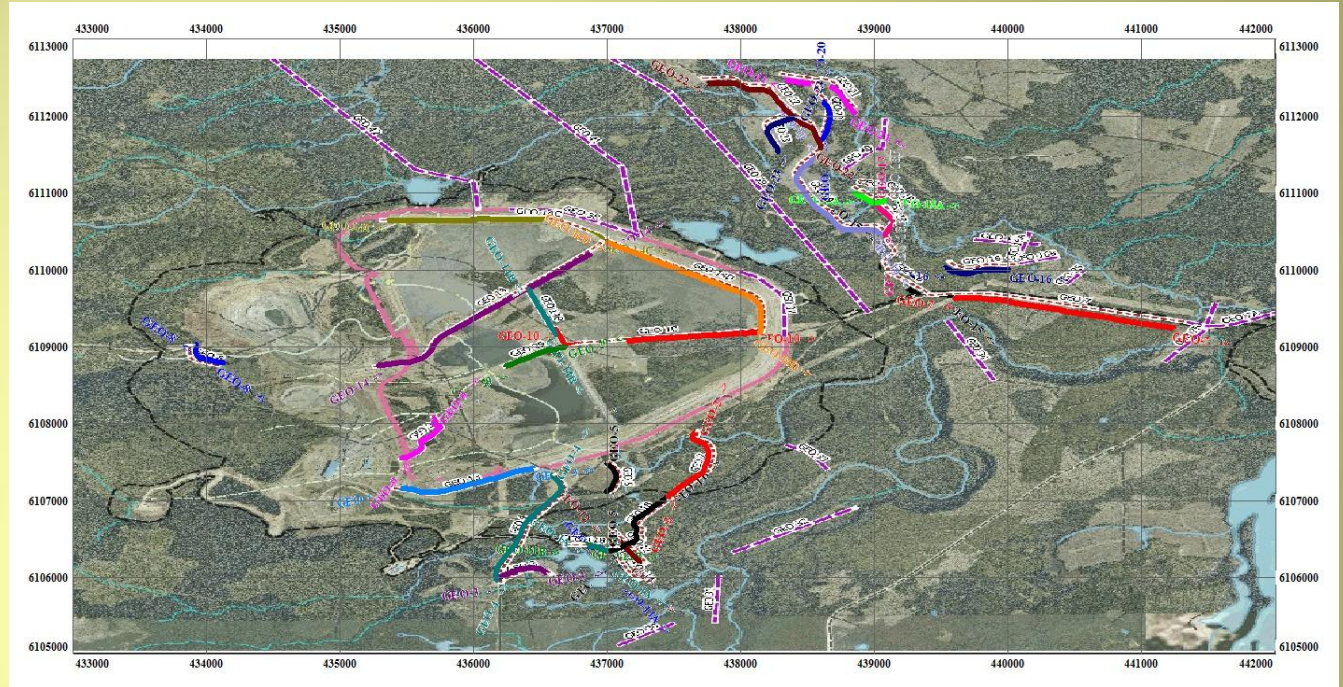
Mapping

- import/export for ArcMap, MapInfo
- create GoogleEarth files
- save as registered PDF
- export 2D Autocad files
- merge maps, transparencies
- annotate maps



QCTool ₇

- *Easy to use*
- *Low cost*
- *Large or small datasets*
- *Small installation*
- *Perfect for infield QC*
- *Imports & Exports*
- *Data Merging and integration*
- *Map Calibration, Annotation and data overlays*



QCTool₈

Data Imports

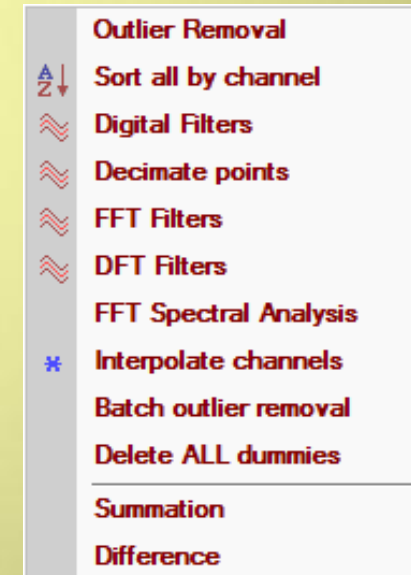
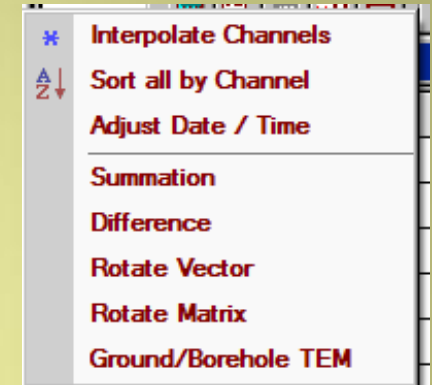
- *Standard Ascii and Excel formats*
- *Geophysical Instrument formats*
- *Borehole log formats*
- *Topography formats*
- *Grid formats*
- *Garmin , Surpac, Geosoft, GPX, .bil and much more*

ASCII XYZ
ASCII CSV
Binary XYZ
Scintrex CG3
Scintrex CG5
Scintrex IPR_12
Scintrex ENVI Cs/Navmag
Scintrex ENVI/ENVI PRO
Micro-g LaCoste Air-Sea (DAT)
Micro-g LaCoste Air-Sea (ENV)
Geometrics G-858/G-859(STN)
Geometrics G-856(STN)
Geometrics G-882
Stratagem impedance file
Zonge AVG (new format)
Zonge AVG (legacy format)
Zonge ZEN
GEM ASCII
SeaSPY(Marine Magnetics)
Geonics EM31 (ASC, M31)

Geonics EM34 (G34)
Geonics EM38 (G38)
Geonics TEM
Pico
GDD IP
Garmin GDB
Phoenix CSAMT (AVG)
Phoenix CSAMT (STK)
Phoenix Time Series
Surpac STR
SMARTem24 (RAW)
Geosoft GBN
Geosoft GDB
MT/CSAMT EDI (Impedance)
MT/CSAMT EDI (Spectral)
MT/CSAMT TBL Format
VLF TBL Format
IRIS VLF ASCII
Universal Sounding Format(USF)
SEG Y format

Geophysical logs (LAS)
GPS Exchange Format(GPX)
EGR Grid File
ArcGIS FLT
Band Interleaved by Line (BIL)
Geosoft grid file (grd)
GTOPO DEM file
CDED DEM file
Grid exchange file (GXF)

- *Merge/Append Files*
- *Geographic Coordinate Transformations*
- *Data Filtering*
- *Vector and Matrix Rotations*
- *FFT/DFT Spectral analyses*
- *a range of digital filters*
- *Data stacking tools*



Specialized Processing Tools

- *Gravity Processing* – all gravity reductions including the most advanced topographic corrections available
- *Magnetic Processing* – standard magnetic processing with enhanced derivative calculations and vector data and vector derivative de-rotations
- *IP Data Processing* – QC/QA for data survey processing and integration, with mapping, line and decay plots, apparent resistivity and Cole-Cole calculations
- *Magnetotelluric Processing*
- *TDEM processing from raw time series*
- *CSEM processing from raw time series*
- *TDEM/FDEM editing and display tools*



EMIGMA Survey Capabilities

Design Aim:

All non-seismic data surveys from DC to 5 MHz!

❖ Data Types

- ❖ *EM, Resistivity, IP, Magnetics, CSAMT, MT, MTEM, CSEM*
- ❖ *Gravity*

Survey Styles

- *surface*
- *airborne*
- *surface to borehole*

➤ *borehole to borehole*

* not all combinations available

Data analyses and editing tools

3D Visualization

3D Model Building

CAD Model Imports (from other applications such as AutoCAD, Surpac and Vulcan)

3D Data Simulation – instrument calibrated – Magnetics, Resistivity, Gravity, EM, IP, MT, CSAMT

3D Magnetic Inversion, 3D Gravity Inversion

3D Resistivity Inversion

3D MT Inversion, CSAMT, land-based CSEM Inversion, ZTEM

1D FEM, TEM, Resistivity, CSEM, MT, CSAMT Inversions

FEM, TEM, Resistivity Pseudo-Depth and Geoelectric Sections

Data Processing, Filtering and Editing

1D Digital and Spatial filters, 2D spatial filters

Advanced Interpolation and Gridding Tools

- rectangular grid elements, multi-component grids
- gradient gridding, non-planar gridding, constant drapes

Model Stripping

Potential field data transforms – filtering, continuation, RTP

Magnetic and Gravity Gradients

Magnetic Compensation

Xhole Tomography

Gravity – 3D Modeling and Inversion

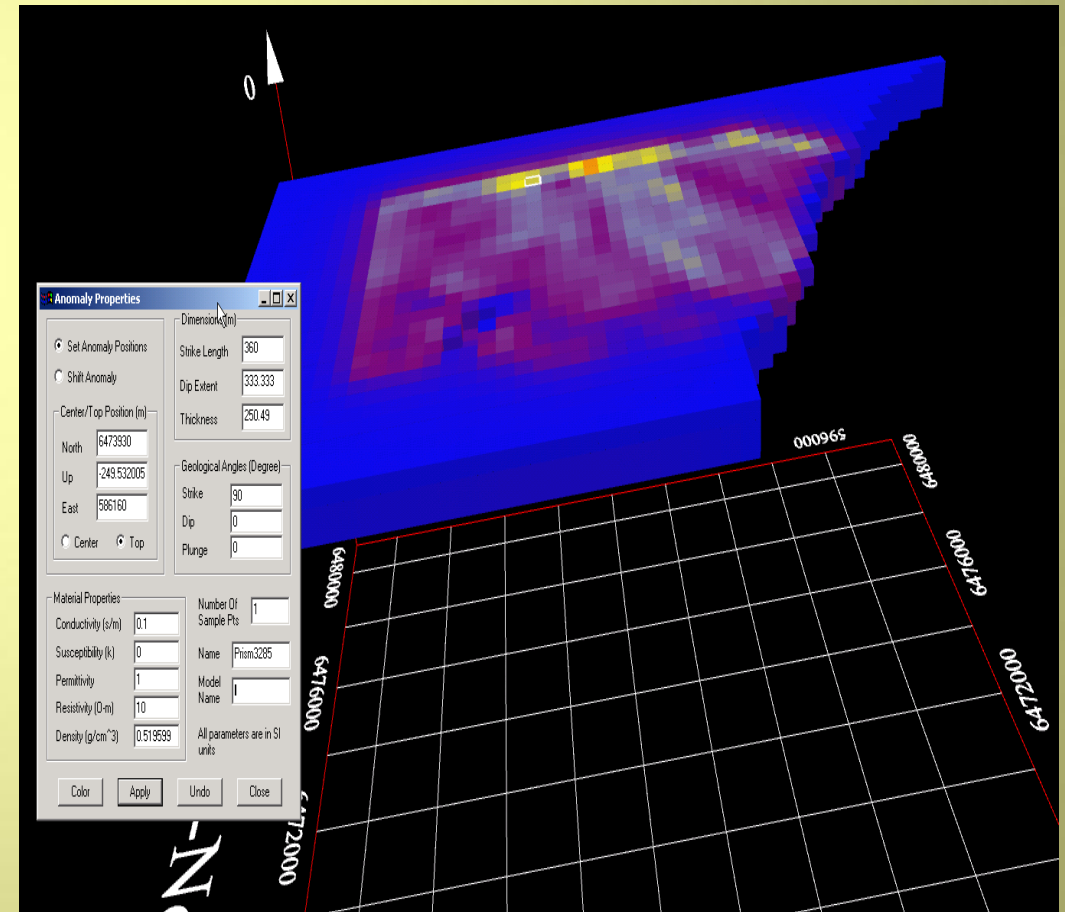
3D Euler and Post-Processing including 3D Visualization

FFT tools

(basic data processing also available)

EMIGMA Tools

Ground Gravity Inversion



the data may be shown and the interface allows the user to define the inversion or “search” grid

centre of XY-grid

total size of XY-grid

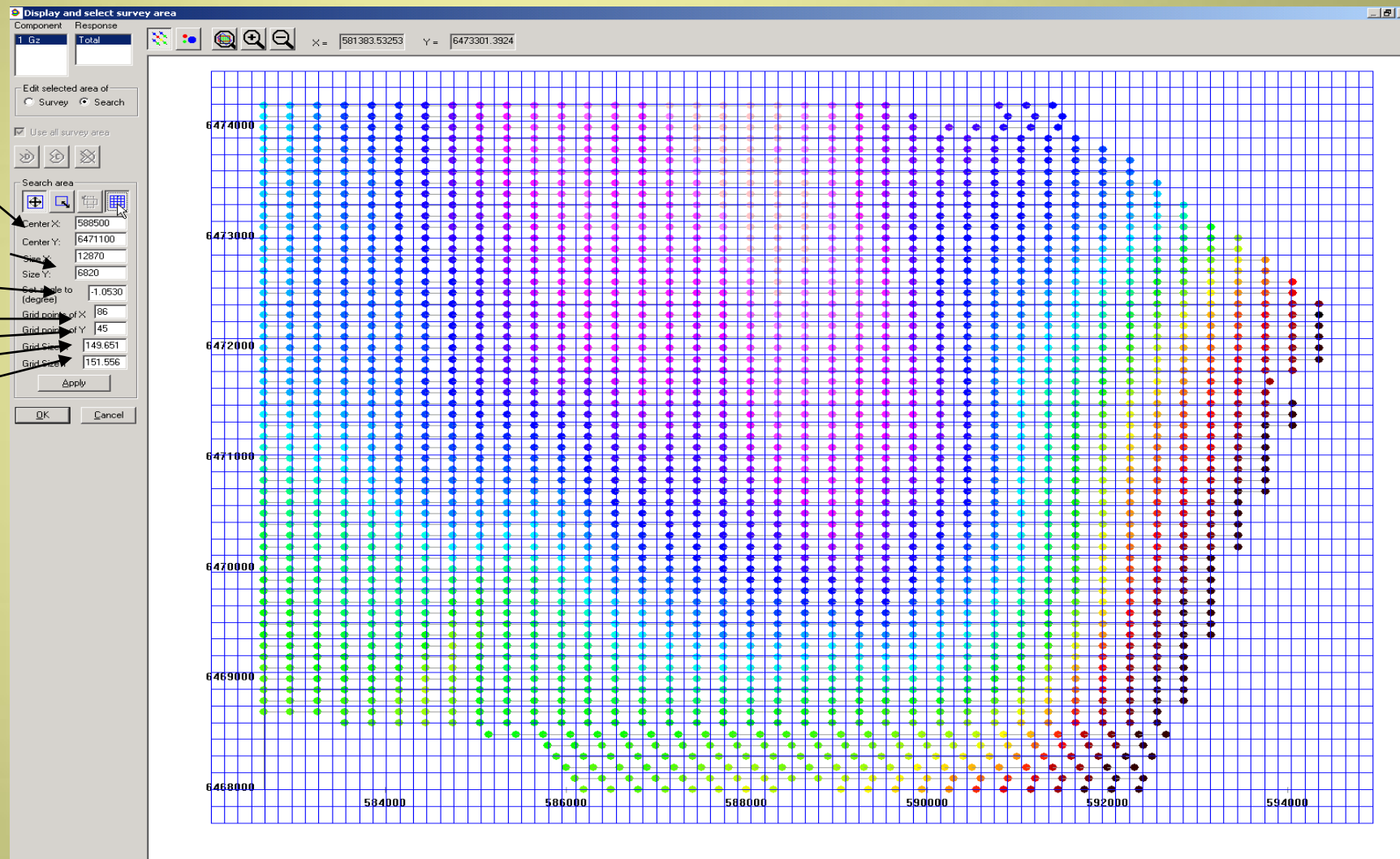
angle of grid

Nx in grid

Ny in grid

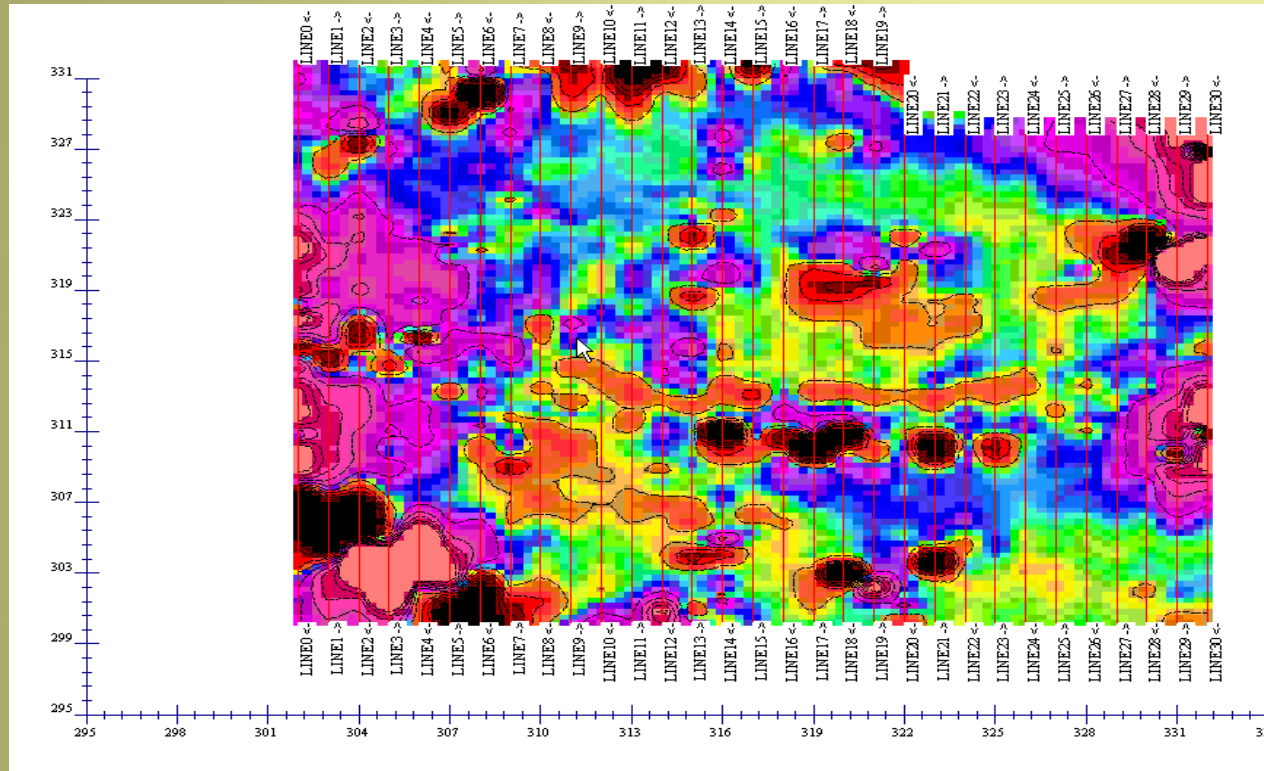
dX in grid

dY in grid



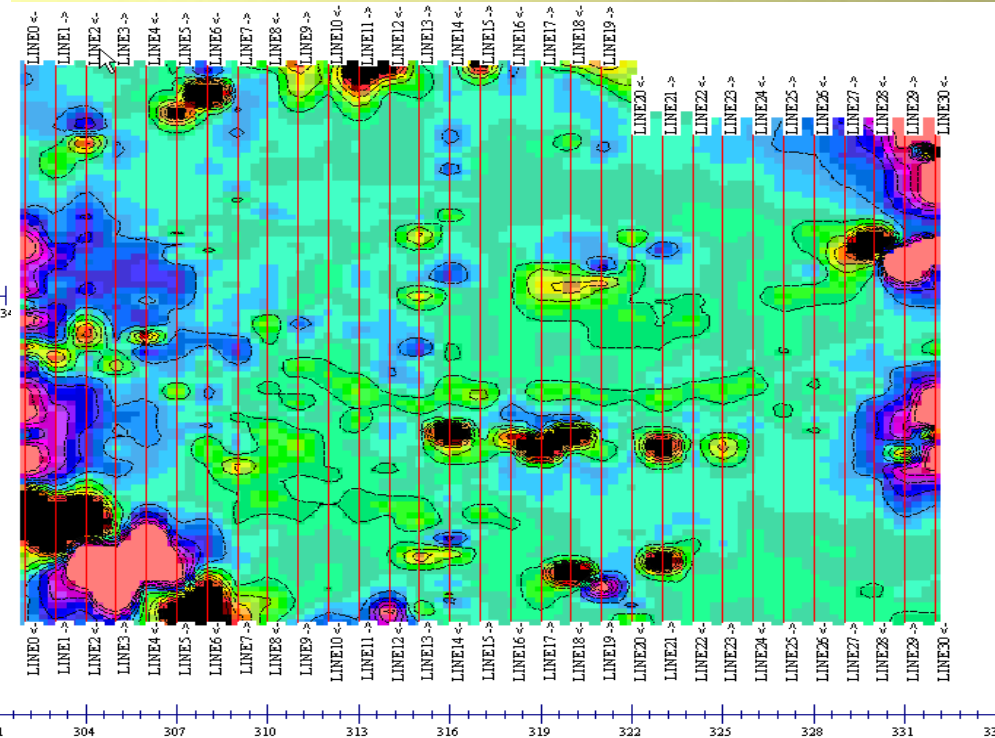
Data Interpolation and Contouring 1

*Natural Neighbour, Shepard, Delaunay - Local
Minimum Curvature - global*



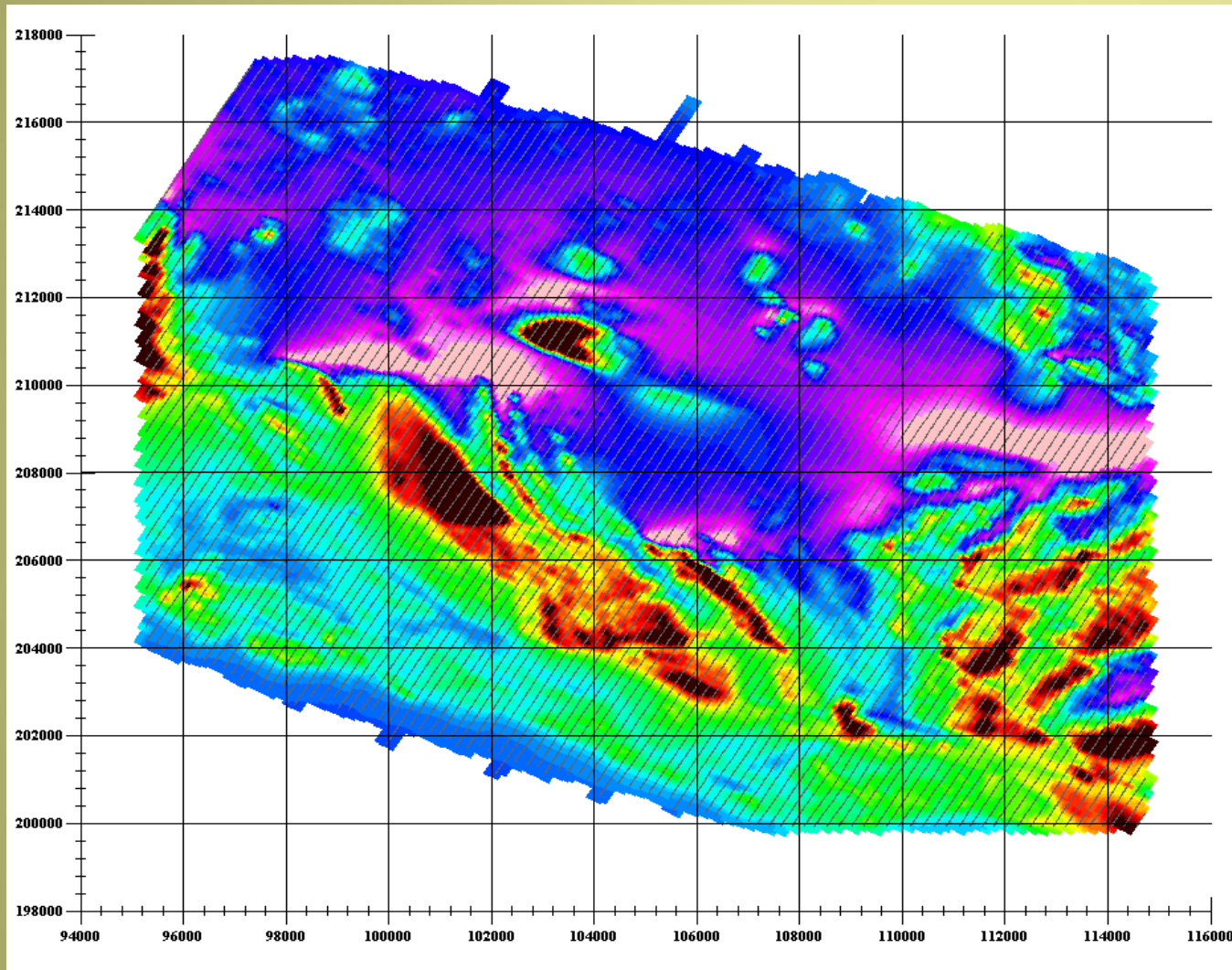
Rectangular grid cells
Multi-component grids

Equal Weight



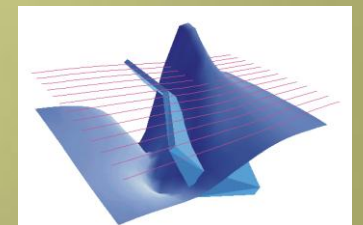
Equal Range

Data Interpolation and Contouring 2



Massive Sulphide Exploration – Spain/Portugal

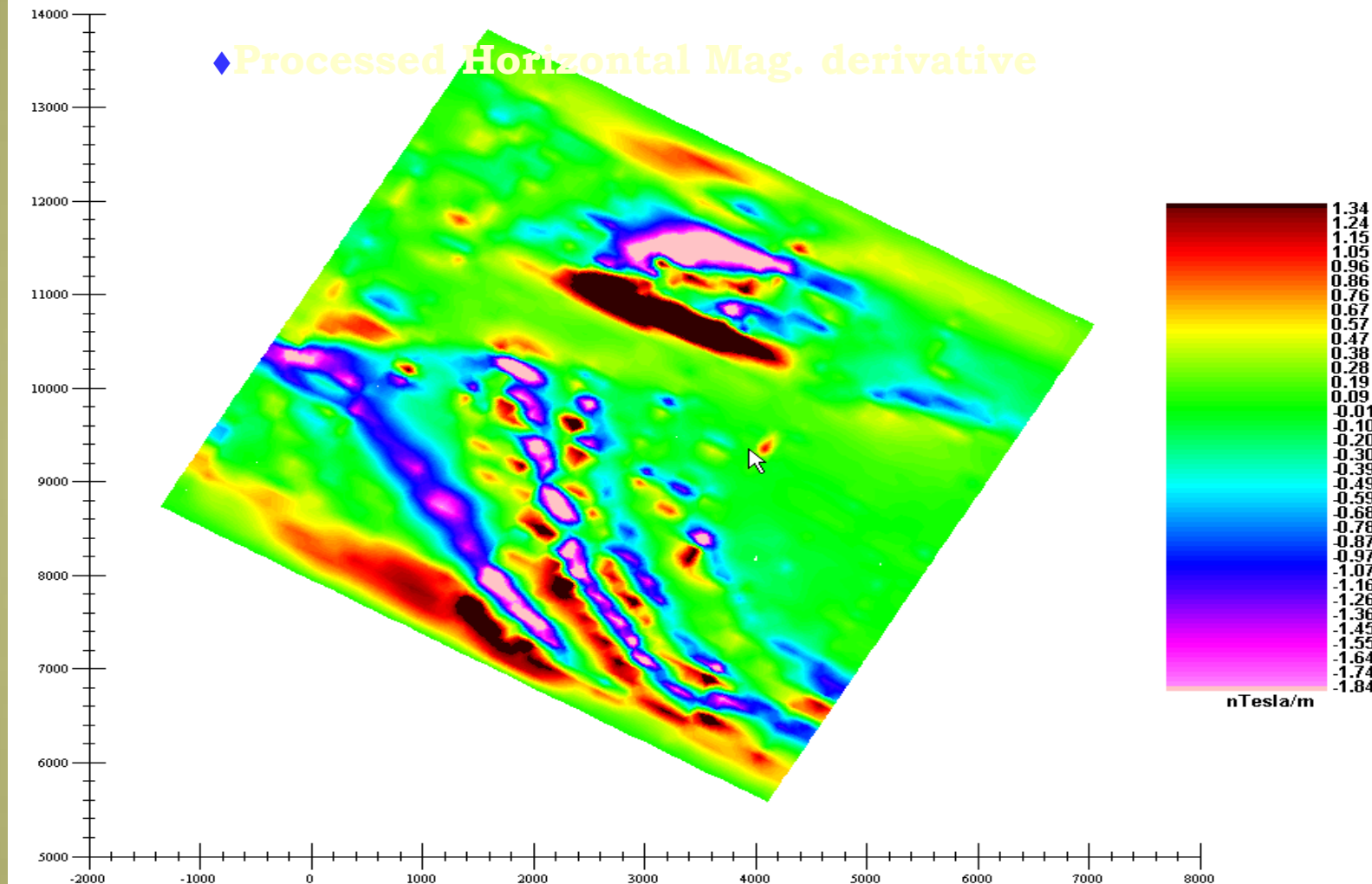
- ✓ **Natural Neighbour Interpolation**
- ✓ **Delaunay Triangulation**
- ✓ **Shepard**
- ✓ **Minimum Curvature**
- ✓ **Splines**



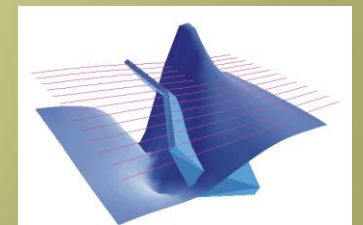
Data Interpolation and Contouring 3

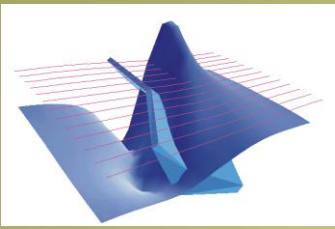
◆ Processed Horizontal Mag. derivative

Grid View

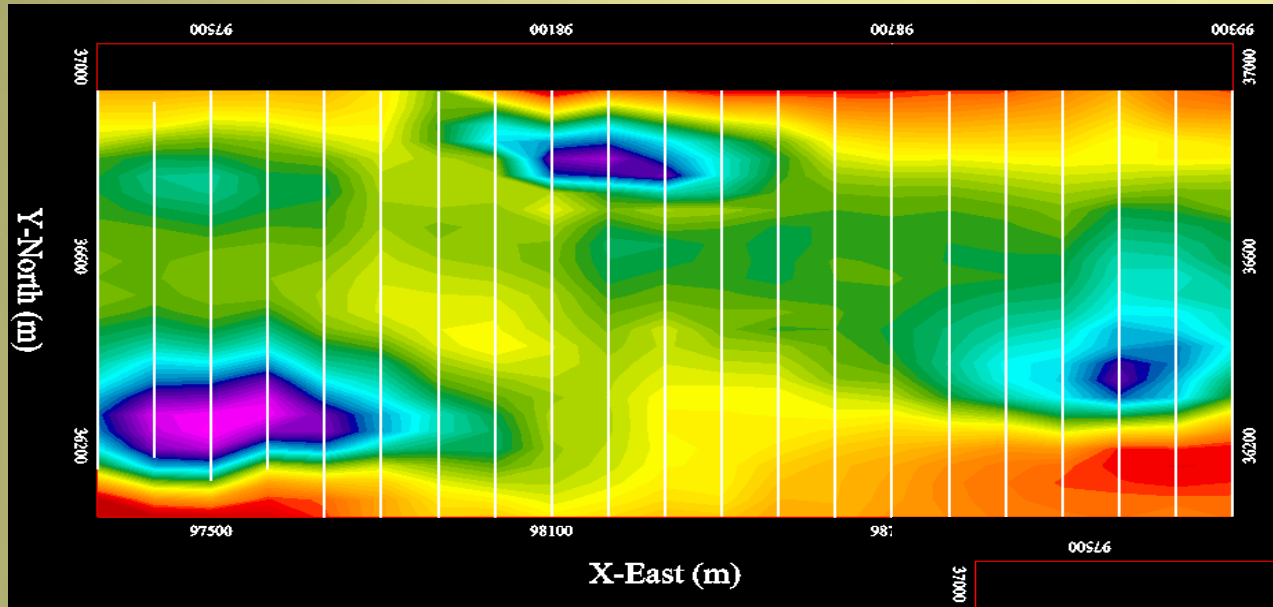


Multiple datum stored in a grid for quick viewing



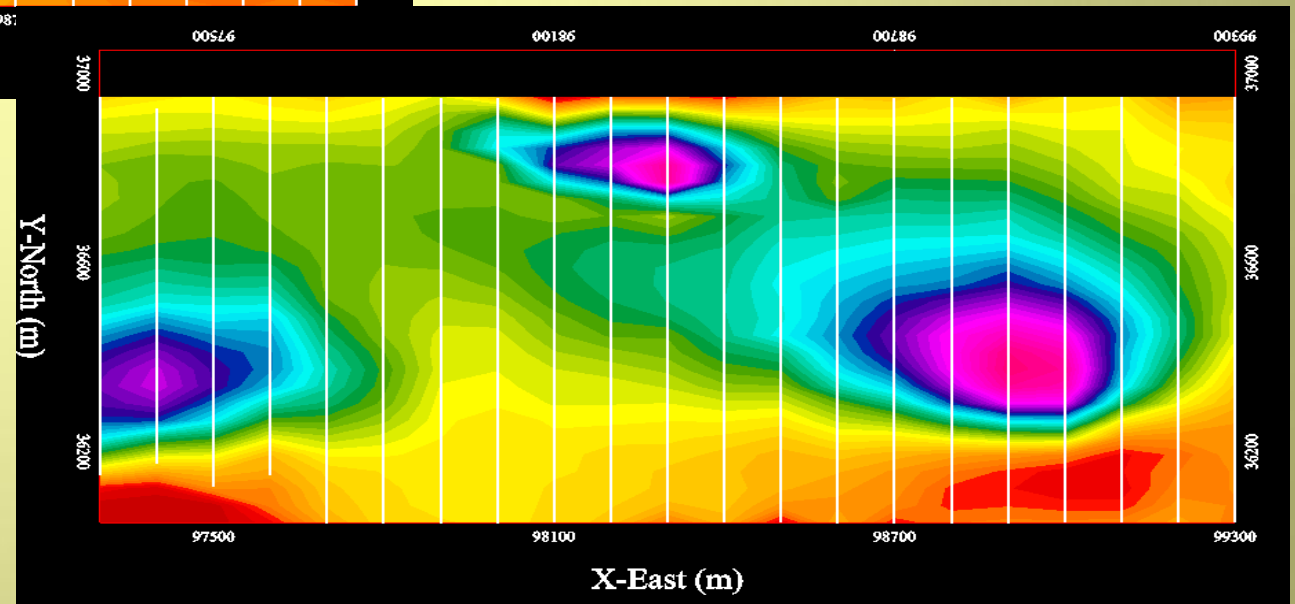


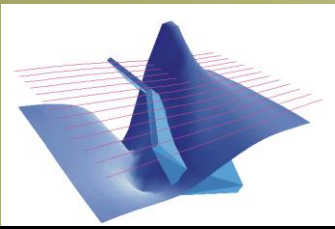
Track anomaly time evolutions



**Mid-Time
TEM data**

**Late-Time
TEM data**

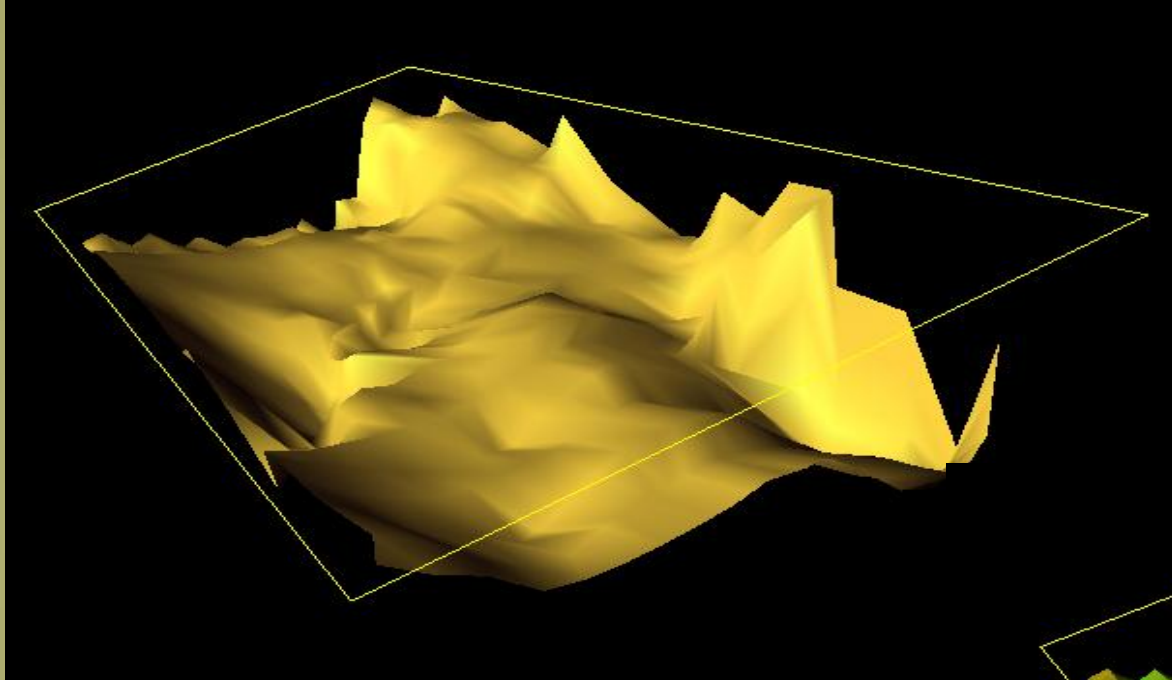




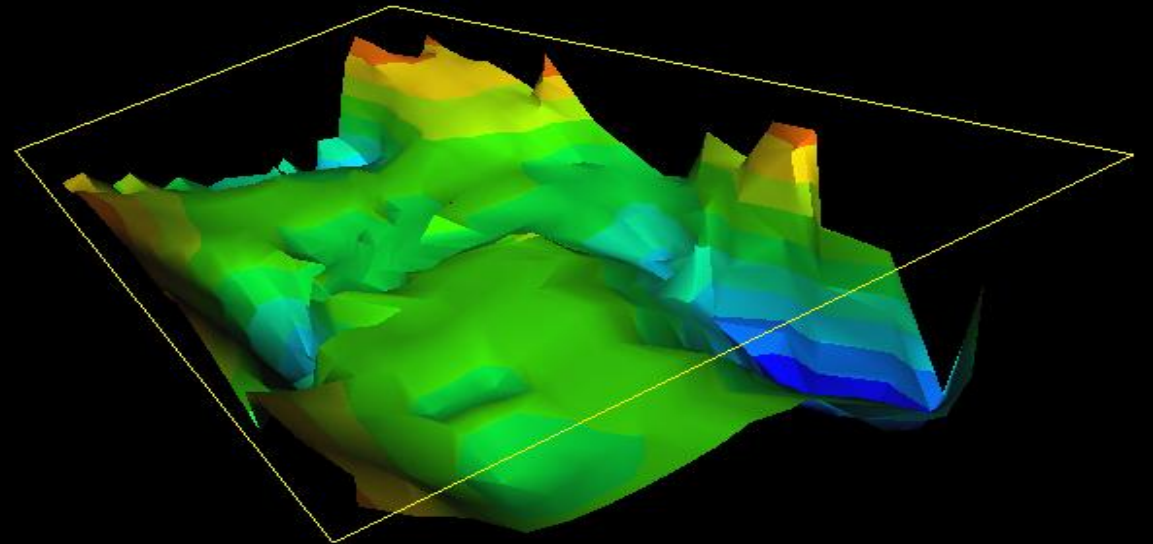
Surface representation of data allows for a spatial display of anomalies

Data Surface

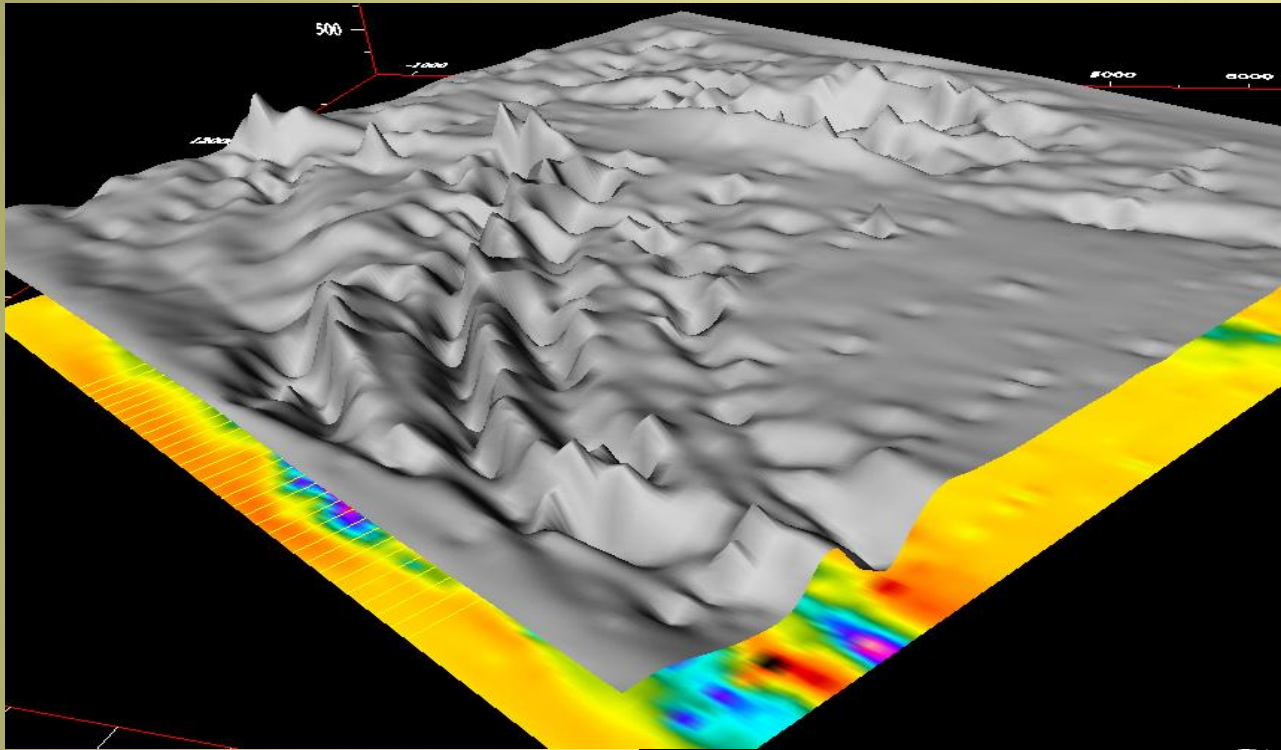
Nickel Exploration – Canadian Arctic



**Contoured
Data Surface**

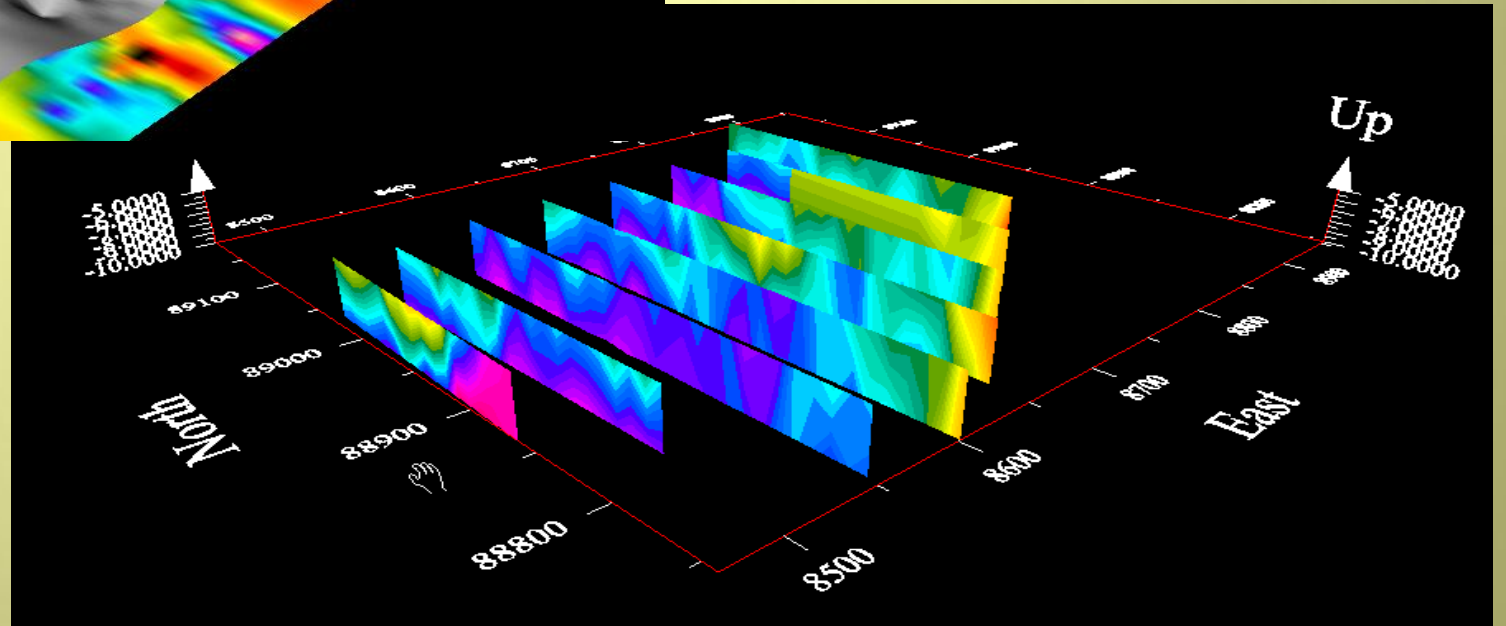


Data Interpolation and Contouring 4



Airborne Gravity – Gulf of Mexico

IP data - Mongolia

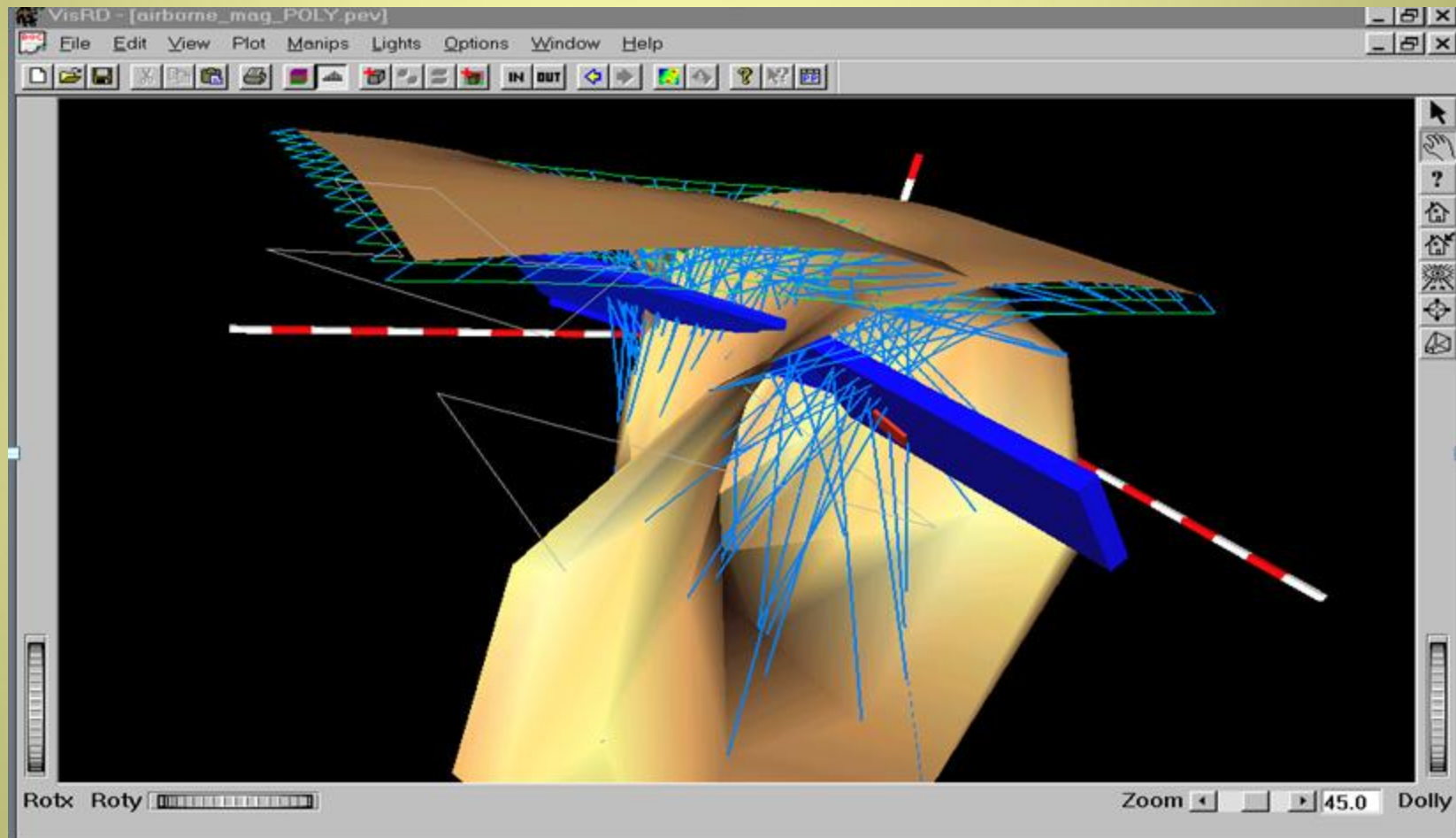


PETROSEIKON
Geophysical exploration

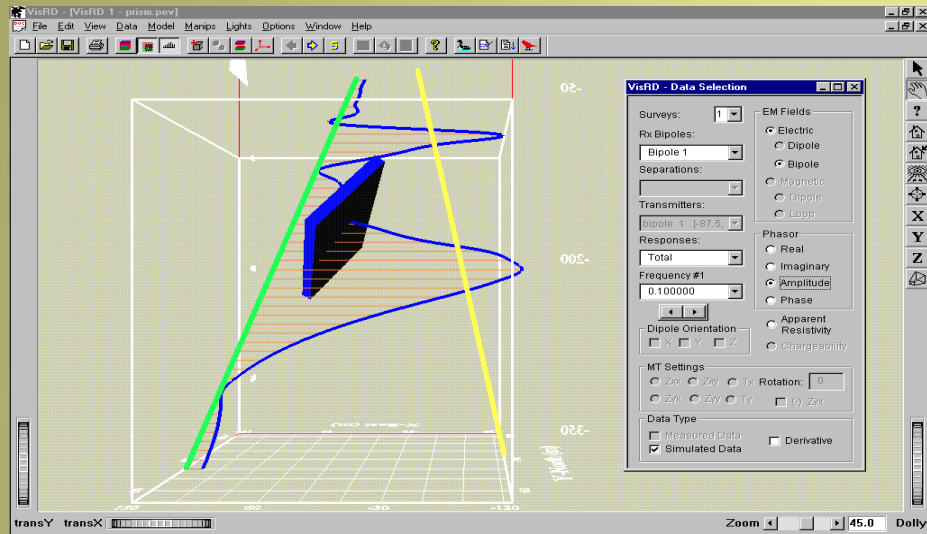


EIKON
TECHNOLOGIES

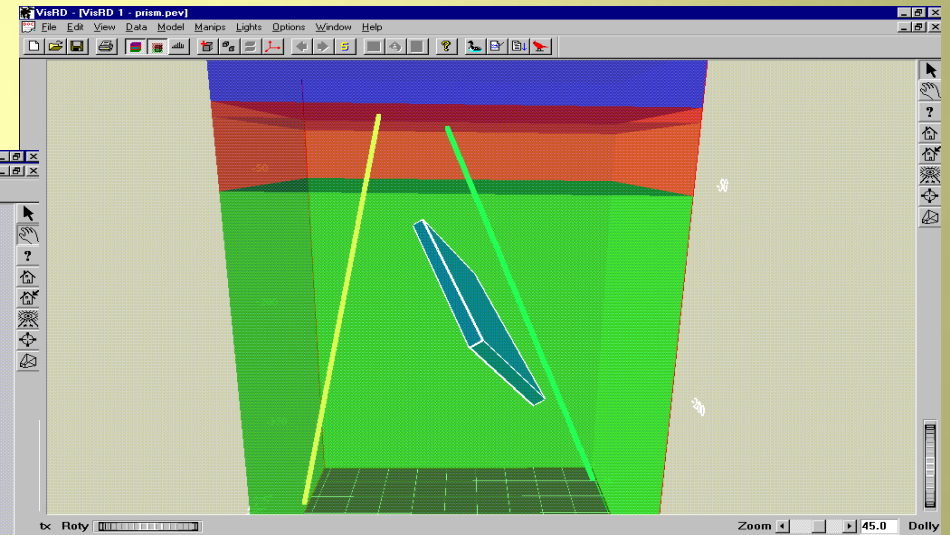
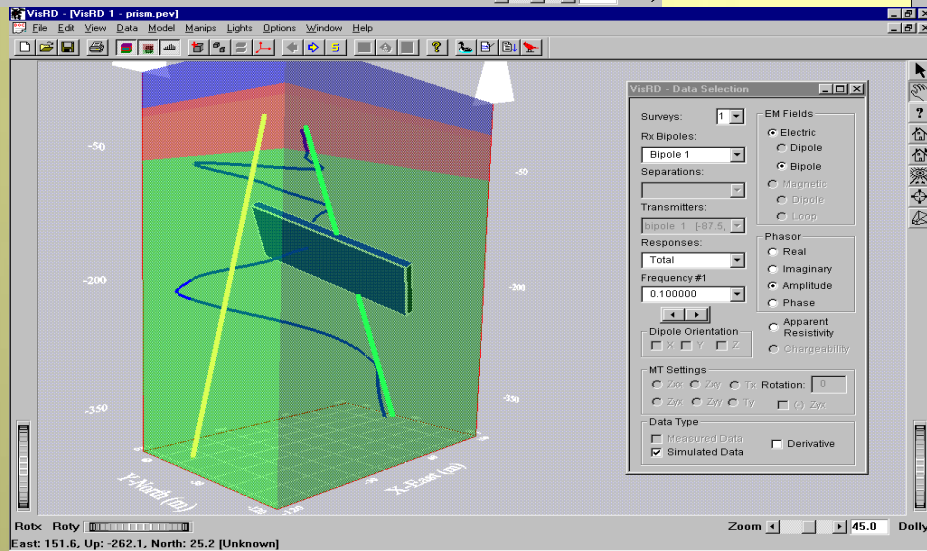
A Range of 3D Data Representations



Model Building and Simulation - 1



View survey, Build models and analyze data in 3D



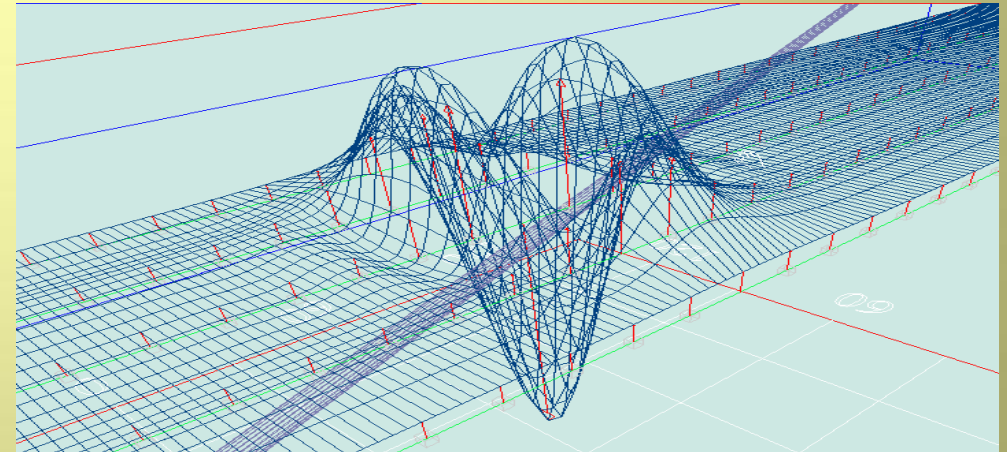
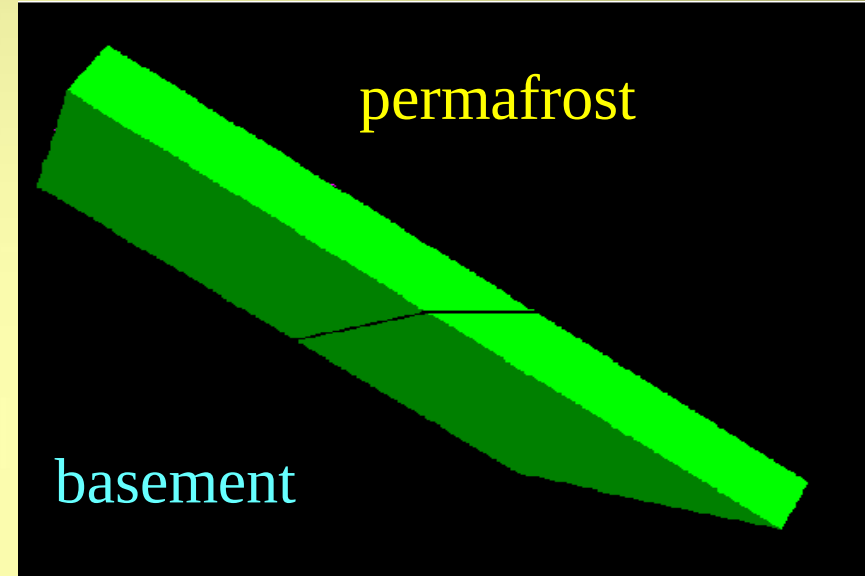
e.g. Crosshole resistivity survey and model – gold deposit delineation

Model Building and Simulation - 2

EM → TDEM and FDEM

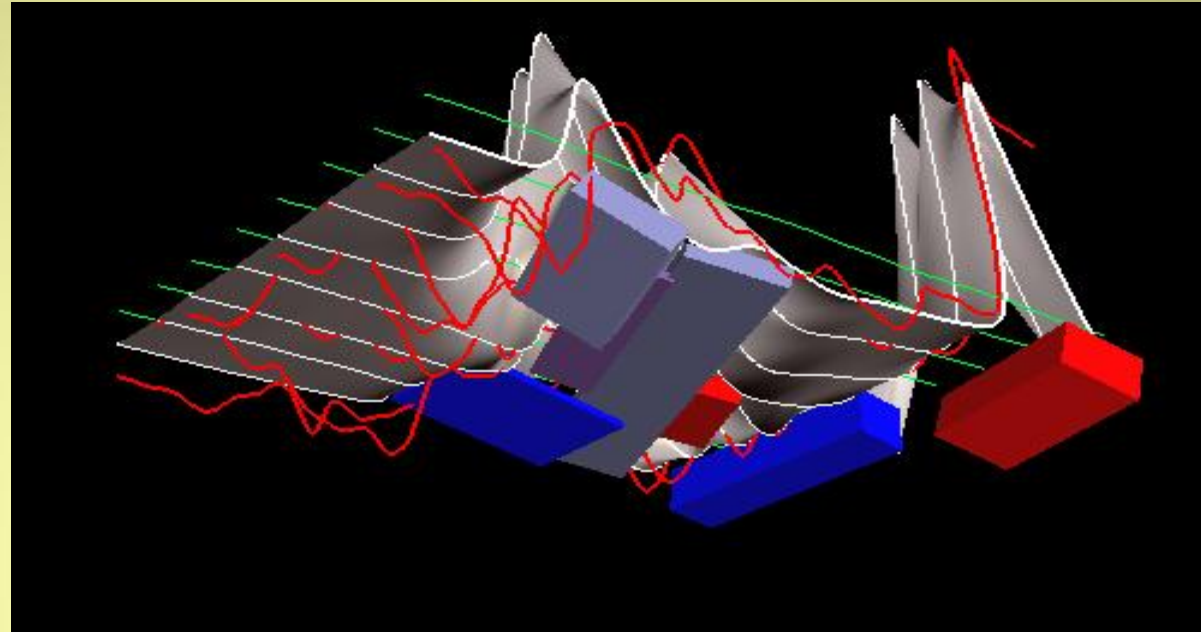
3 Algorithms – 3D integral equations in layered host

- Prisms, Plates and Polyhedra
- Strong and Weak Interactions
- Calibrated Impulse, Step and INPUT Waveforms
- Airborne, Ground and Borehole
- Fixed, Moving and Stepwise Moving Transmitter
- Pseudo-Section analyses
- Magnetic effects – magnetostatic and galvanic
- IP effects
- direct comparisons to measured data
- super-engine architecture for large models or surveys
- Model Suites
- Batch modelling



Model Building and Simulation - 3

Pb/Zn exploration
Helicopter FEM



Magnetics

- 3 Algorithms – 3D integral equation
 - Born (weak), Strong (non-linear), Permanent
- Prisms and Polyhedra
- Strong and Weak Interactions
- Airborne, Ground and Borehole
- Gradients (up to 2nd order)
- 3-axis (i.e. Components)
- direct comparisons to measured data
- super-engine architecture for large models or surveys

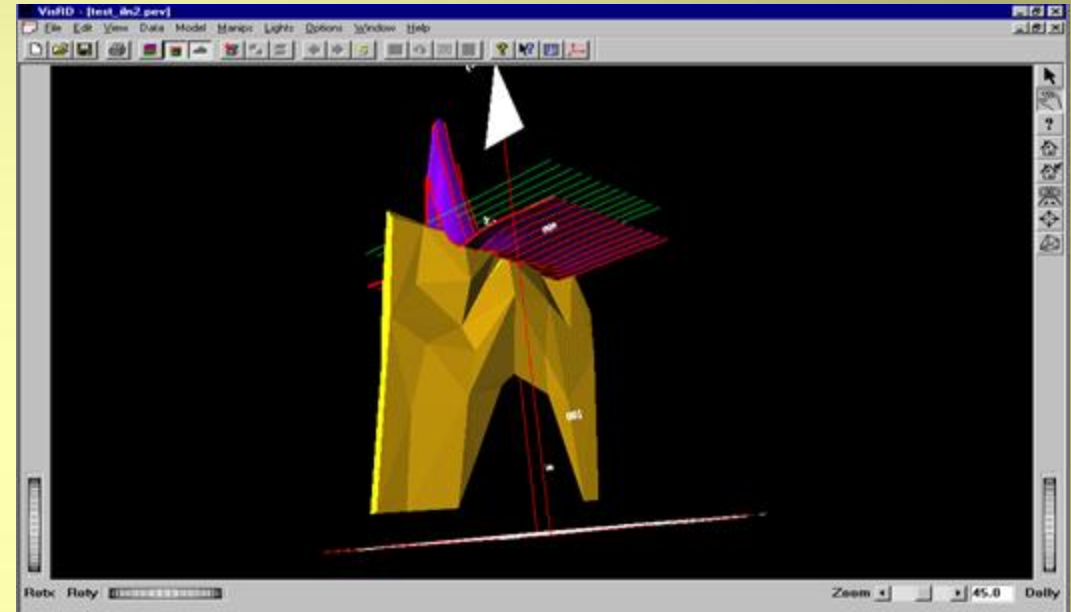
UXO cleanup



Model Building and Simulation - 4

IP/Resistivity/MIP

- 3D integral equation
 - Born (weak) and Strong (non-linear)
- Prisms and Polyhedra
- Strong and Weak Interactions
- TEM and FEM
- EM effects in IP (magnetic effects of current wires)
- Full contrast between host and bodies
- Ground, Surface to Borehole, Borehole to Surface, borehole to borehole
- direct comparisons to measured data
- PseudoSections and depth imaging tools
- super-engine architecture for large models or surveys



Model Building and Simulation - 5

Others

Gravity – 3D (Now available)

analytic and numerical integration – (total and vector field)

borehole modelling

gravity gradients (full tensors)

MT, CSAMT (3D)

impedances or fields

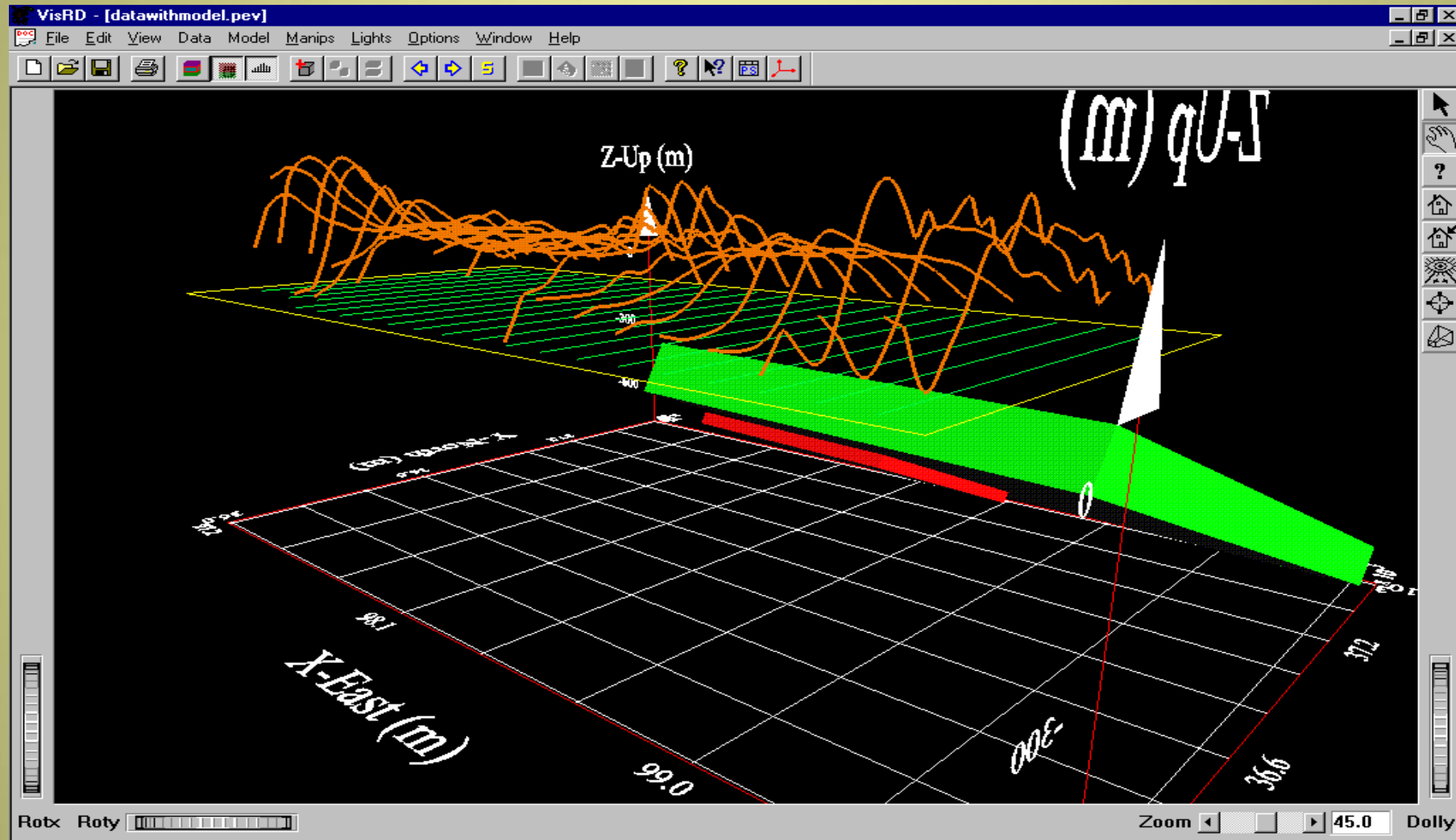
Strong and Weak Interactions

Crosshole

electric (3 antennae types) or magnetic antennae

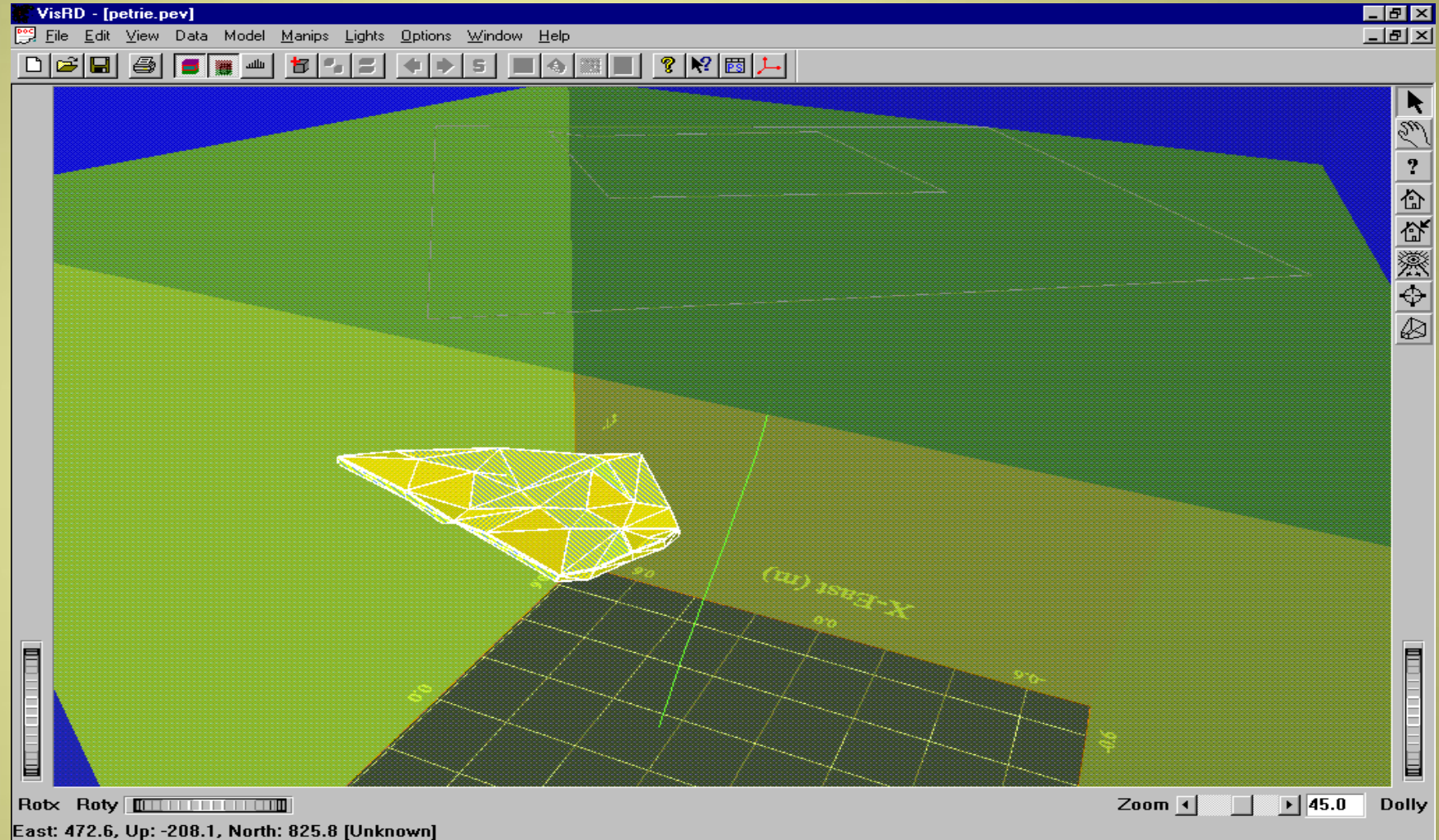
Experimental Systems

Data and Structure Representation in EMIGMA's 3D Visualizer



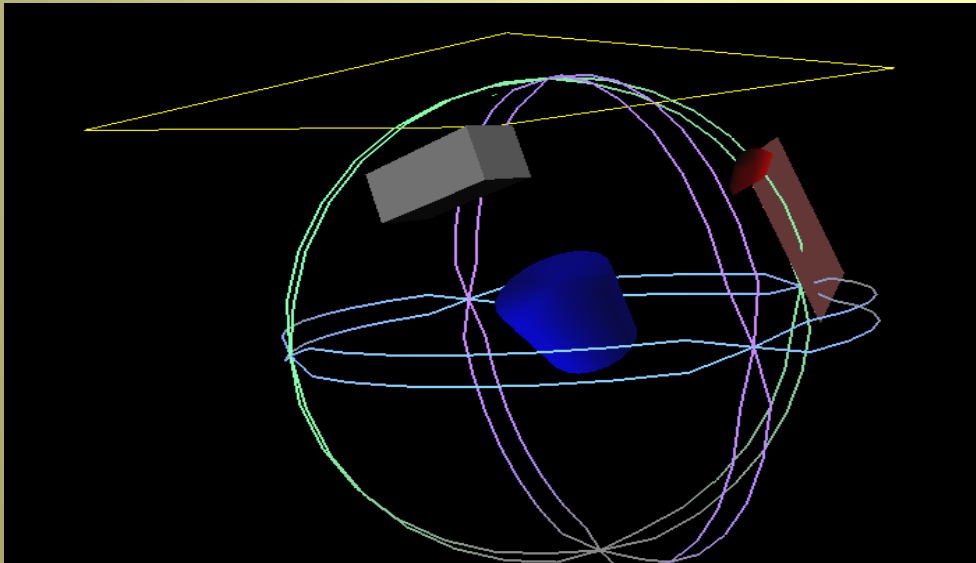
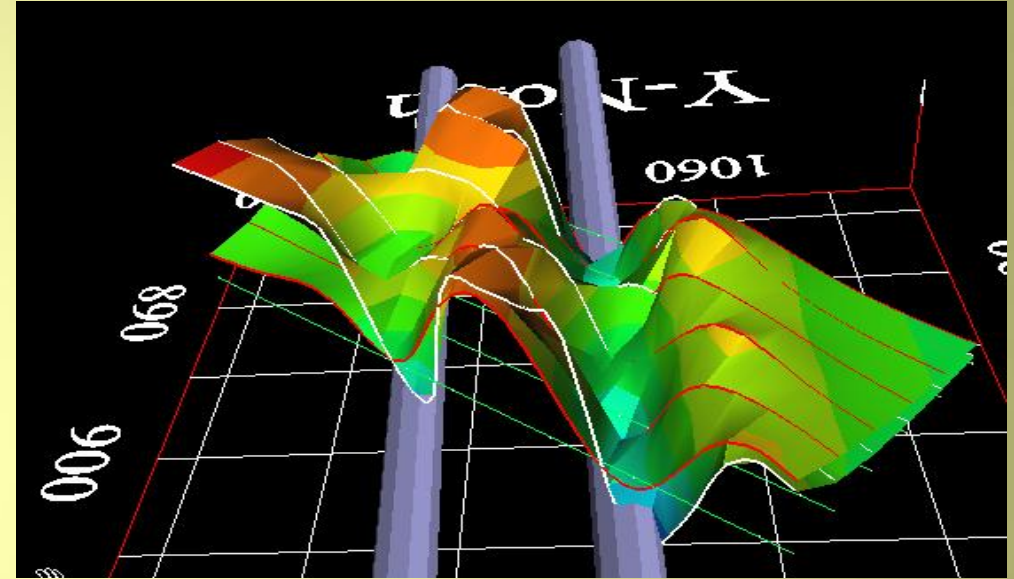
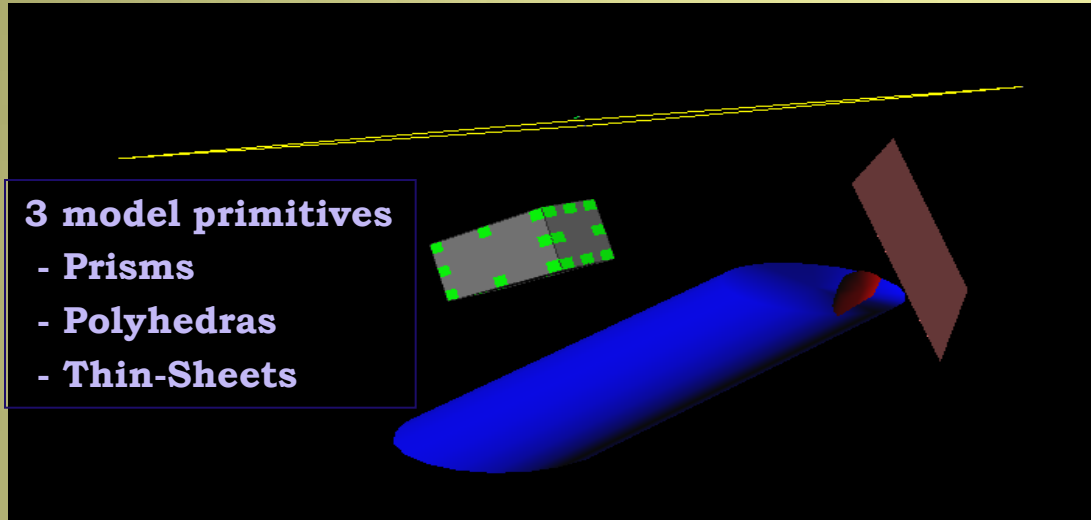
A fully integrated 3D visualization tool

Geological CAD Models

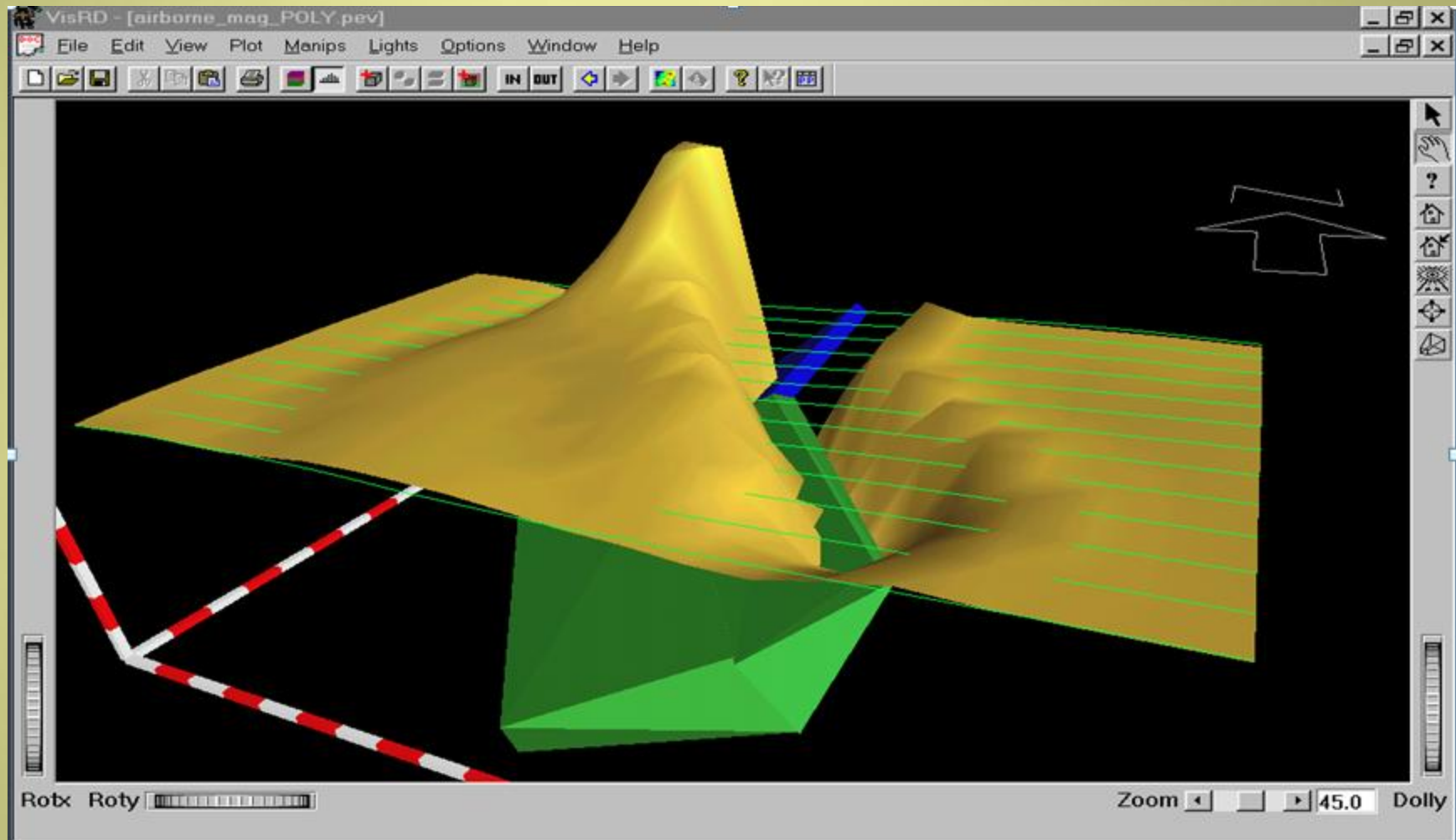


Complex 3D modelling capabilities including imports of geological models from CAD applications

3D Visual Model Building



Complex Structure and Data Visualization

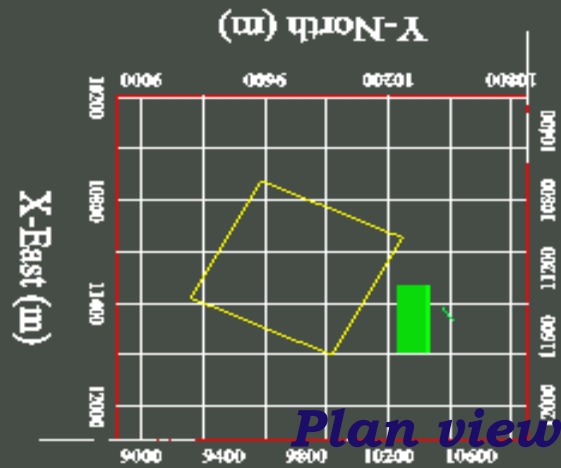


e.g. Airborne Magnetic Field Modelling

Simulation Calibrations

- ◆ to other algorithms
- ◆ to scale models
- ◆ to known geological targets

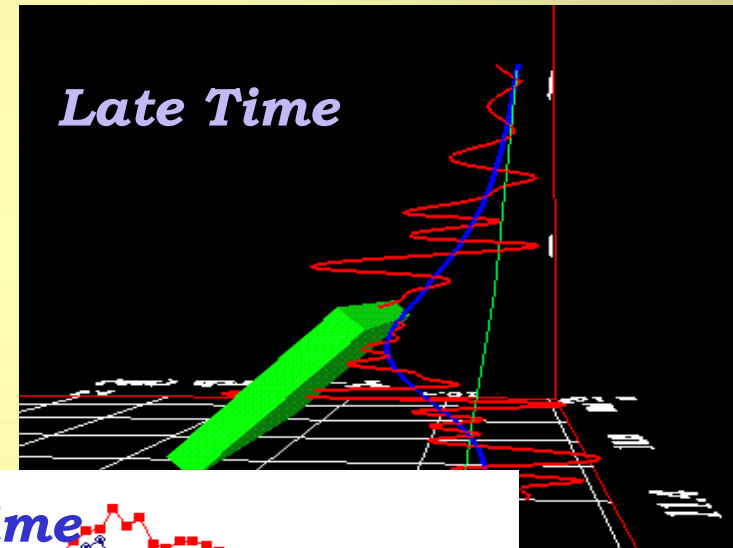
e.g TEM borehole response



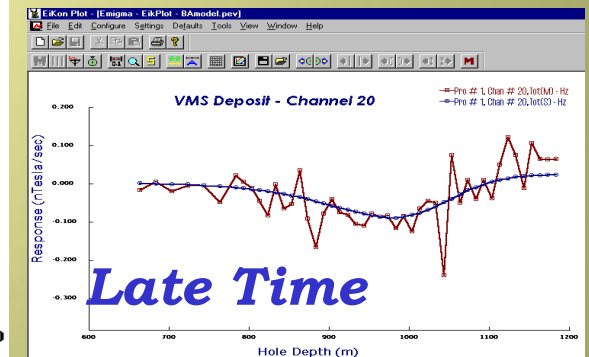
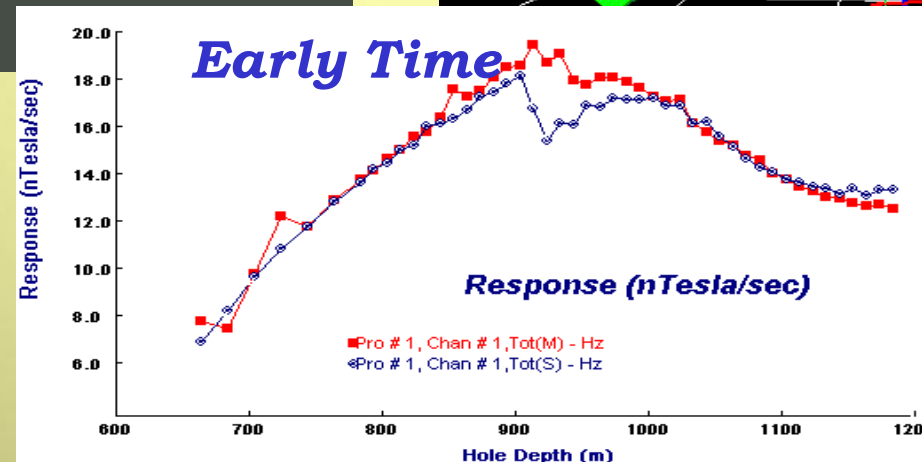
North view



East view



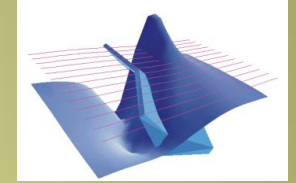
Blue line -
simulated
Red line -
field data



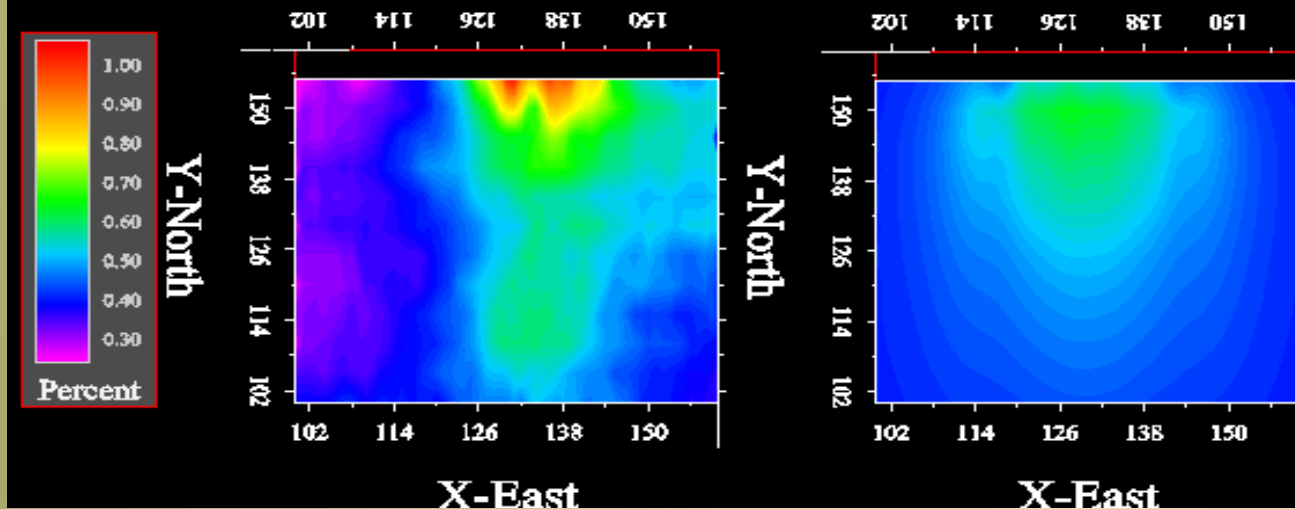
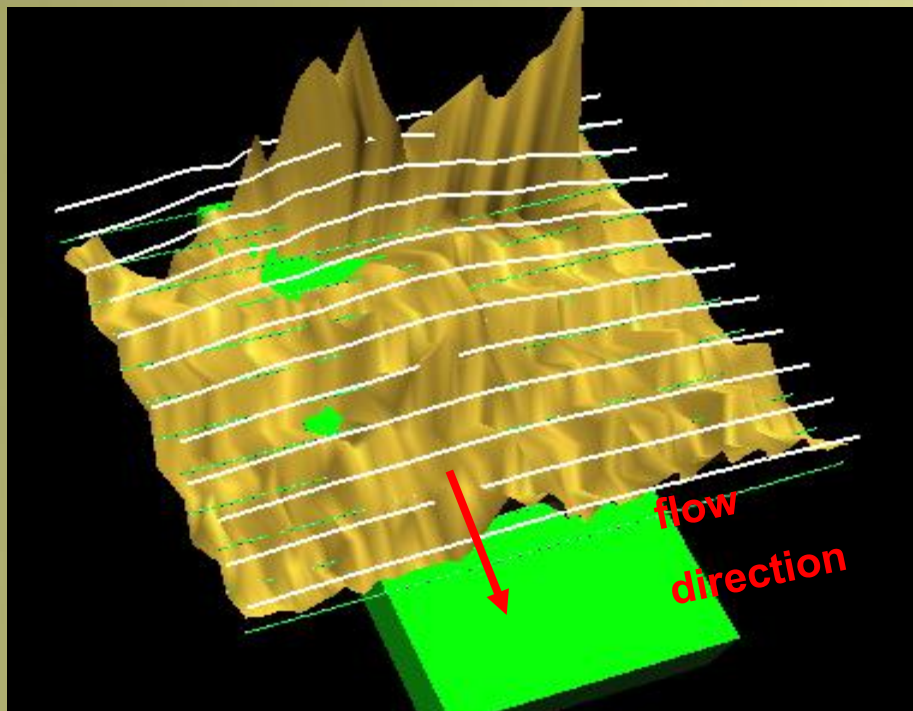
Model and Data Comparison

Contaminant Plume - EM31

Canadian landfill site

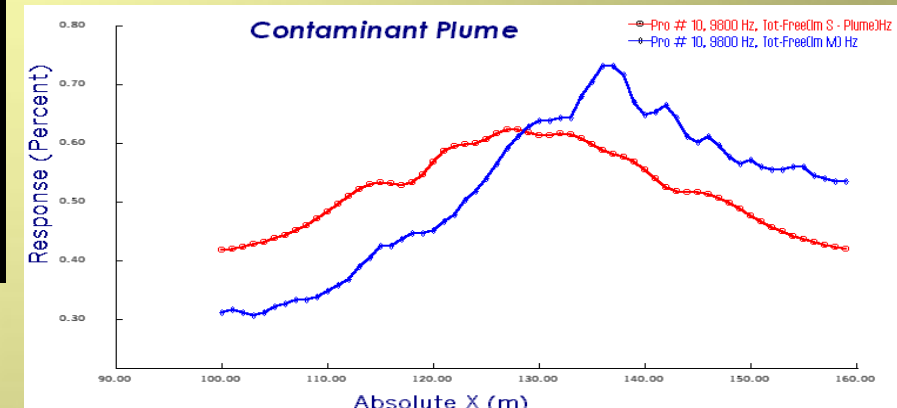


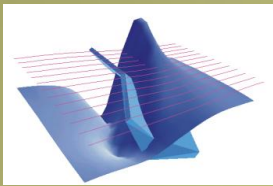
- ◆ 3D surfaces
- ◆ 2D contours
- ◆ 1D plots



Measured Plume Quadrature response

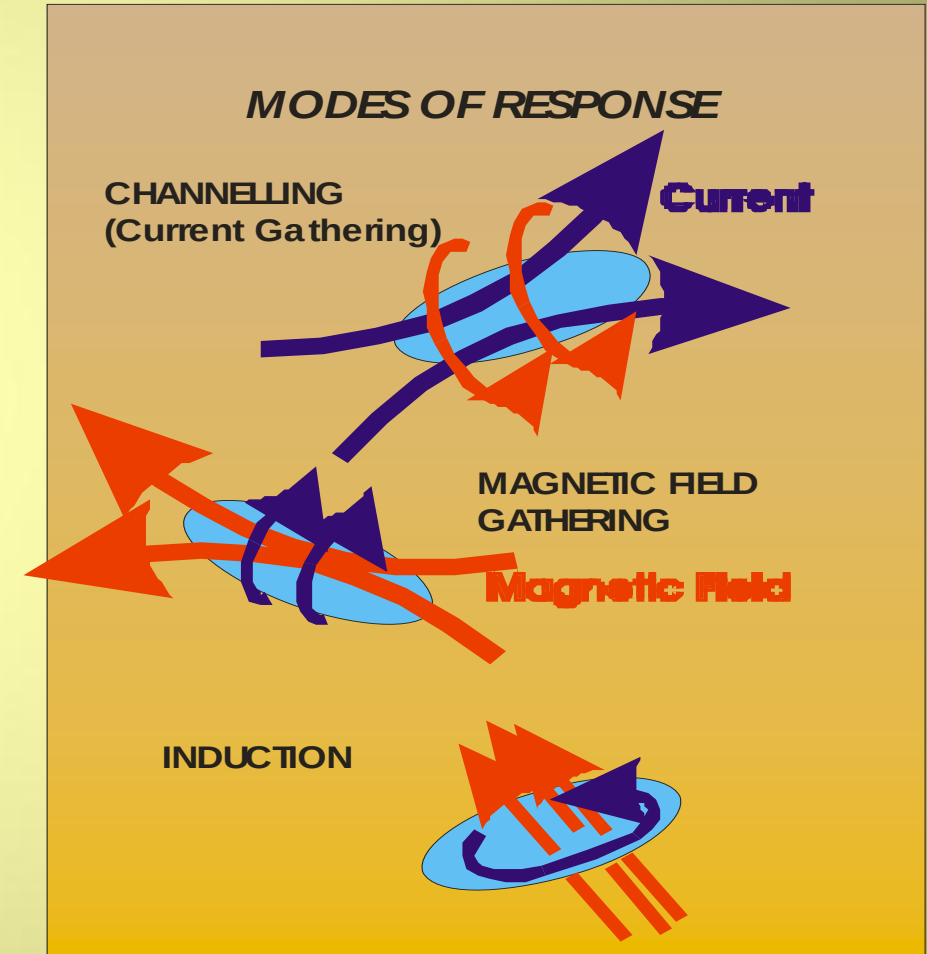
Simulated Plume Quadrature response





Geophysical Responses

- ♦ EMIGMA Algorithms
- ♦ LN (FEM,TEM,IP)
- ♦ EikPlate (FEM,TEM) in a conductive medium
- ♦ Eikplate (FEM,TEM) inductive layered solution
- ♦ ILN (FEM,TEM)
- ♦ MLN (Induced, Permanent)
- ♦ 3D Gravity (3 methods)
- ♦ Born techniques
- ♦ 3D Resistivity (fast, flexible, accurate)
- ♦ MMR ground and borehole



3D Modelling Capabilities 2

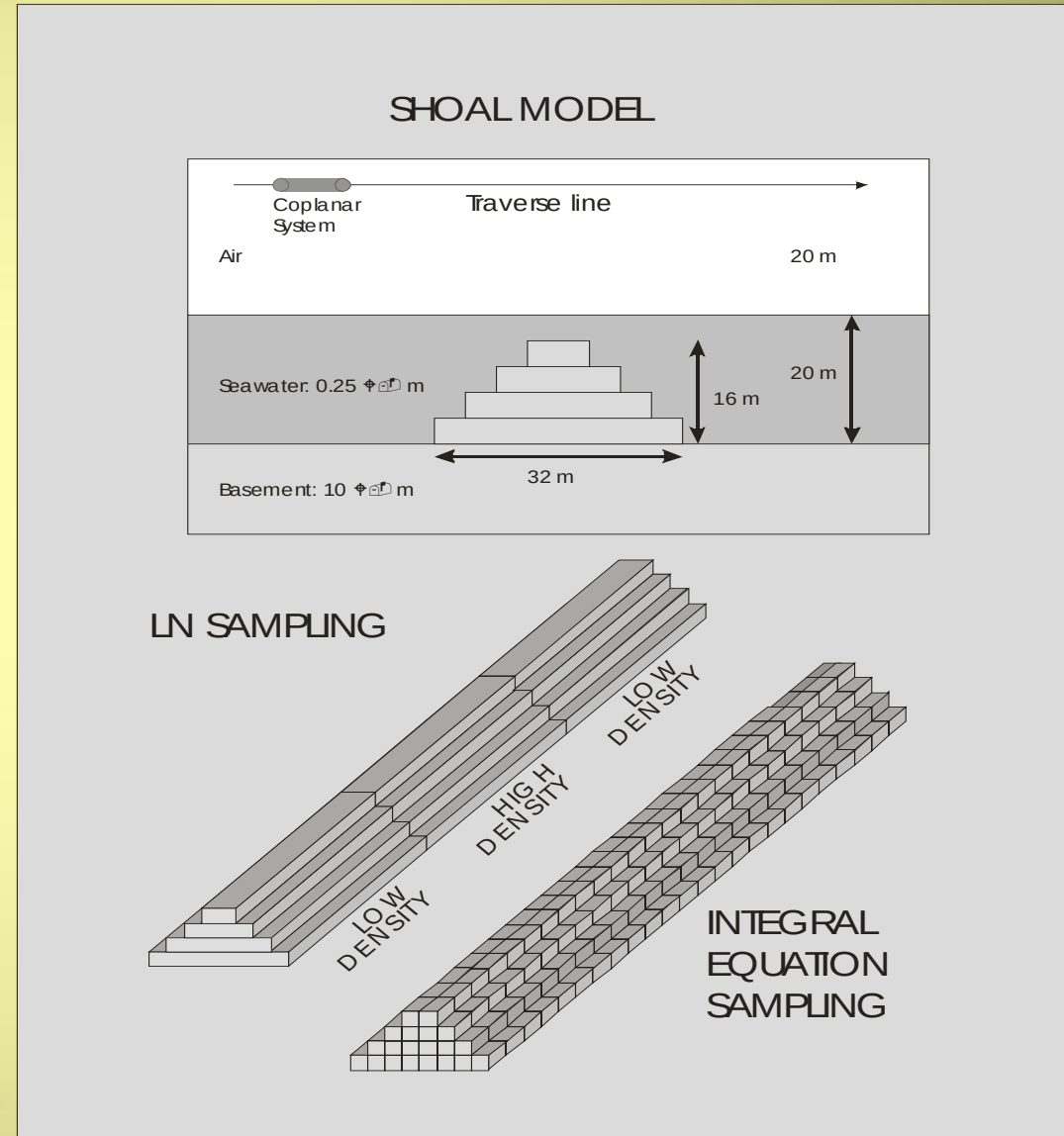
EMIGMA EM Algorithms

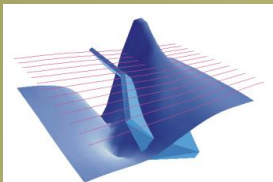
- ✓ LN
- ✓ EiKPlate
- ✓ ILN
- ✓ MLN
- ✓ VHPlate
- ✓ FS (Free Space) plate

Rapid Convergence

Flexible and

Easy-to-Use Grids



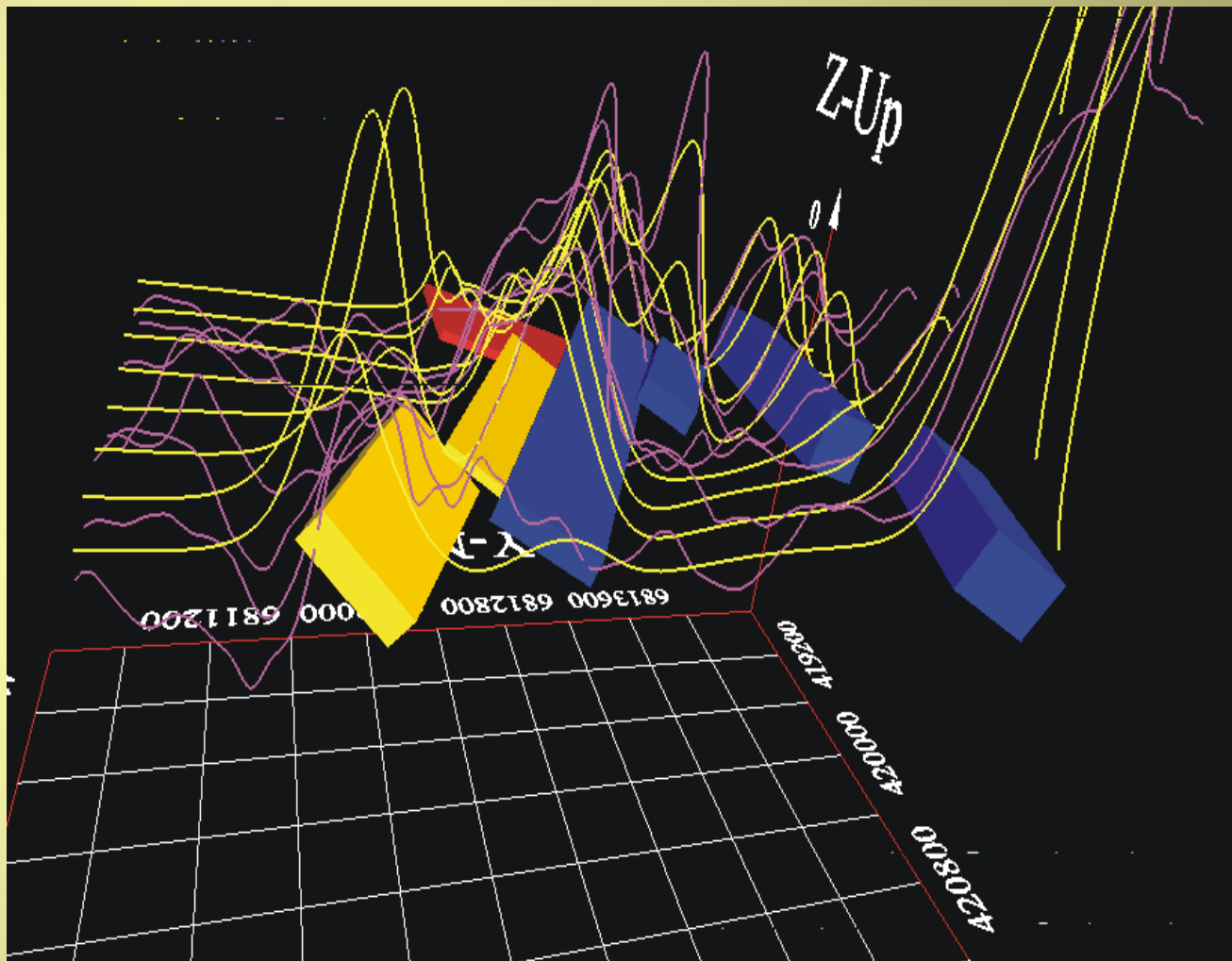


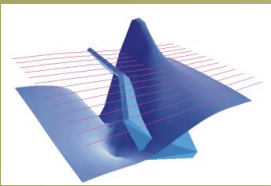
3D Modelling Capabilities 3

Complex Models

Full Range of Target Interactions

- ◆ **Superposition**
 - ◆ **Near-Field (in contact)**
 - ◆ **Far-Field (interactions between anomalies at a distance)**
- 
- A 3D grid visualization of a rectangular prism, likely representing a volume in a coordinate system. The grid is composed of white lines on a dark background. A red line runs diagonally across the top surface of the prism. A label '4208074' is visible in the top right corner, oriented diagonally.

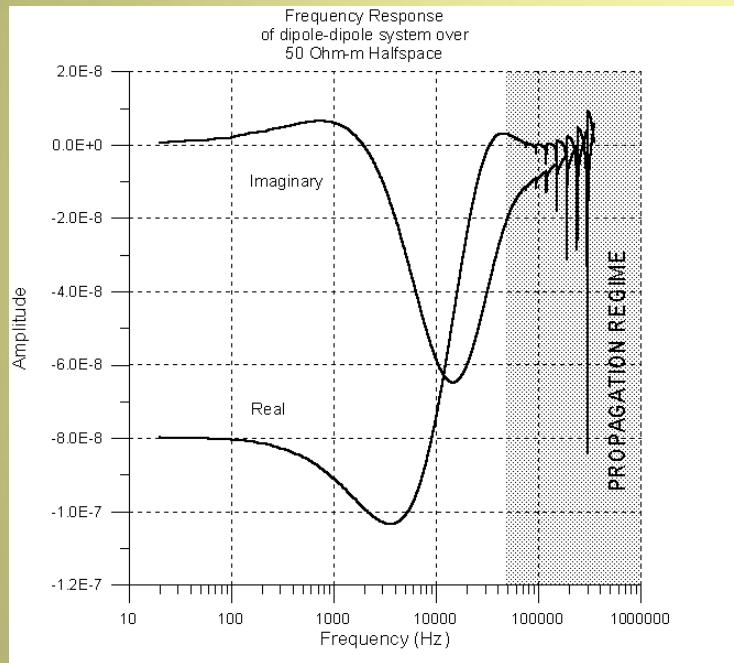




3D Modelling Capabilities 4

Frequency to Time-Domain Transform

- ◆ Why
- ◆ How
- ◆ Waveforms
- ◆ Bandwidth



Typical Magnetic Response

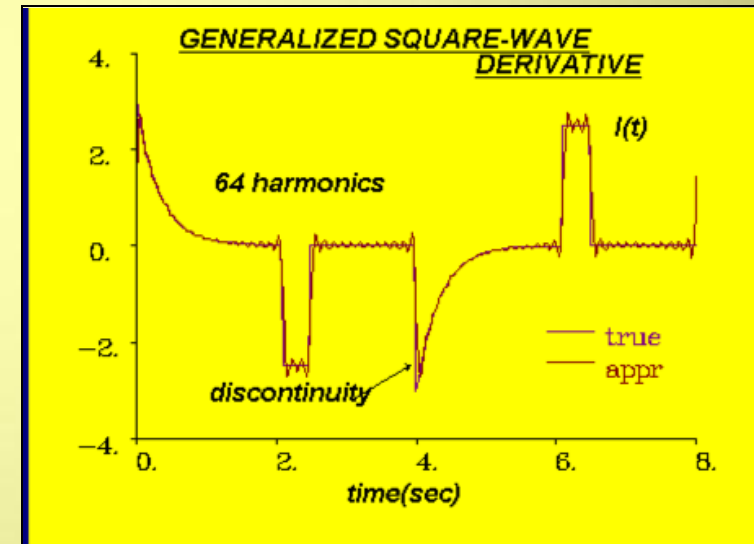
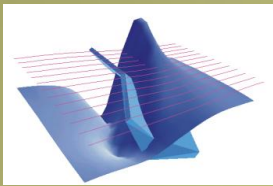


Figure 15: Fourier representation of derivative of the Generalized Square Wave using 64 harmonics.

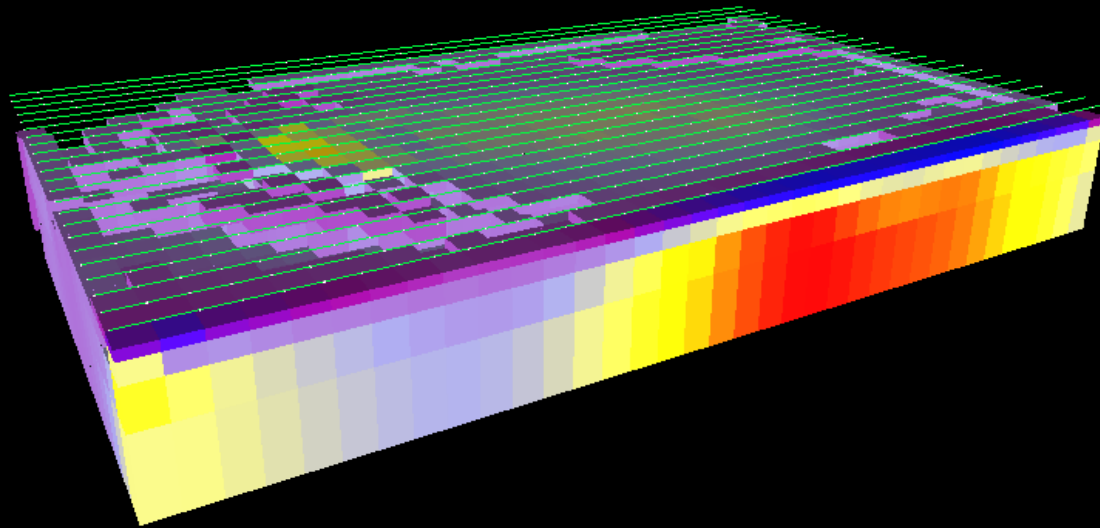
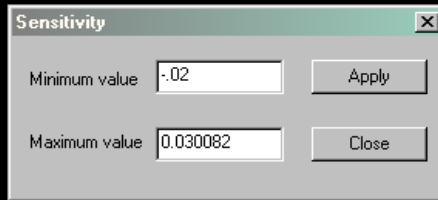
Band limited Coil Response

Incredibly accurate transforms



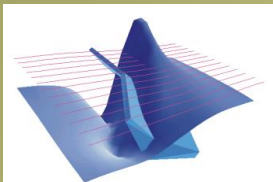
Inversion Capabilities 1

3D Magnetic field Inversion for Susceptibility



- ◆ **Multiple levels**
- ◆ **Gradients**
- ◆ **Components**
- ◆ **Matrix**
- ◆ **Optimization**
- ◆ **Linear/ Non-Linear**
- ◆ **Simulation Starting Models**
- ◆ **Strike rotated inversion grids**

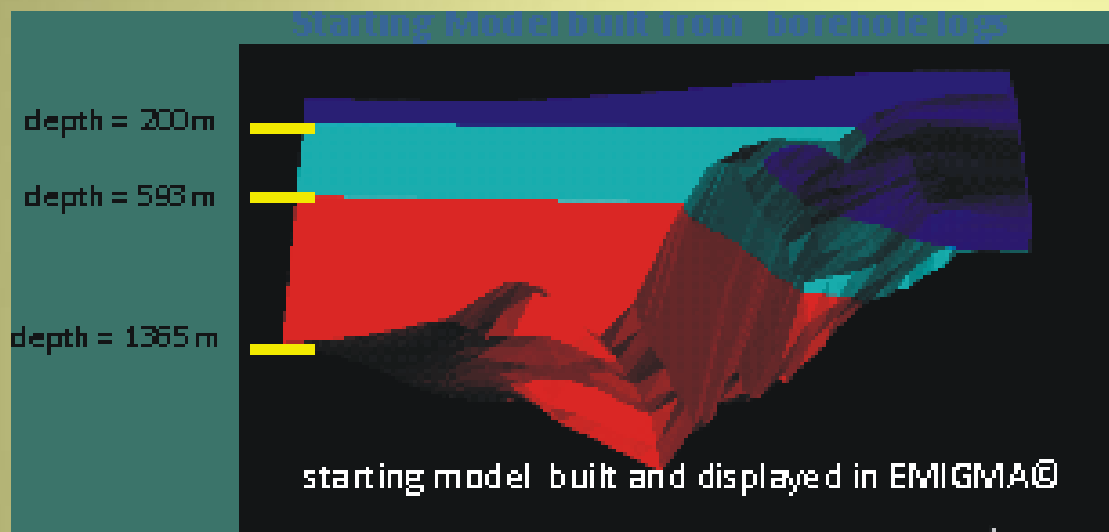
- **Magnetization Vector Inversions**
- **3D Euler plus statistical processing**



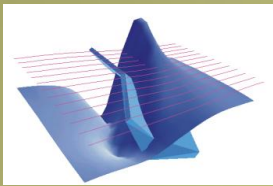
3D Gravity Inversion

Inversion Capabilities 2

- ◆ Utilization of topography
- ◆ Gradient capabilities
- ◆ use of horizon and drillhole constraints
- ◆ Extended Euler
- ◆ Fast inversions through new compile and multi-core processing



➤ 3D Euler plus statistical processing



Inversion Capabilities 3

1D Inversion

TEM, FEM and Resistivity

FEM

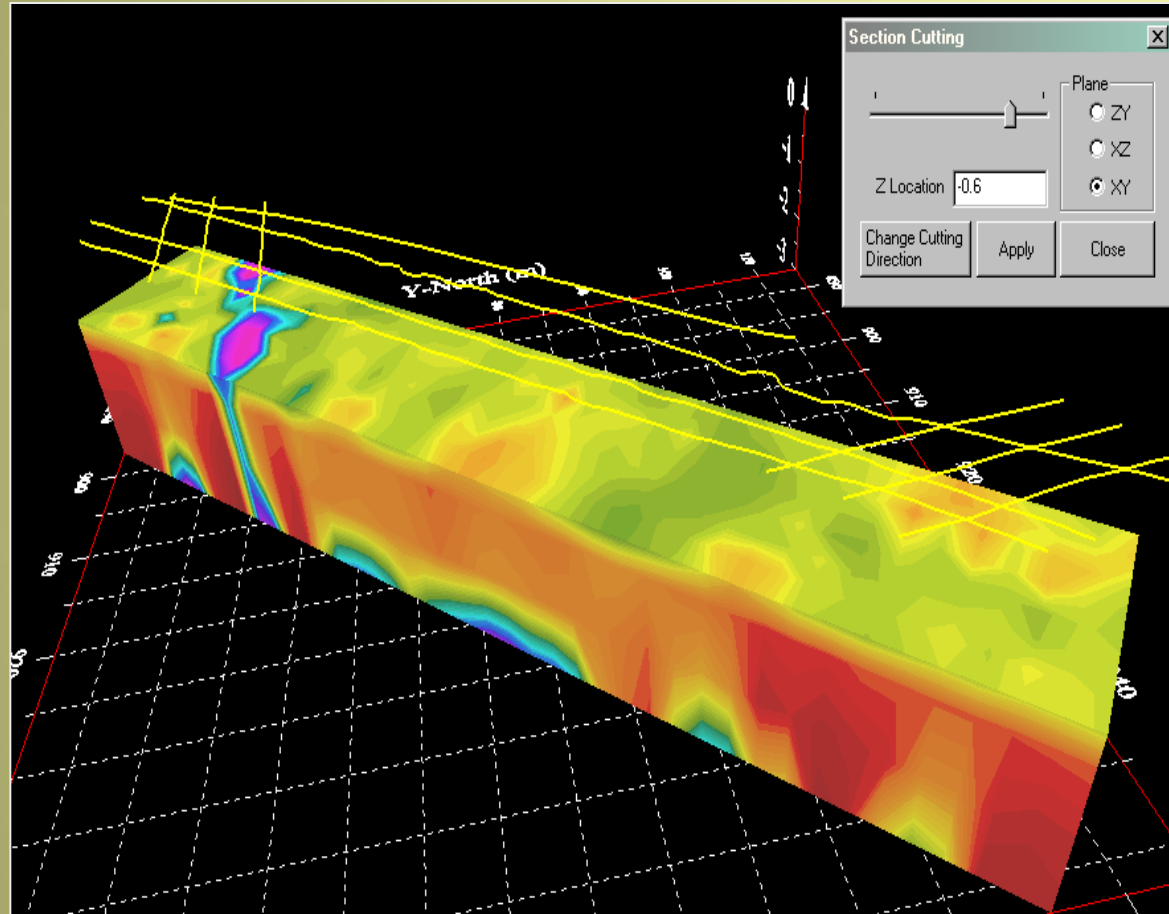
**– ground , HEM, fixed-wing
joint resistivity and
susceptibility**

**TEM – multiple base frequency
and multiple component capabilities**
- in-loop, out-of-loop
- ground, airborne

Resistivity: 1D/3D Inversion

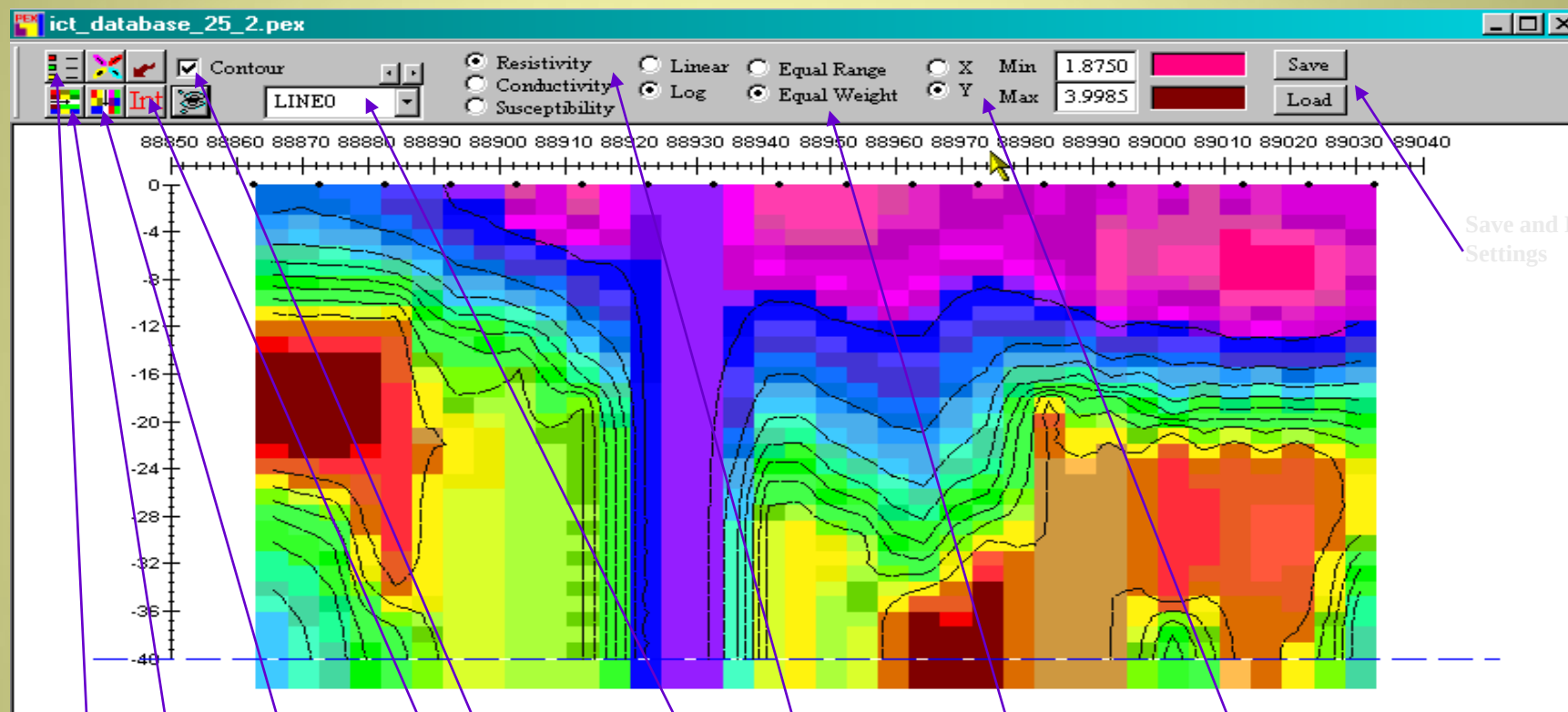
**Sengpiel Sections:
HEM, Fixed-Wing**

**FEM, TEM Apparent Resistivity
HEM and Ground**



Inversion Capabilities 4

PEX- file Viewer



Save and Retrieve Plot Settings

Legend

2D Interpolation

ModelUnits

Horizontal Axis selection

Interpolate Vertically

Apply Contour

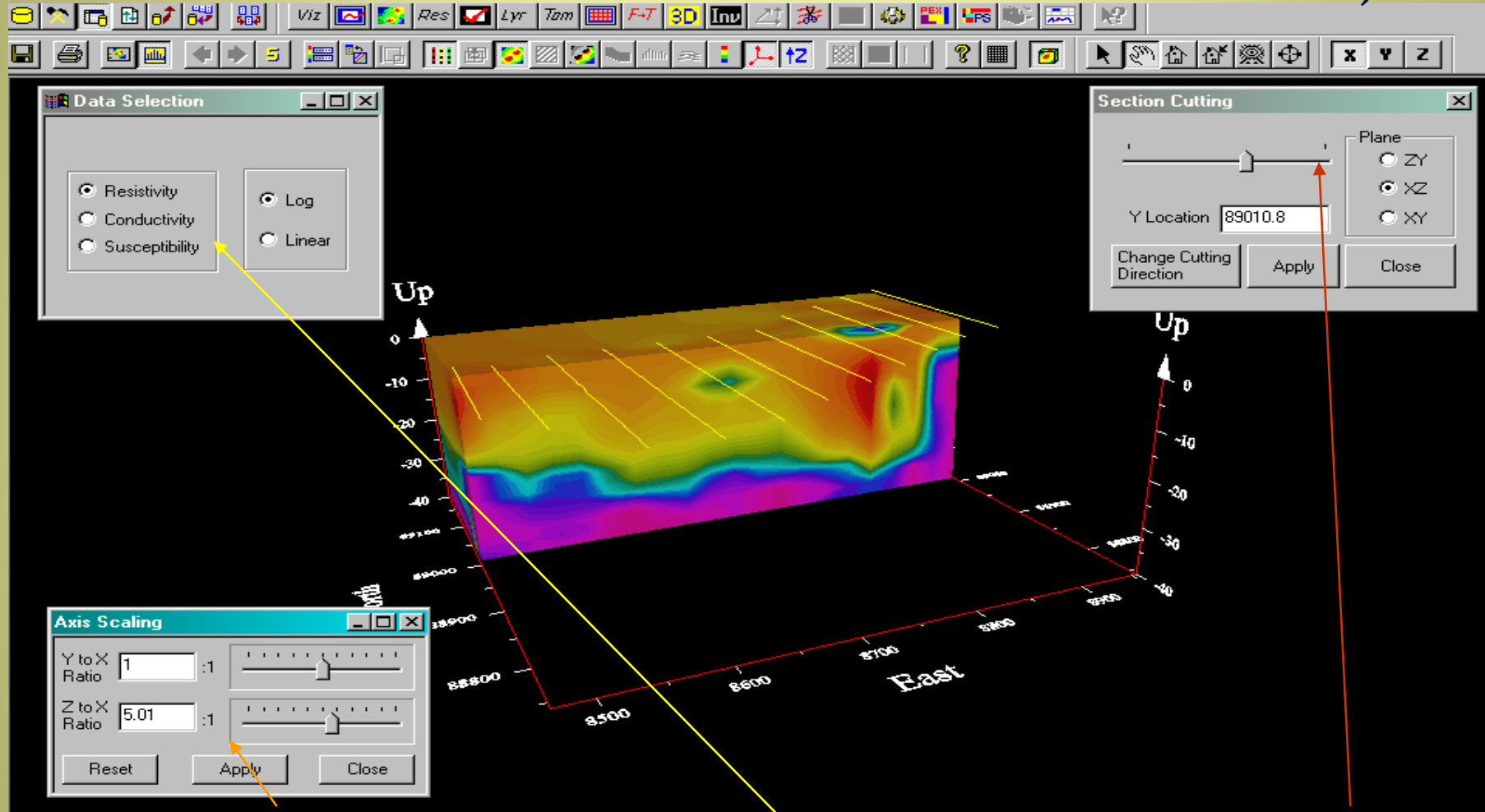
Select Line

Colour Distribution
Equal Range – intervals equal
Equal Weight – distribution equal

Interpolate Horizotally

Inversion Capabilities 5

3D Volume Contour
(with Inversion model
dataset selected)

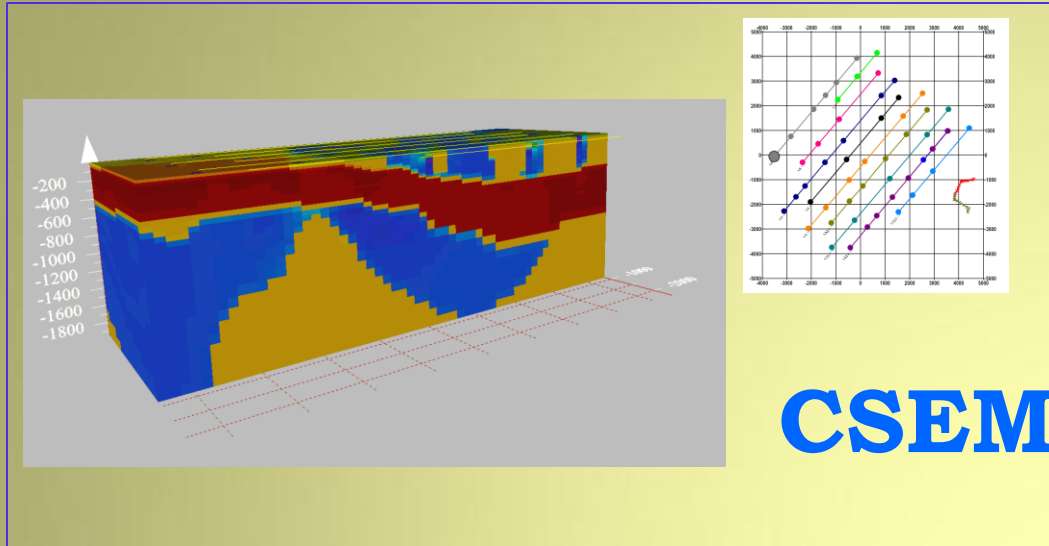


Axis Scaling

Model Units

Section Cutting

Inversion Capabilities 5



3D Inversion

Gravity and Magnetics

Resistivity

MT and CSAMT

CSEM – land based

Gravity and Magnetics

ground or airborne data with measured and processed derivatives

topography effects, geological structures and a host of other features

Resistivity – dipole-dipole, pole-dipole and pole-pole surveys

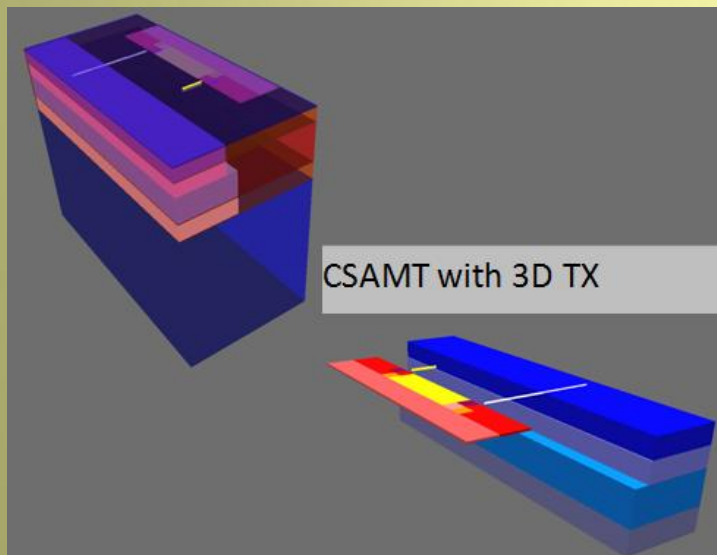
-resistivity constraints and user-specified starting model

MT

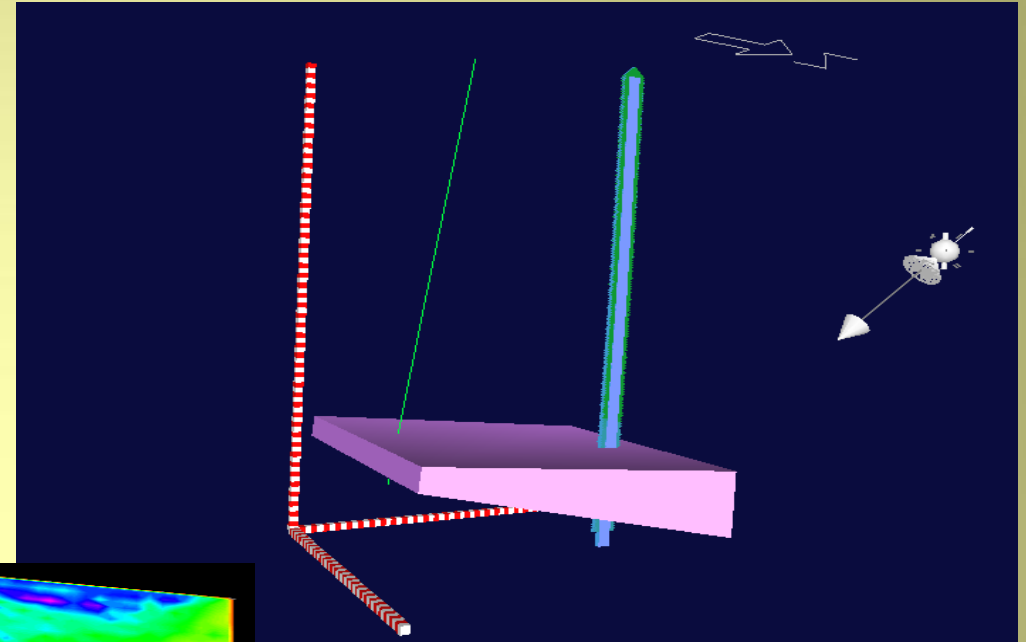
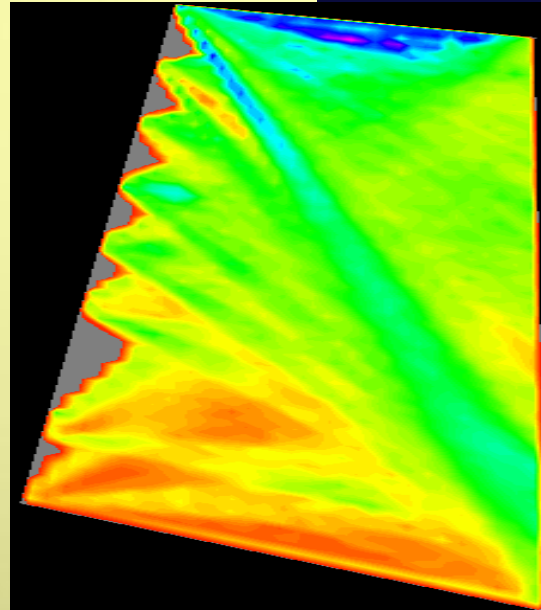
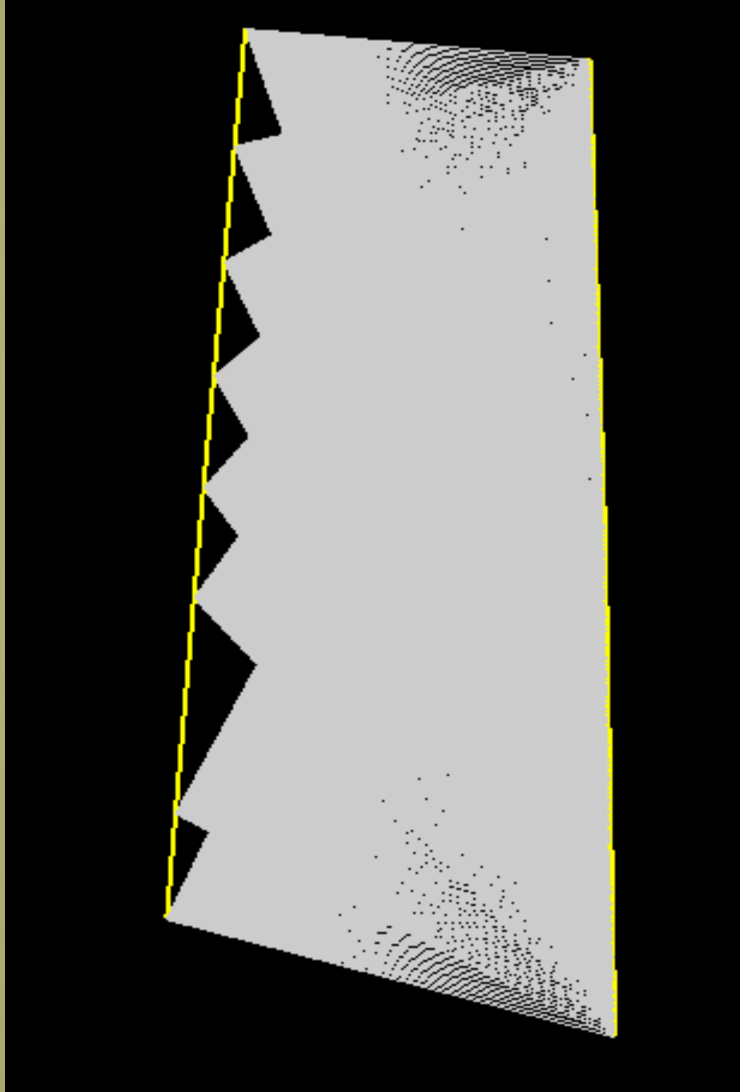
-3D inversion (with post-inversion removal of grid cells)

CSAMT

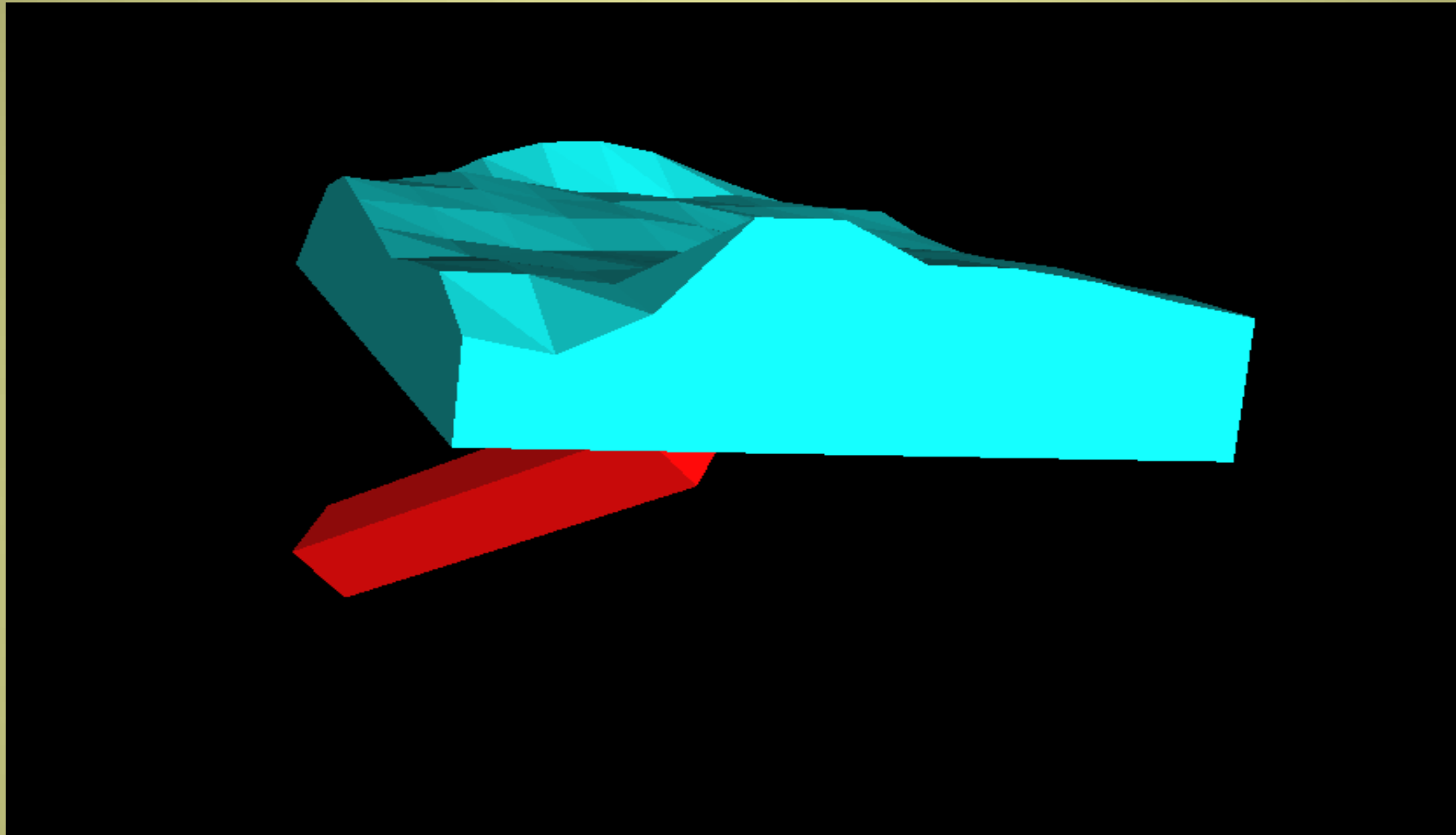
-accurate 3D inversion (utilizing source geometry)



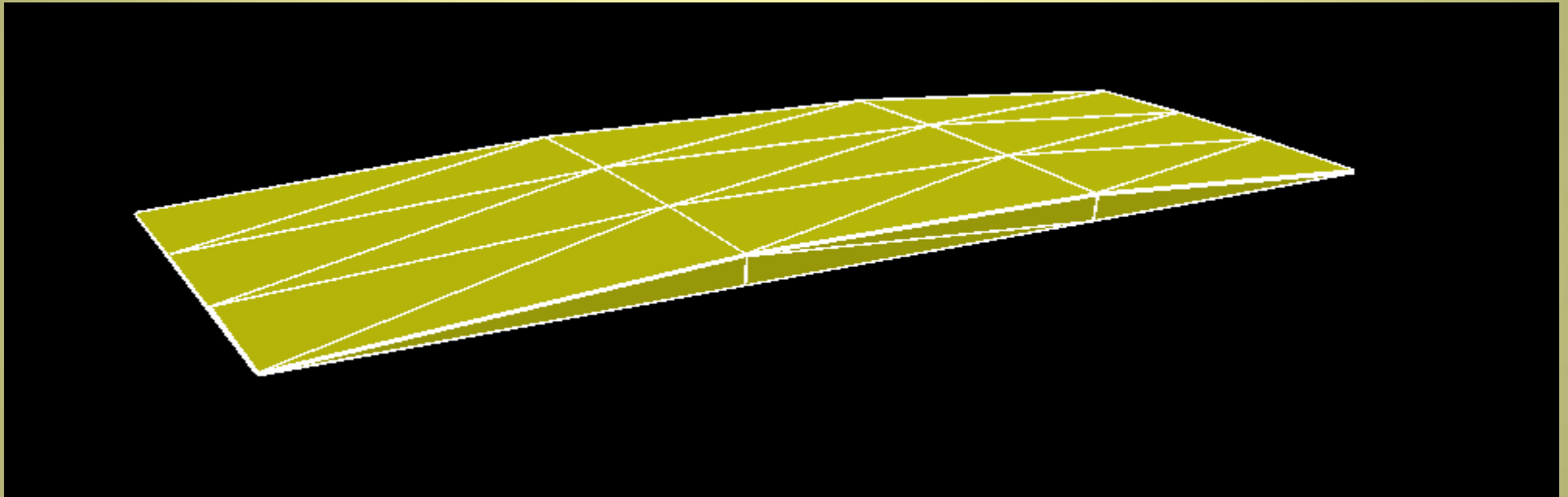
Crosshole Applications



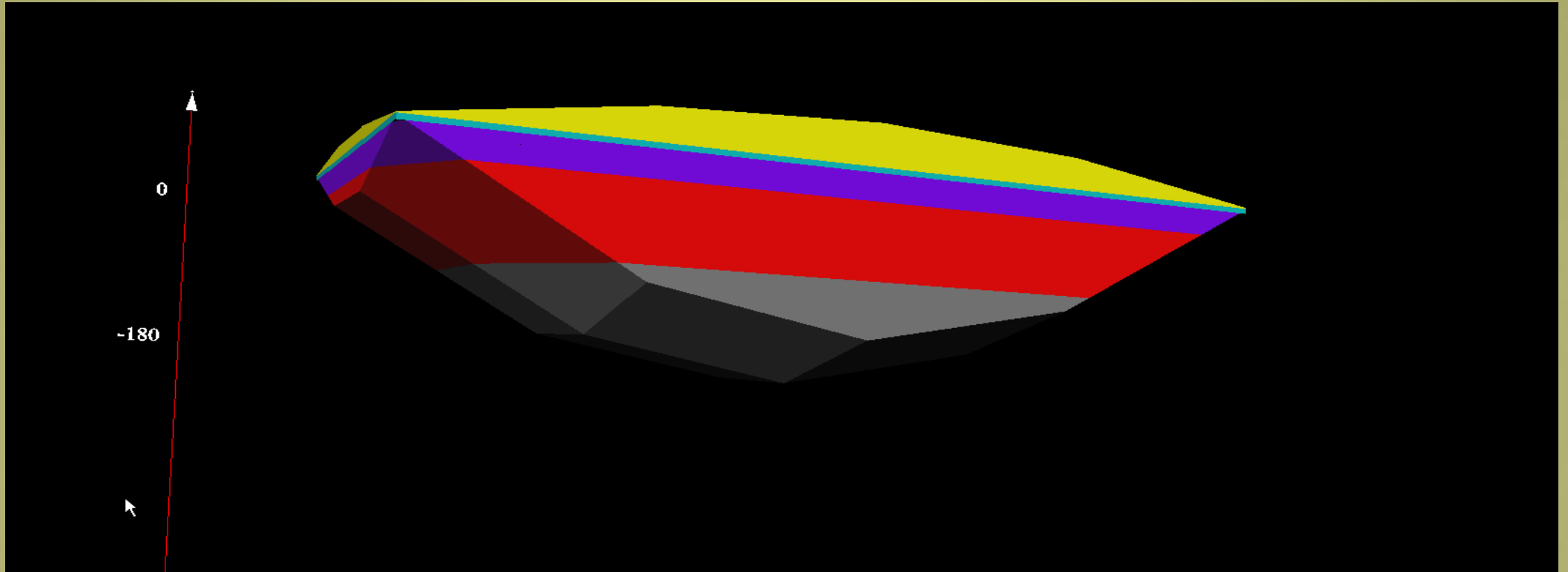
RIM data – lead mine



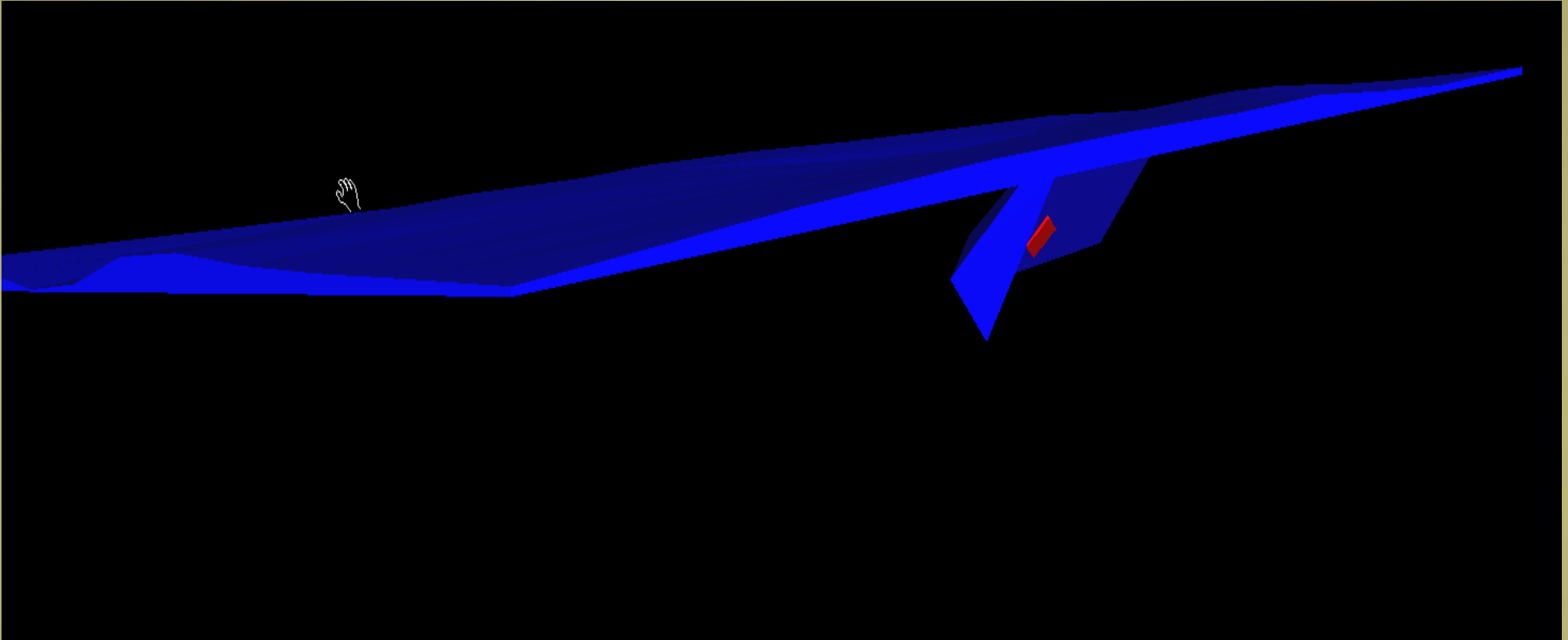
◆ **Topography plus Anomaly – MT project**



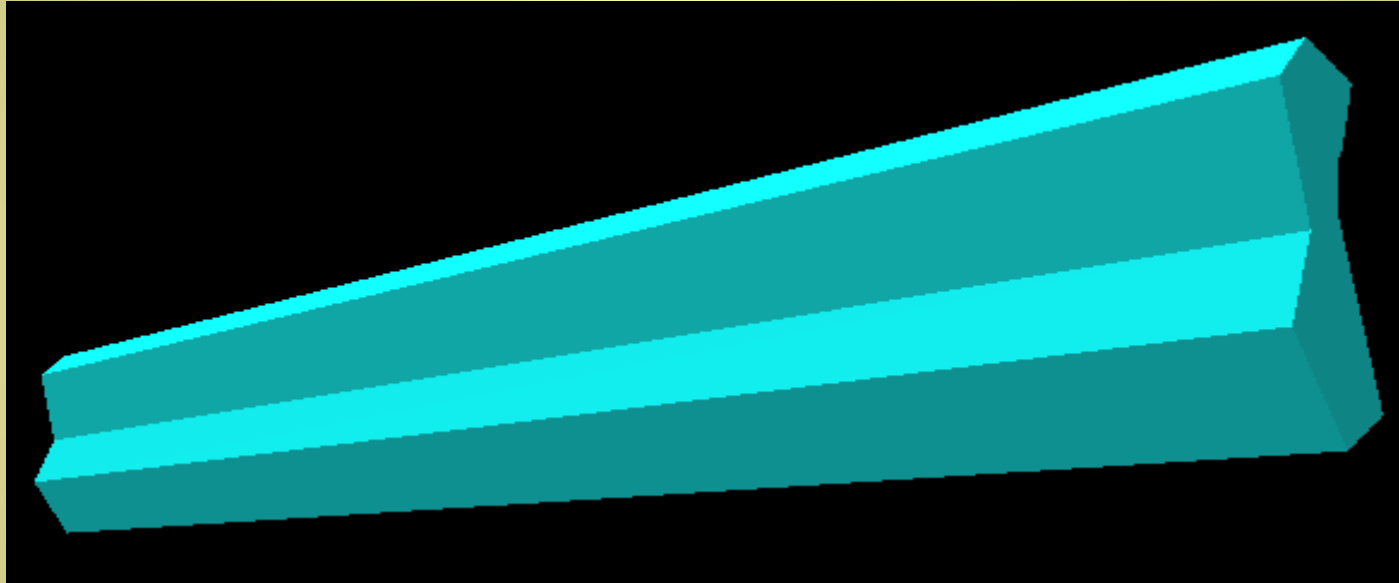
◆ **Anticline – MT plus gravity project**



◆ **Waste Dump Modeling: EM, gravity, IP, magnetics**



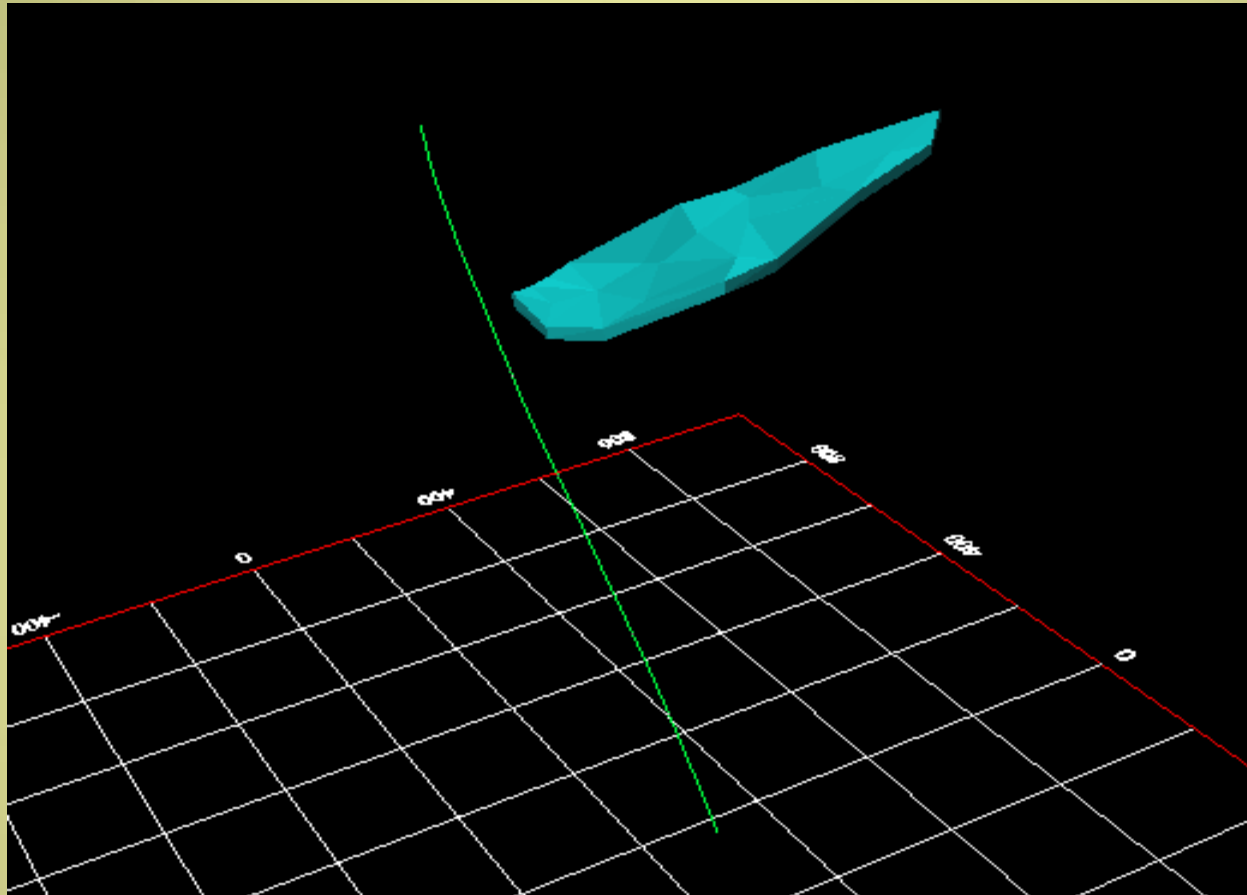
- ◆ **Magnetic Intrusions plus Topography plus Target**
- ◆ **Airborne magnetics and EM**



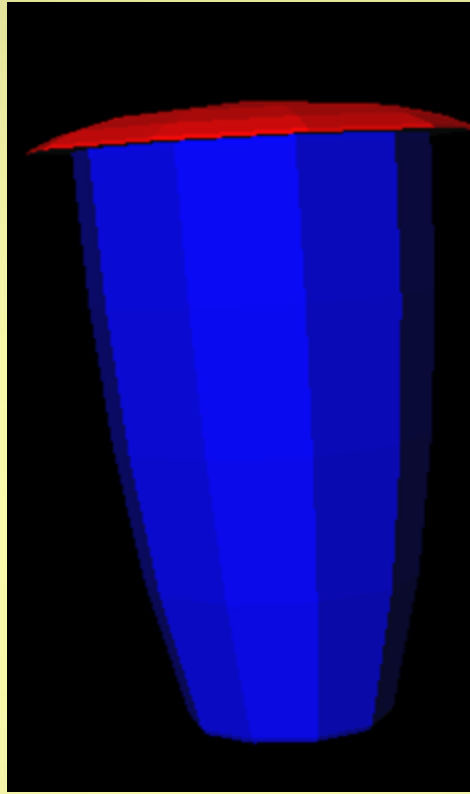
◆ **TEM Conductor:**
Copper – Nickel project



Copper-Nickel Resource: Magnetics, Gravity, EM



◆ **Massive Sulphide Deposit – Borehole TEM plus Magnetics**



◆ **Classic Salt Dome Model - Gravity**



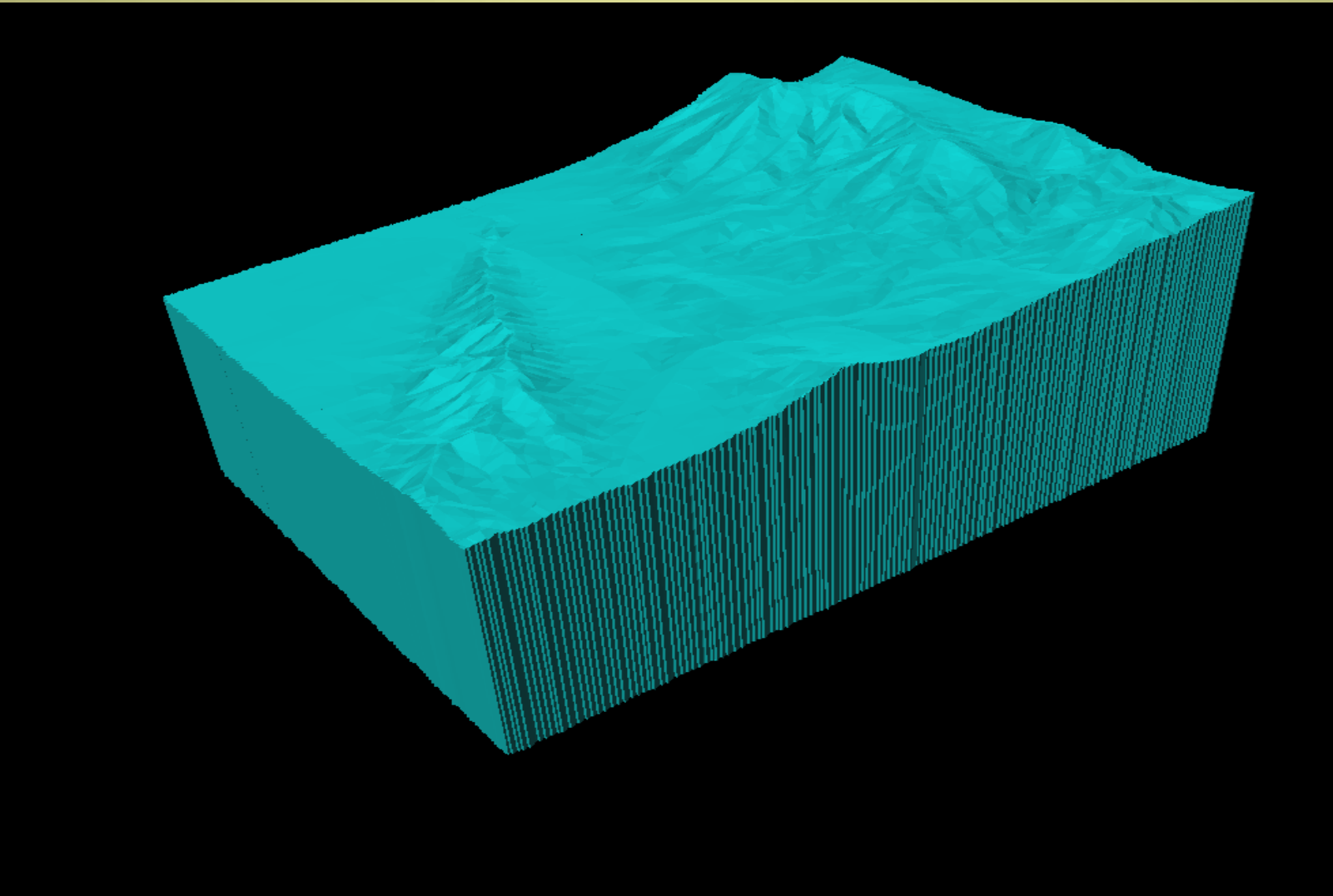
◆ **Steel Utility Pipe - towed FEM ground array**



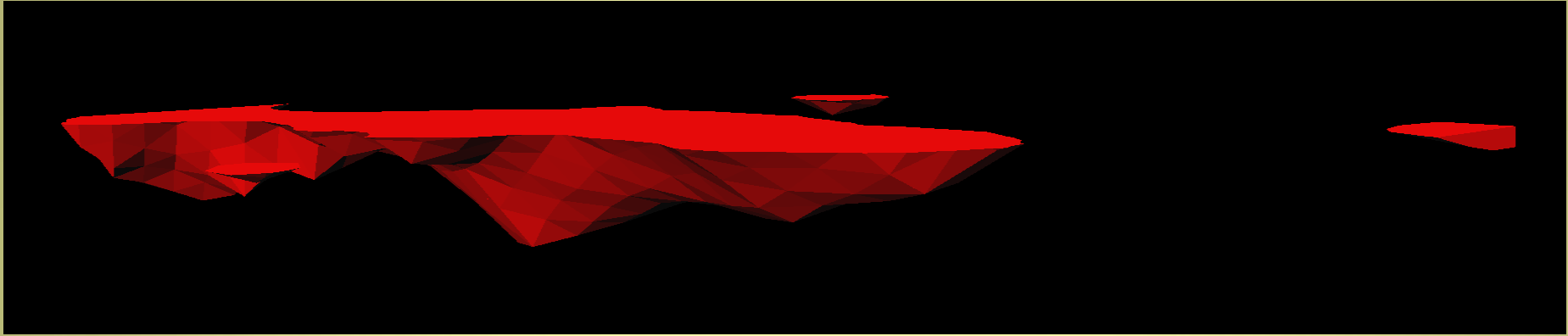
◆ **Gold Resource - IP, Gravity and Magnetics**



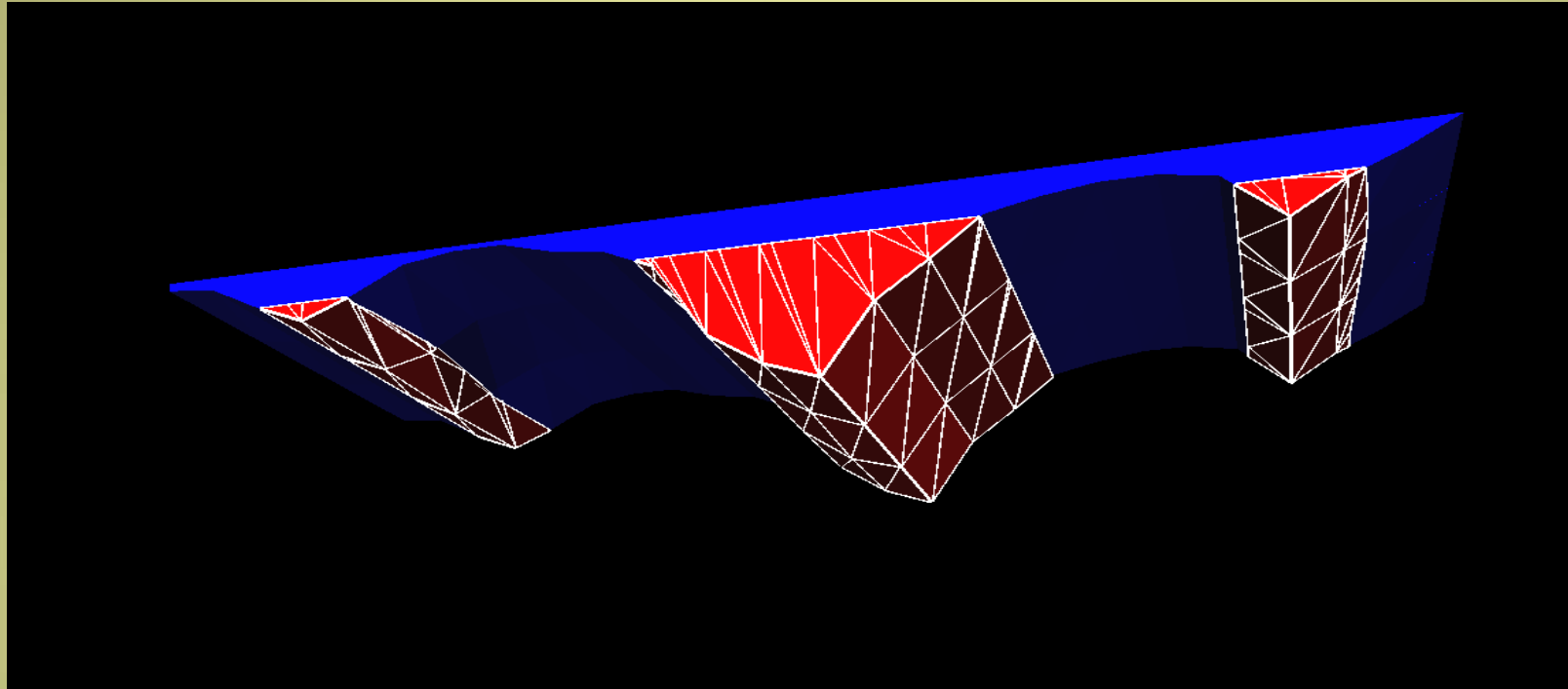
- ◆ **Underground Mine Workings:**
- ◆ **Borehole, Ground and airborne gravity**



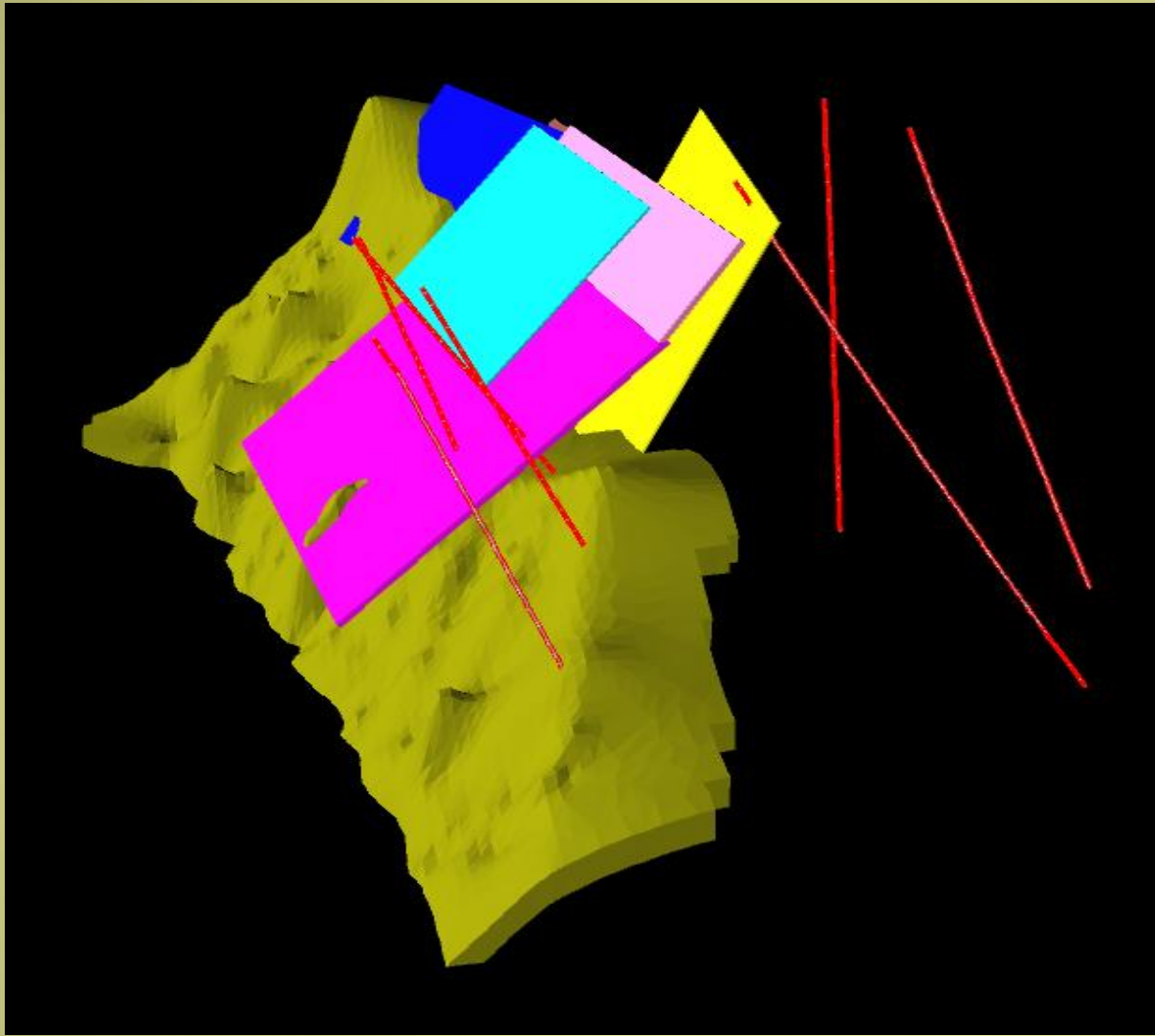
◆ **Complex Topography Model: Gravity**



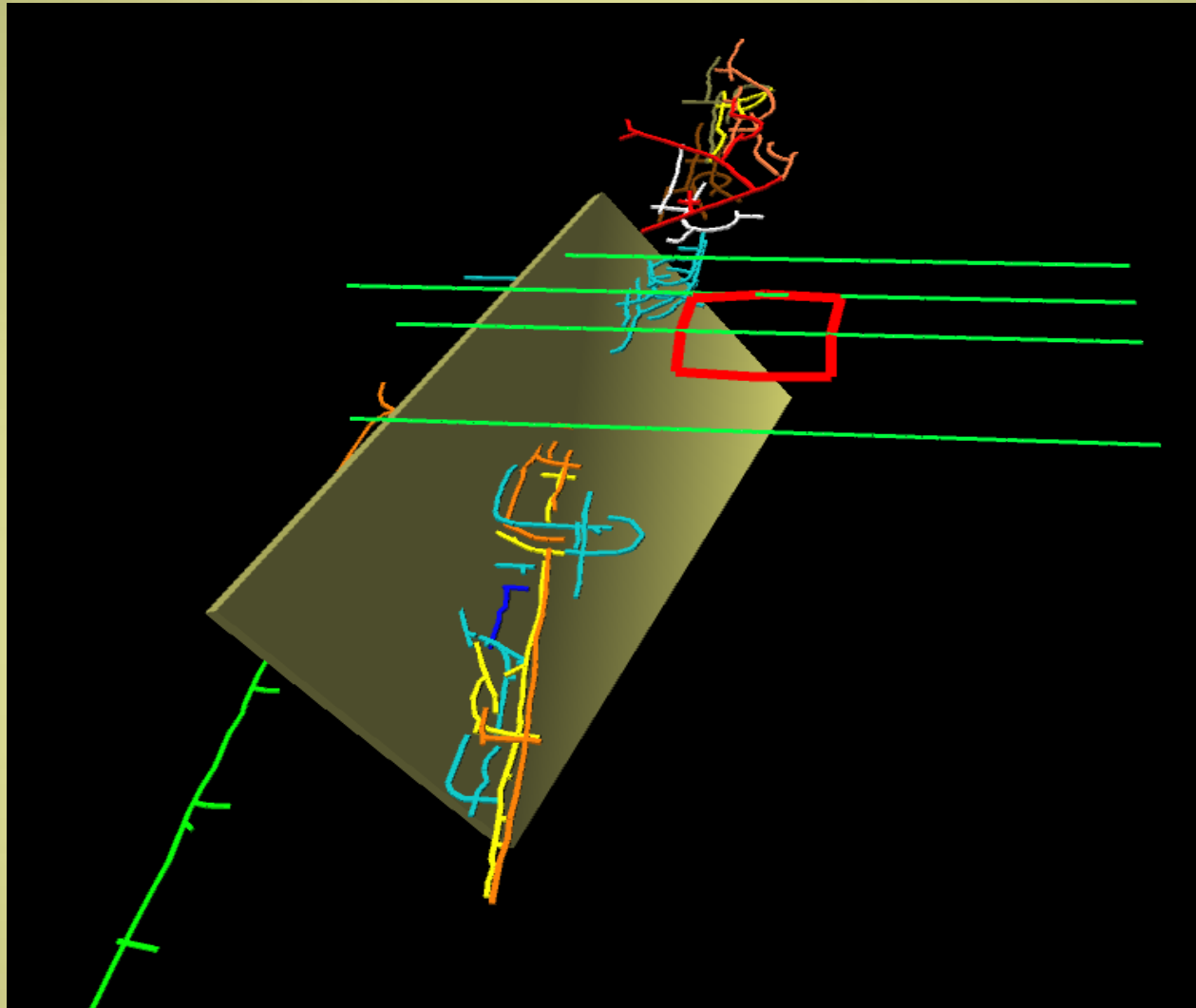
◆ Basin Model: Gravity



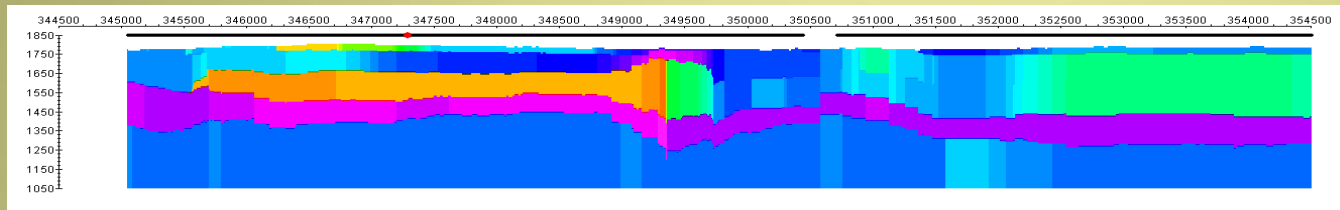
◆ **Aquifers Model: Ground Gravity and Airborne TEM**



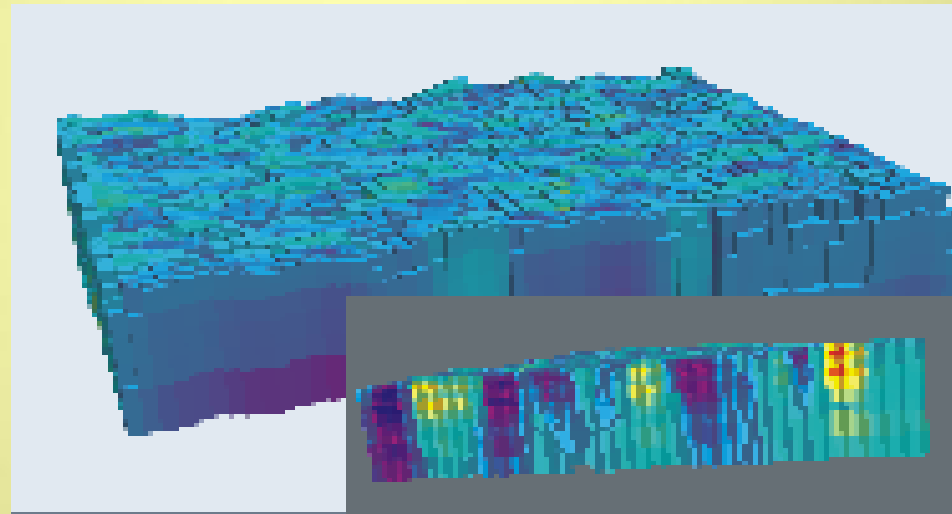
◆ Ore bearing zone, new TEM targets, boreholes



**Ground TEM modeling in conjunction
with underground workings**



Airborne TEM Inversion



AeroGravity Inversion

EMIGMA Training Tools



- Manual in Text and Digital Form !
- *describes all the basic concepts*
- *HELP – embedded within product*
- Movie Tutorials
- extensive examples
- Tutorials in .ppt and .doc formats
- Technical References
- Support : e-mail, and online help
- www.petroseikon.com, support@petroseikon.com