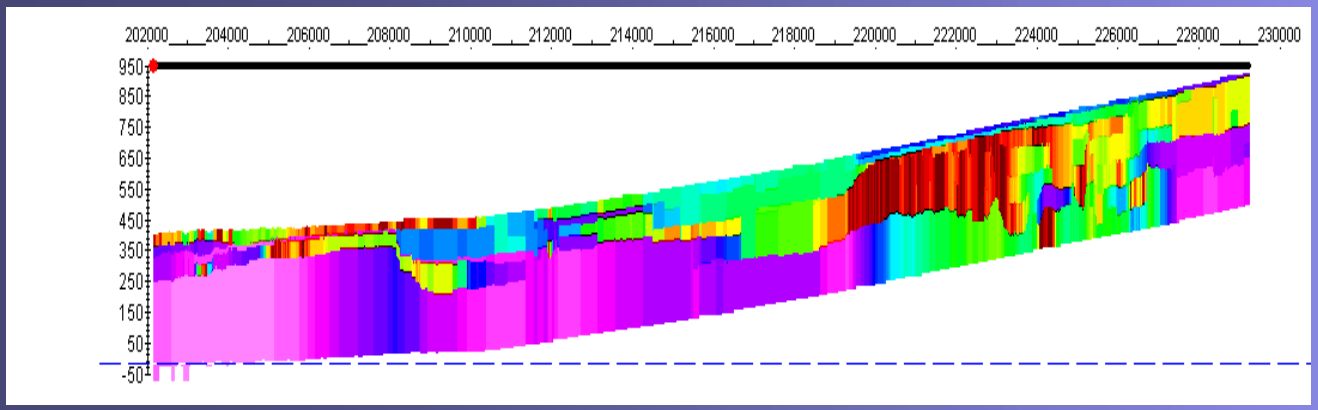
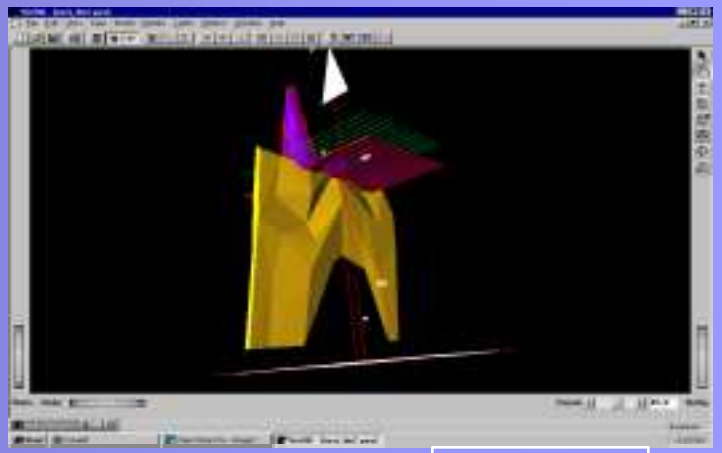
PetrosEikon (Earth Imaging)

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

Aquifer study





Ni/Zn Deposit

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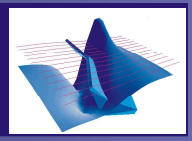
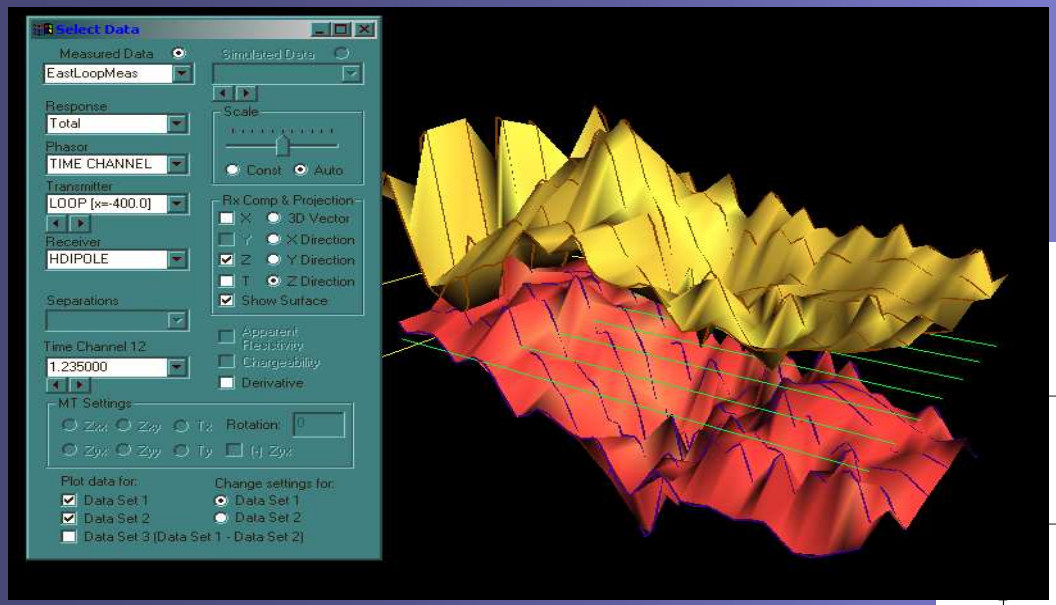
Sophisticated software for the practicing Geoscientist

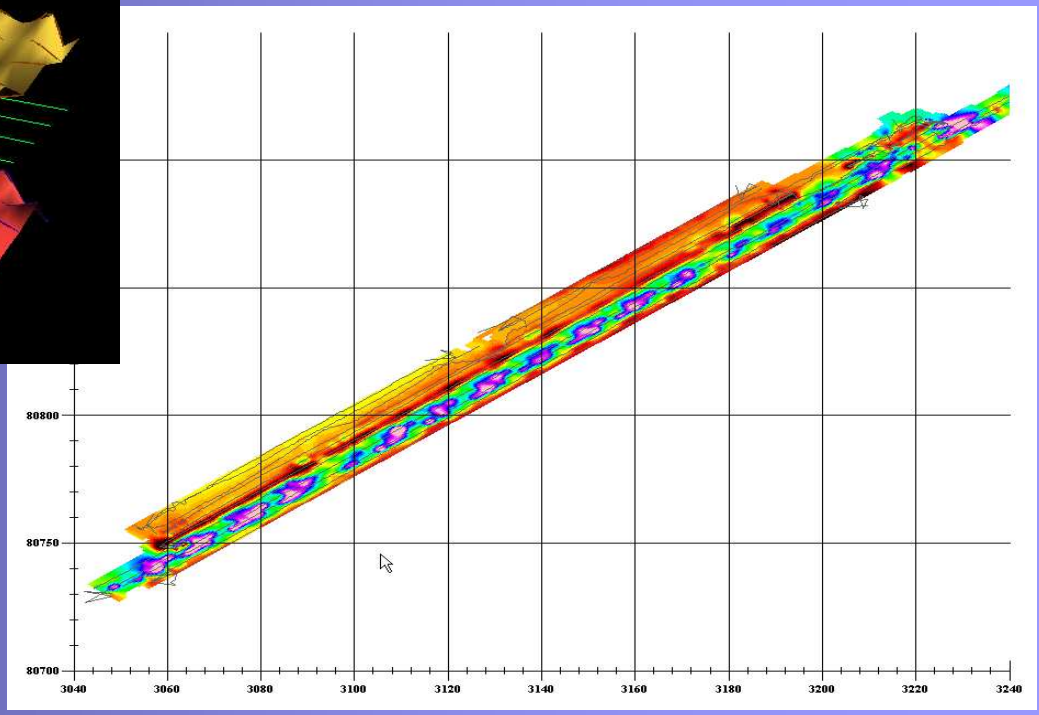


Since 1994, Developers of Software for Interpretation of Geophysical Data



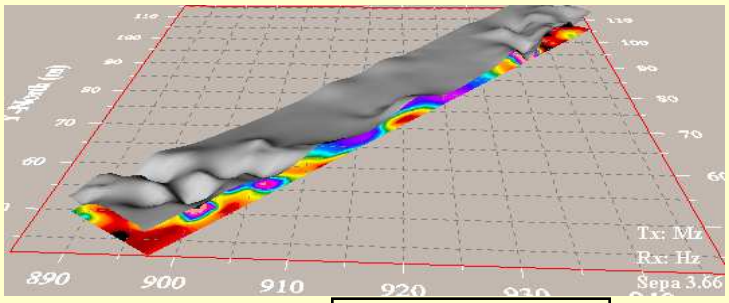
Uranium Exploration

Urban Hazards



Modelling, Inversion, Data Analyses, Research

Applications



Road Construction

FEM
MAGNETICS
AEM
HEM
CSAMT
TEM
IP
RESISTIVITY
GRAVITY
MT

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

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

EMIGMA Tools

- *Data analyses and editing tools*

- *3D Visualization*
- *3D Model Building*
- *CAD Model Imports*

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

- *3D Magnetic Inversion, 3D Gravity Inversion*
- *1D FEM, TEM and Resistivity Inversion*
- *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 griddling, non-planar girding, constant drape*

- *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)*

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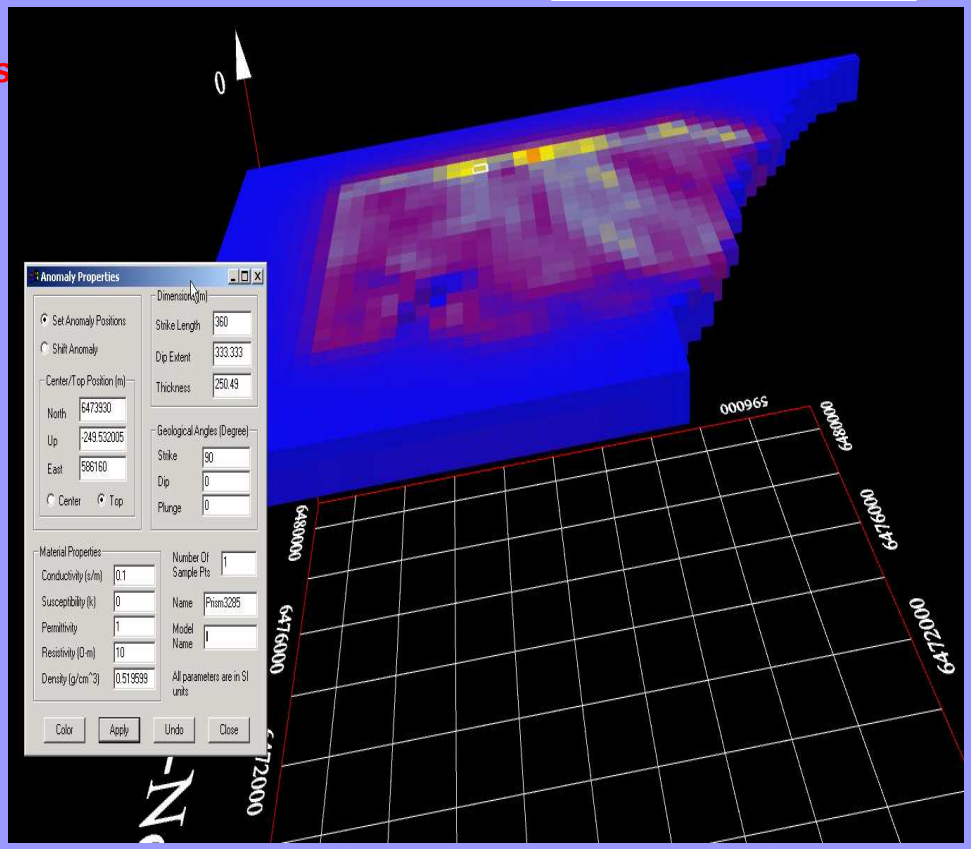
Sophisticated software for the practicing Geoscientist

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

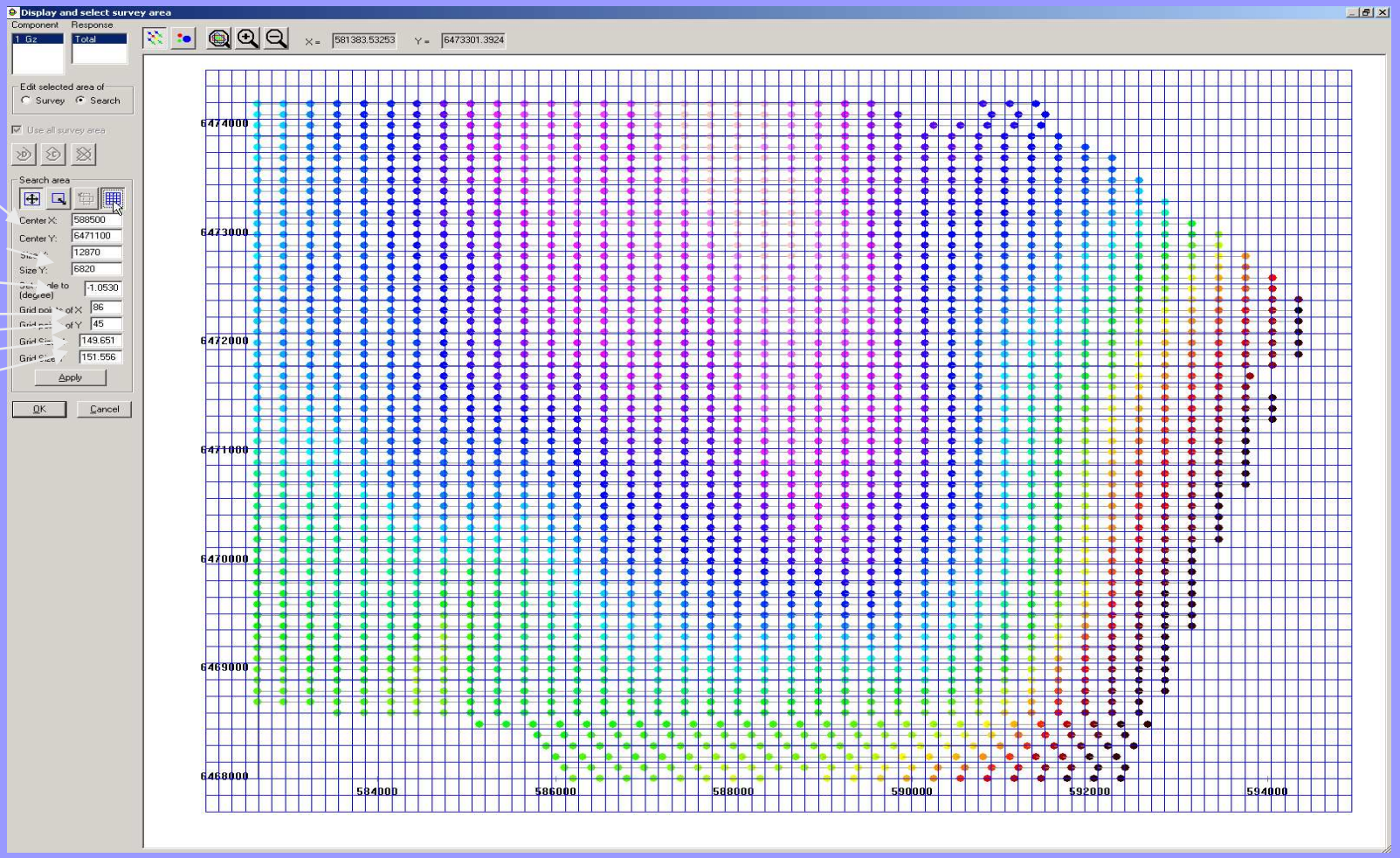
angle of grid

Nx in grid

Ny in grid

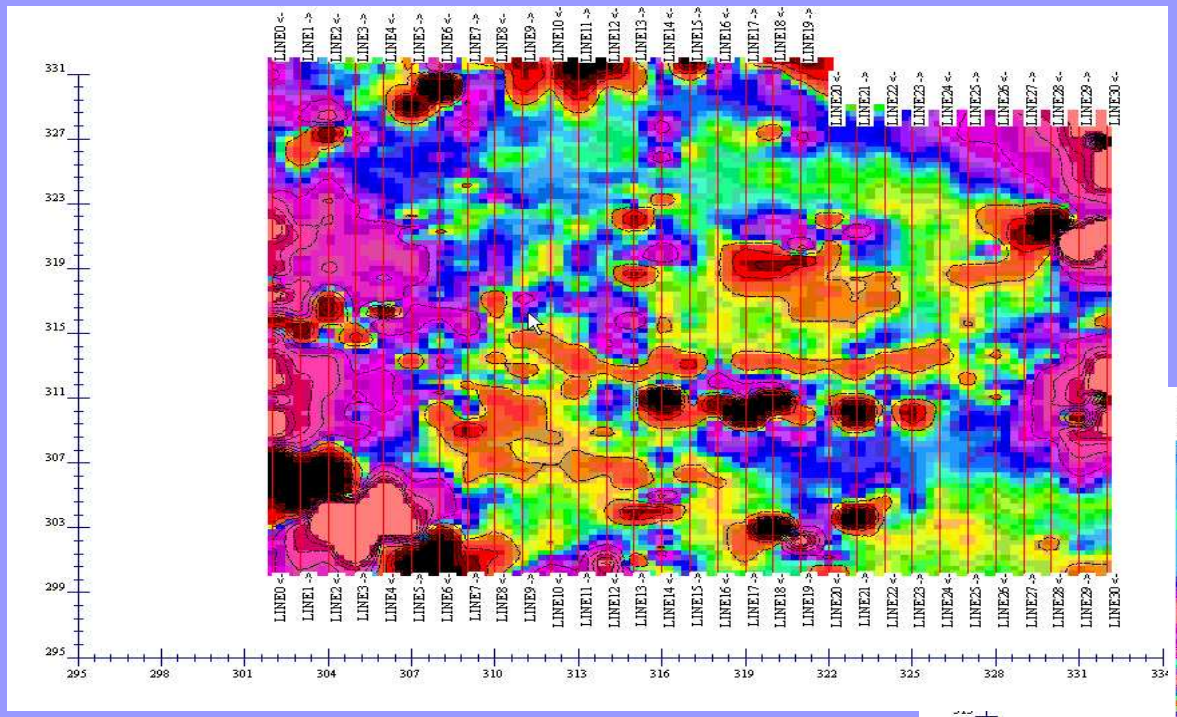
dX in grid

dY in grid



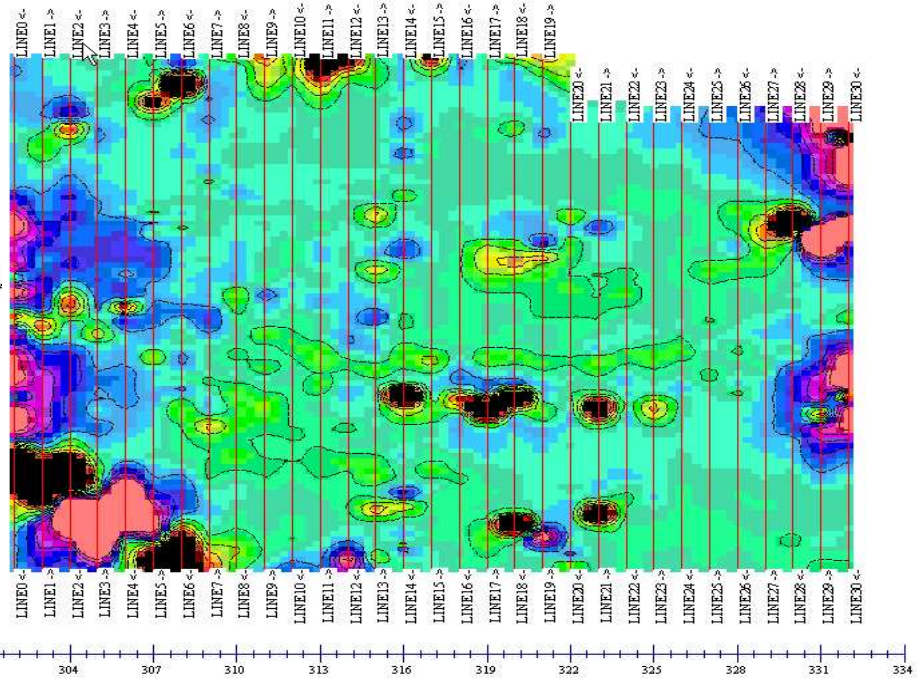
Data Interpolation and Contouring 1

Natural Neighbour, Shepard, Delauney - Local
Minimum Curvature - global



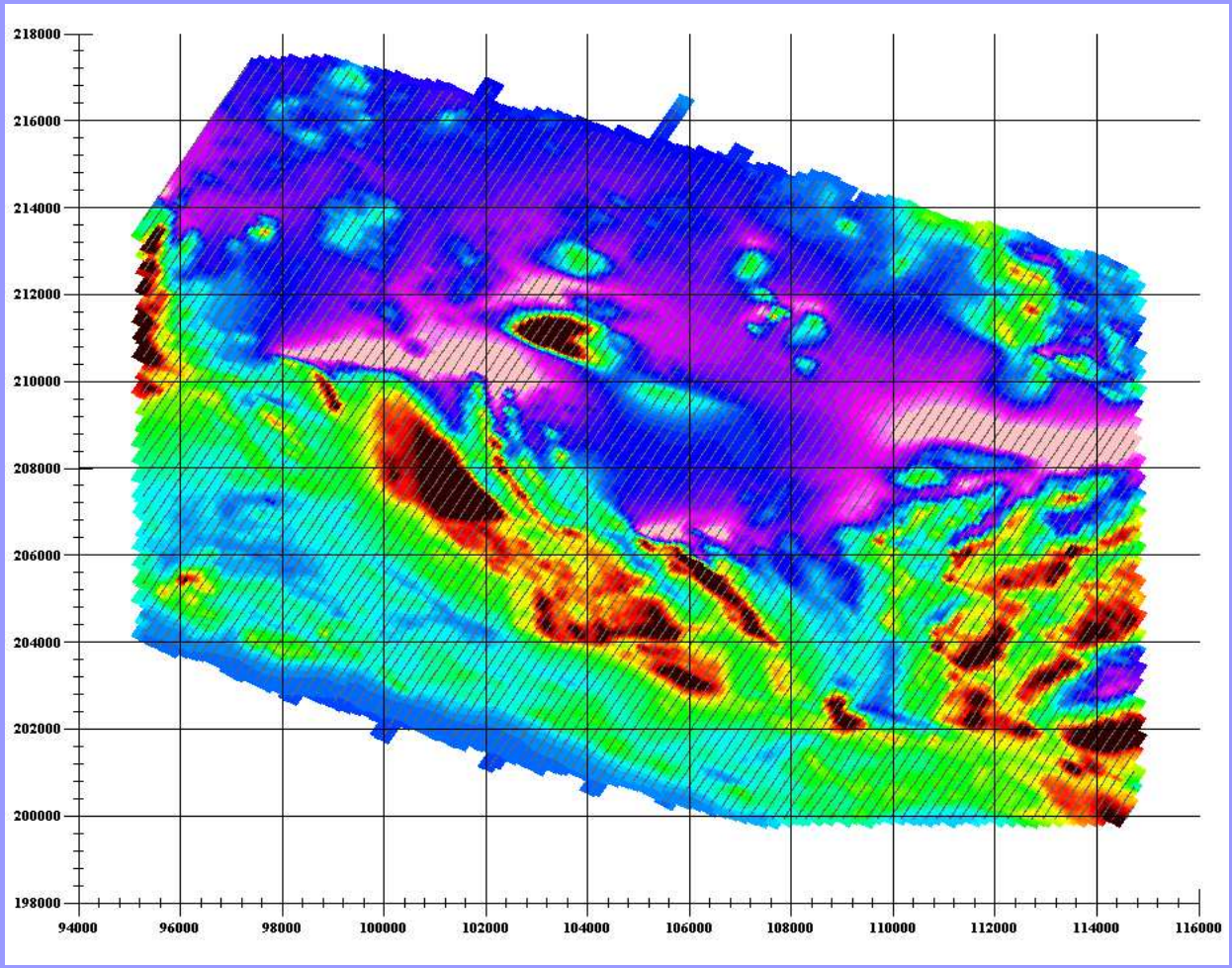
Rectangular grid cells
Multi-component grids

Equal Weight



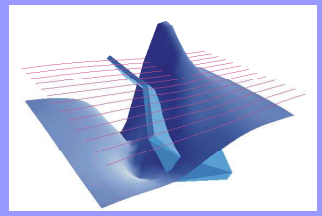
Equal Range

Data Interpolation and Contouring 2

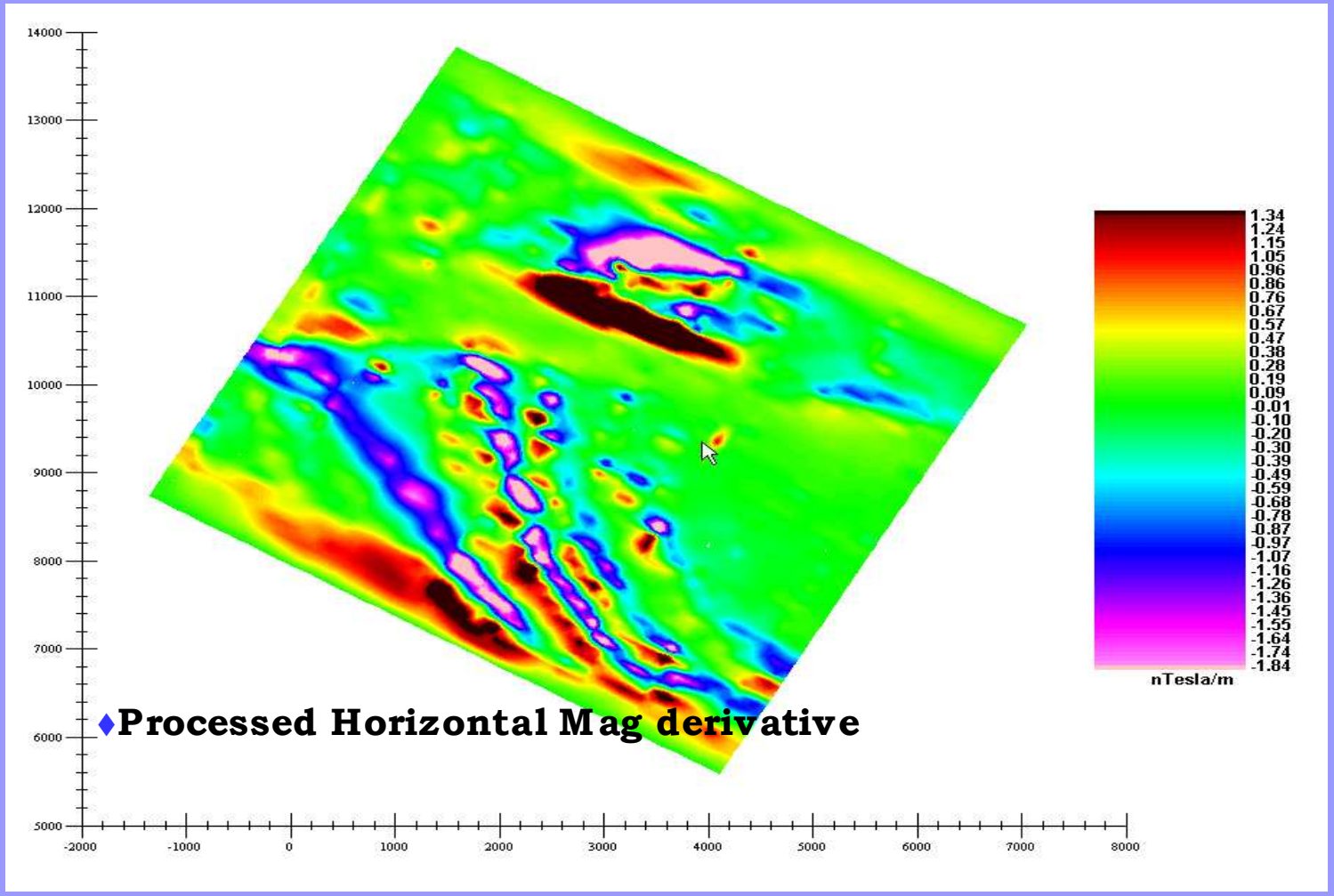


Massive Sulphide Exploration – Spain/Portugal

- ✓ **Natural Neighbour Interpolation**
- ✓ **Delauney Traingulation**
- ✓ **Minimum Curvature**
- ✓ **Splines**

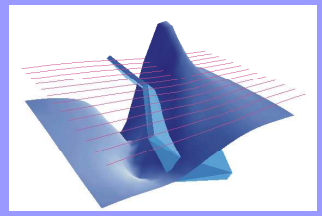


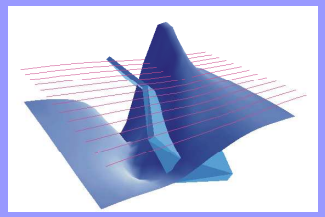
Data Interpolation and Contouring 3



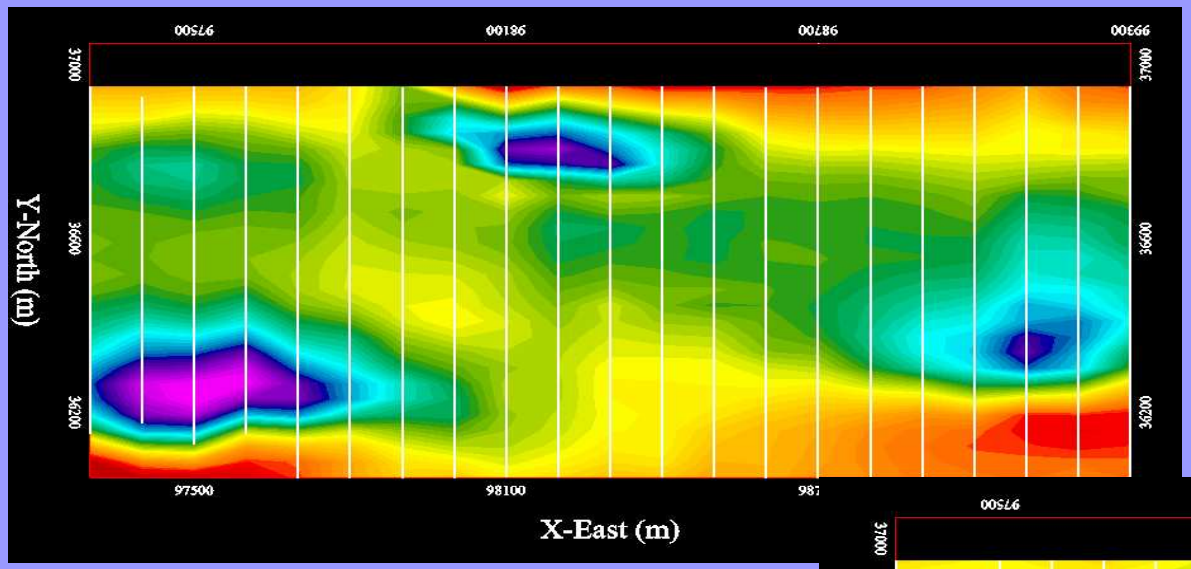
Grid View

Multiple datum stored in a grid for quick viewing

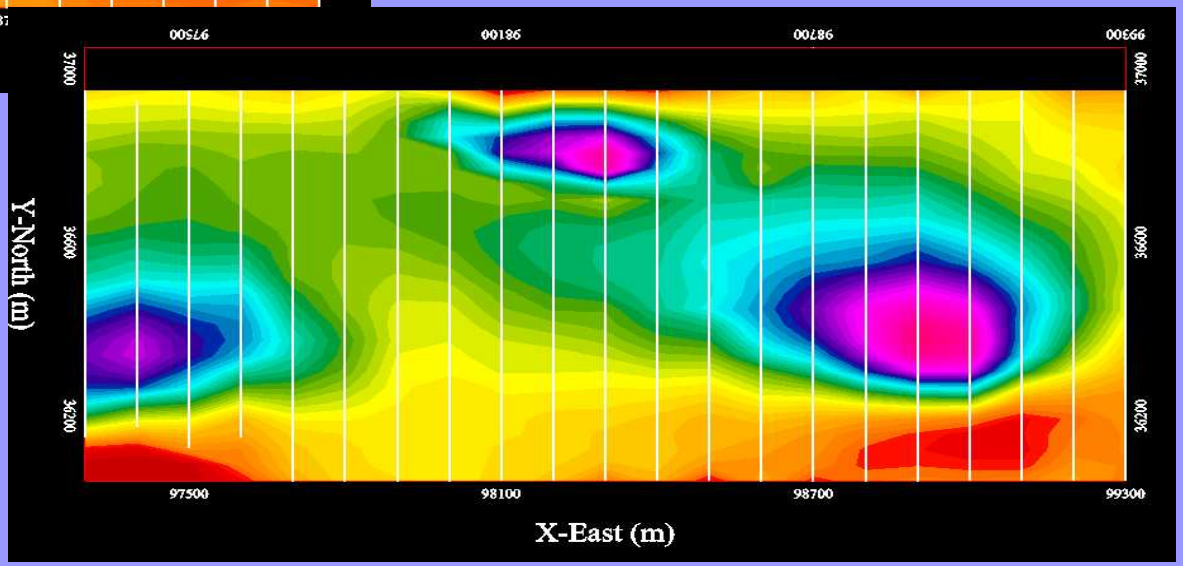




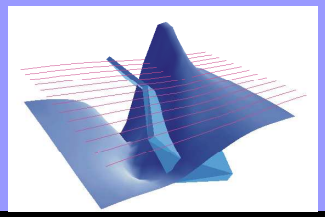
Track anomaly time evolutions



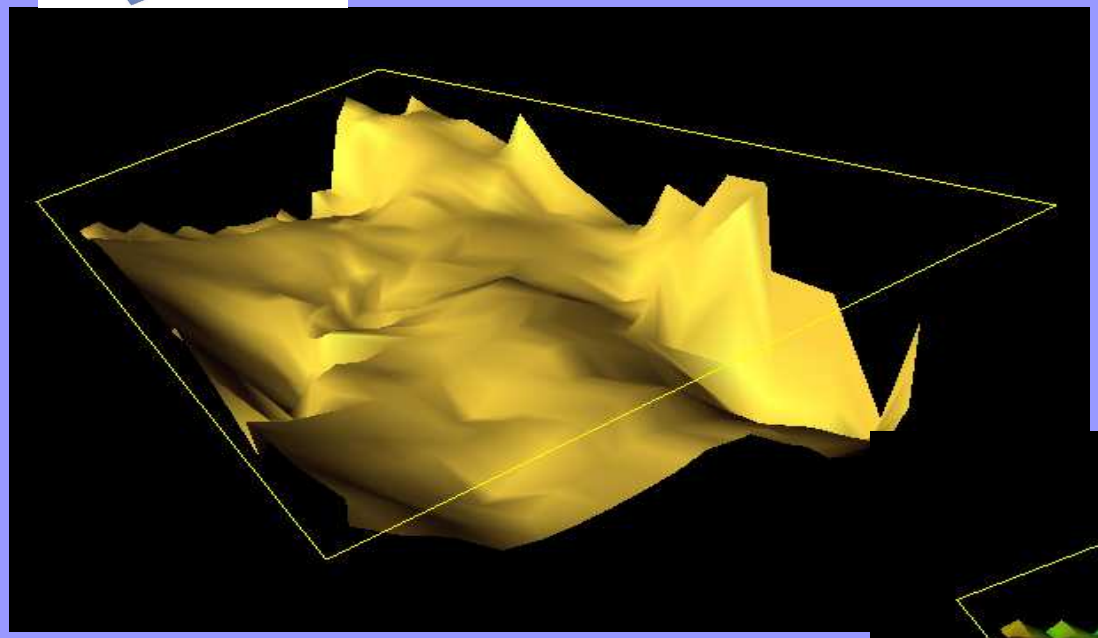
Mid-Time TEM data



Late-Time TEM data

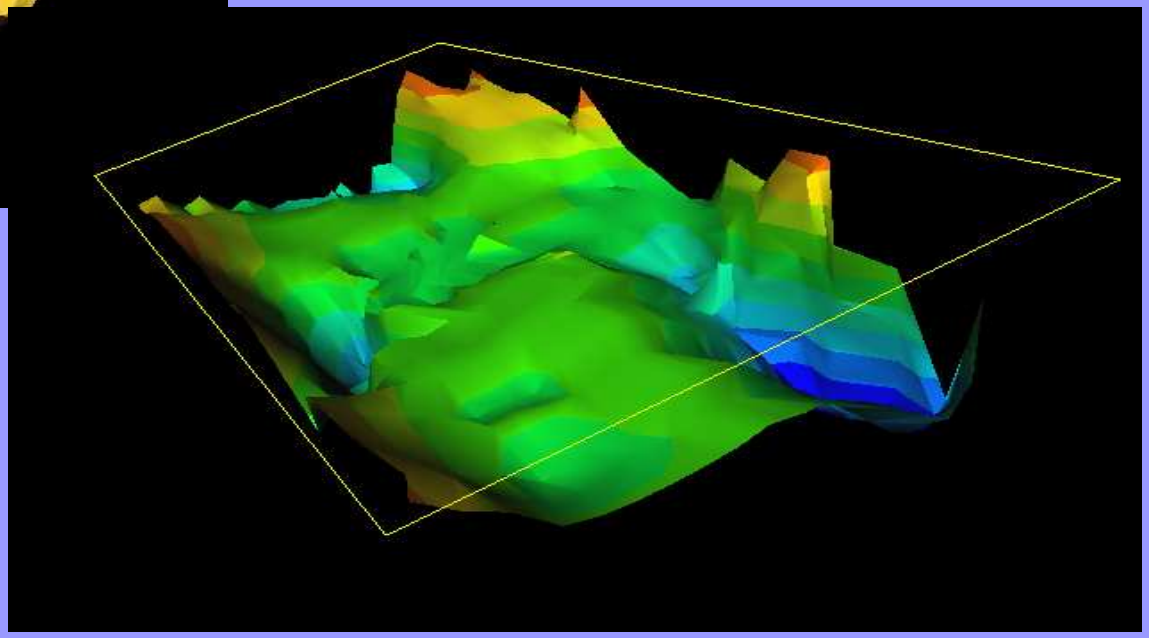


Surface representation of data allows for a spatial display of anomalies



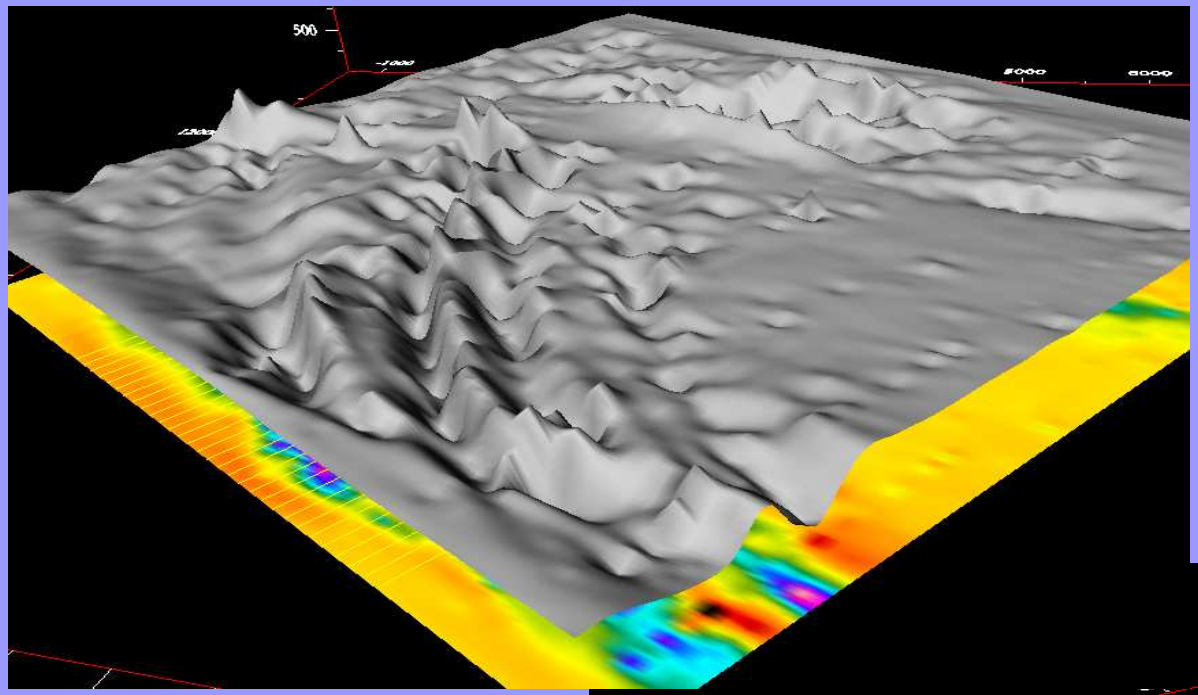
Data Surface

Nickel Exploration – Canadian Arctic



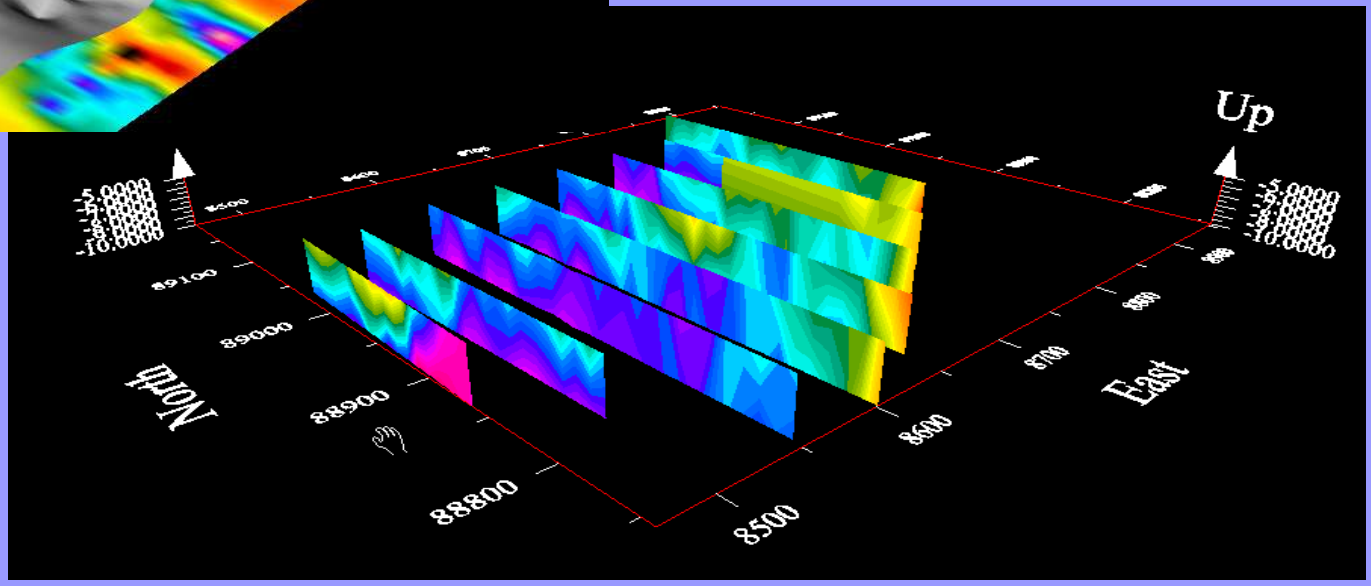
Contoured Data Surface

Data Interpolation and Contouring 4



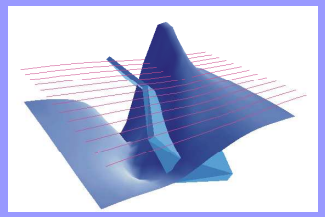
Airborne Gravity – Gulf of Mexico

IP data - Mongolia

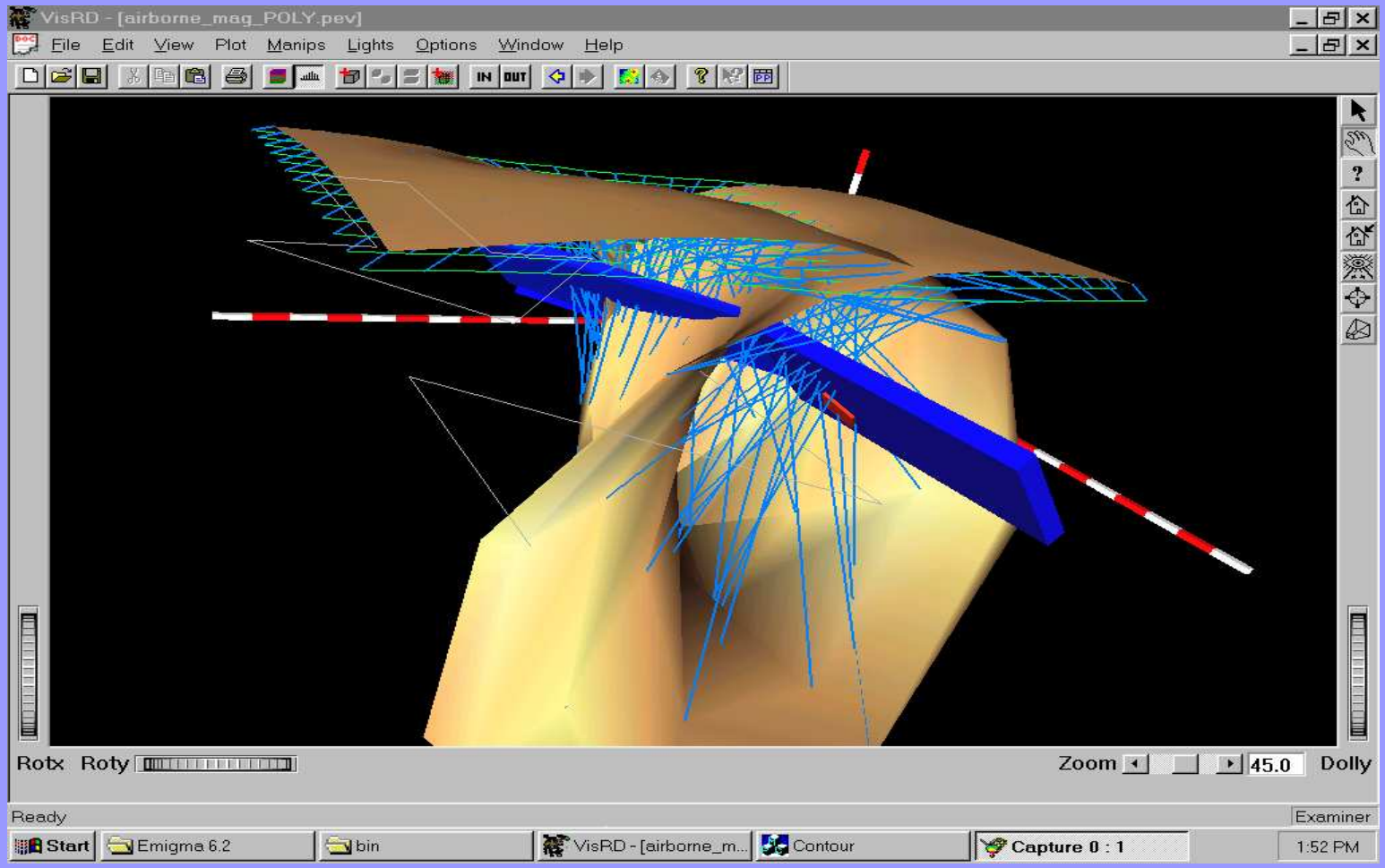


EM:GMA V6.1

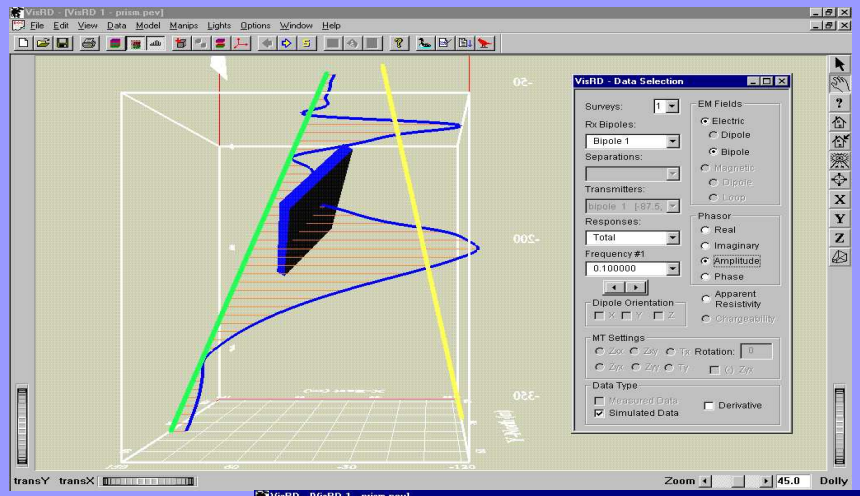
Sophisticated software
for the practicing Geoscientist

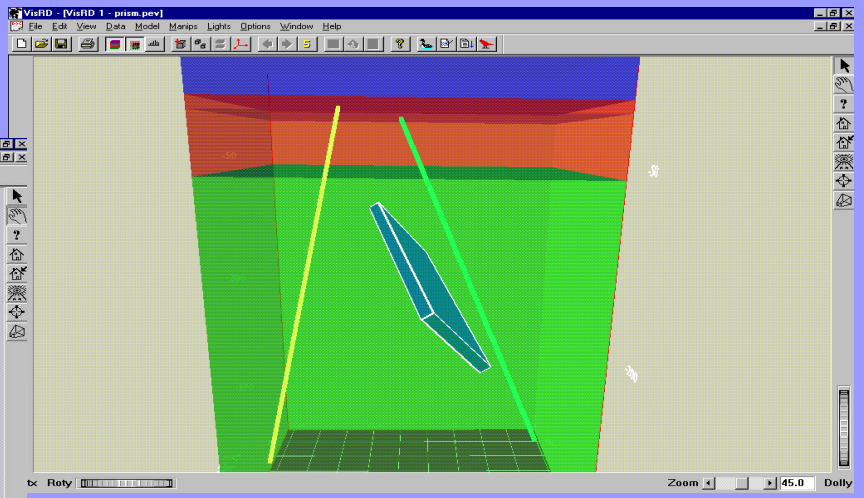


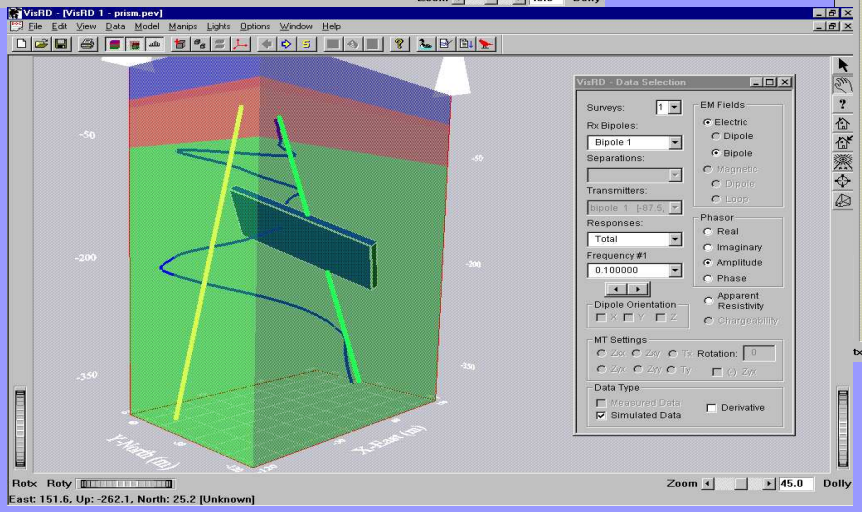
A Range of 3D Data Representations



Model Building and Simulation - 1







View survey, Build models and analyse data in 3D

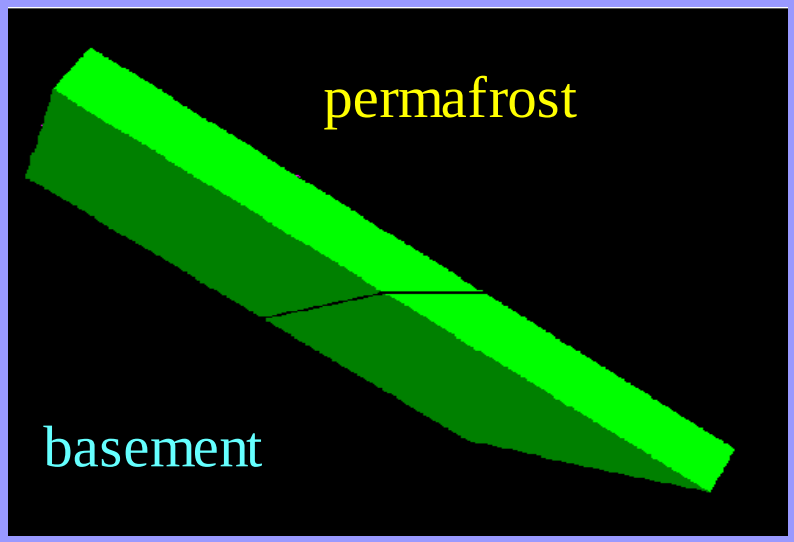
***e.g.* Crosshole resistivity survey and model – gold deposit delineation**

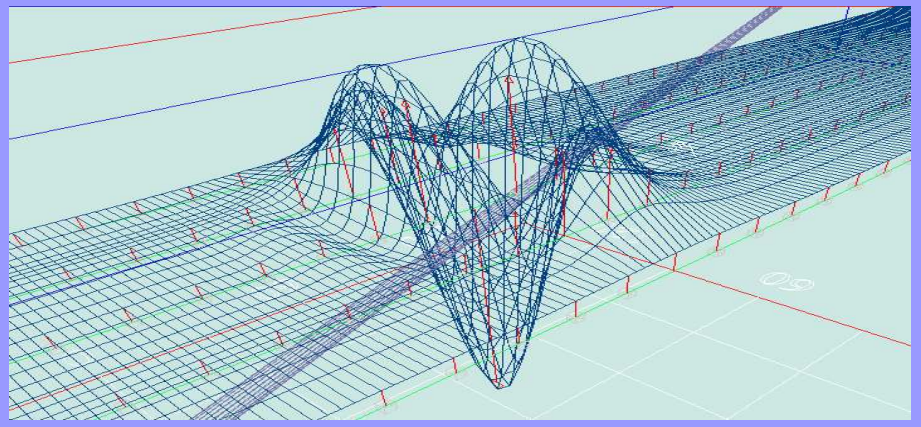
Model Building and Simulation - 2

EM –> TDEM and FDEM

3 Algorithms – 3D integral equation 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**

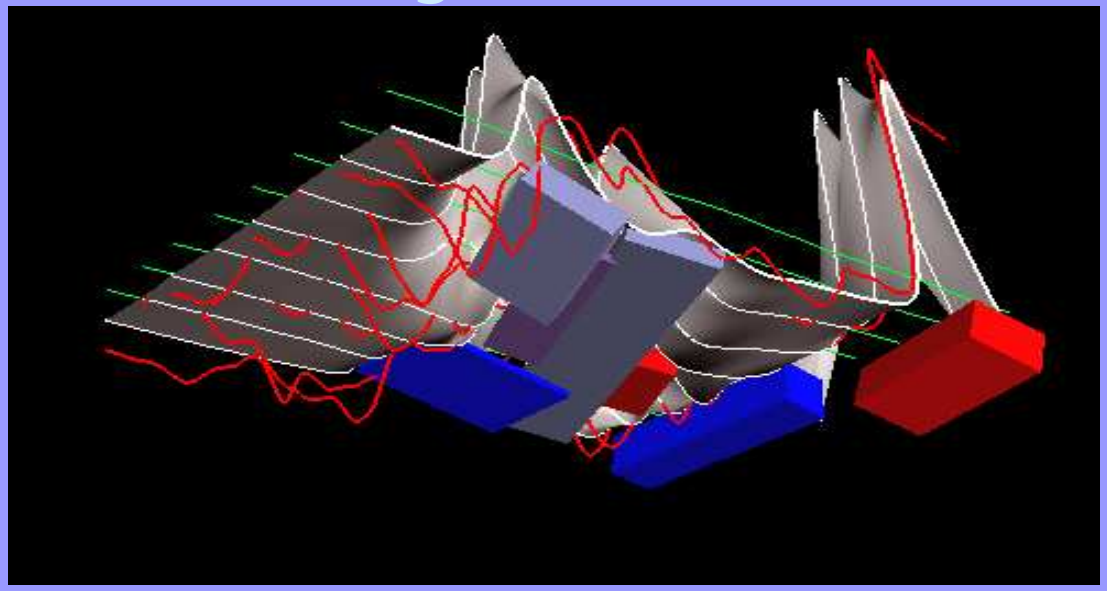




EMIGMA V6.1
Sophisticated software
for the practicing Geoscientist

Model Building and Simulation - 3

EMIGMA V8.1
Sophisticated software
for the practicing Geoscientist



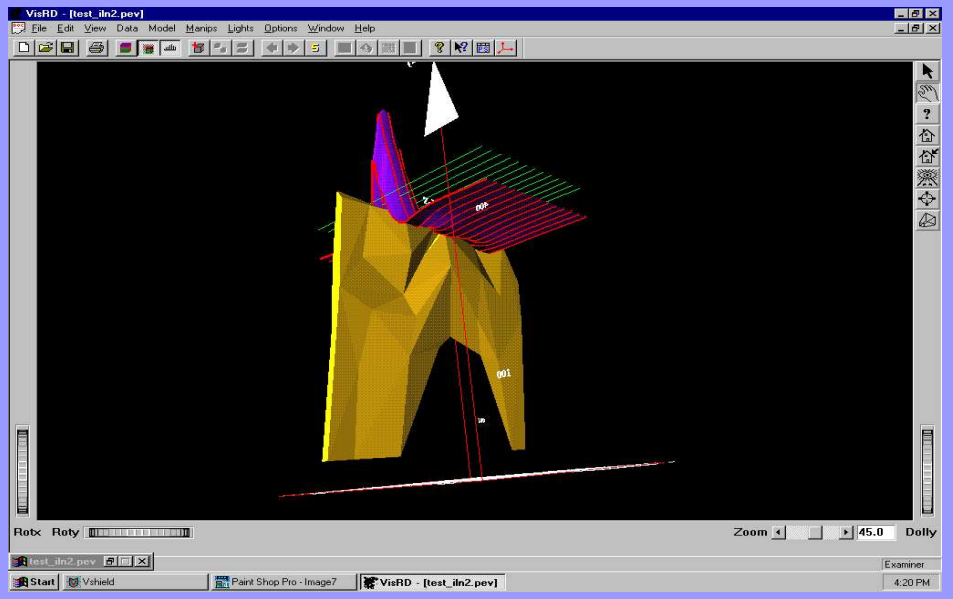
Pb/Zn exploration
Helicopter FEM

Magnetics

- 3 Algorithms – 3D IE
  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)
- Ground, Surface to Borehole, Borehole to Surface, borehole to borehole
- direct comparisons to measured data
- super-engine architecture for large models or surveys

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for the practicing Geoscientist

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

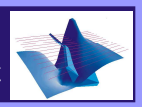
Crosshole

electric (3 antennae types) or magnetic antennae

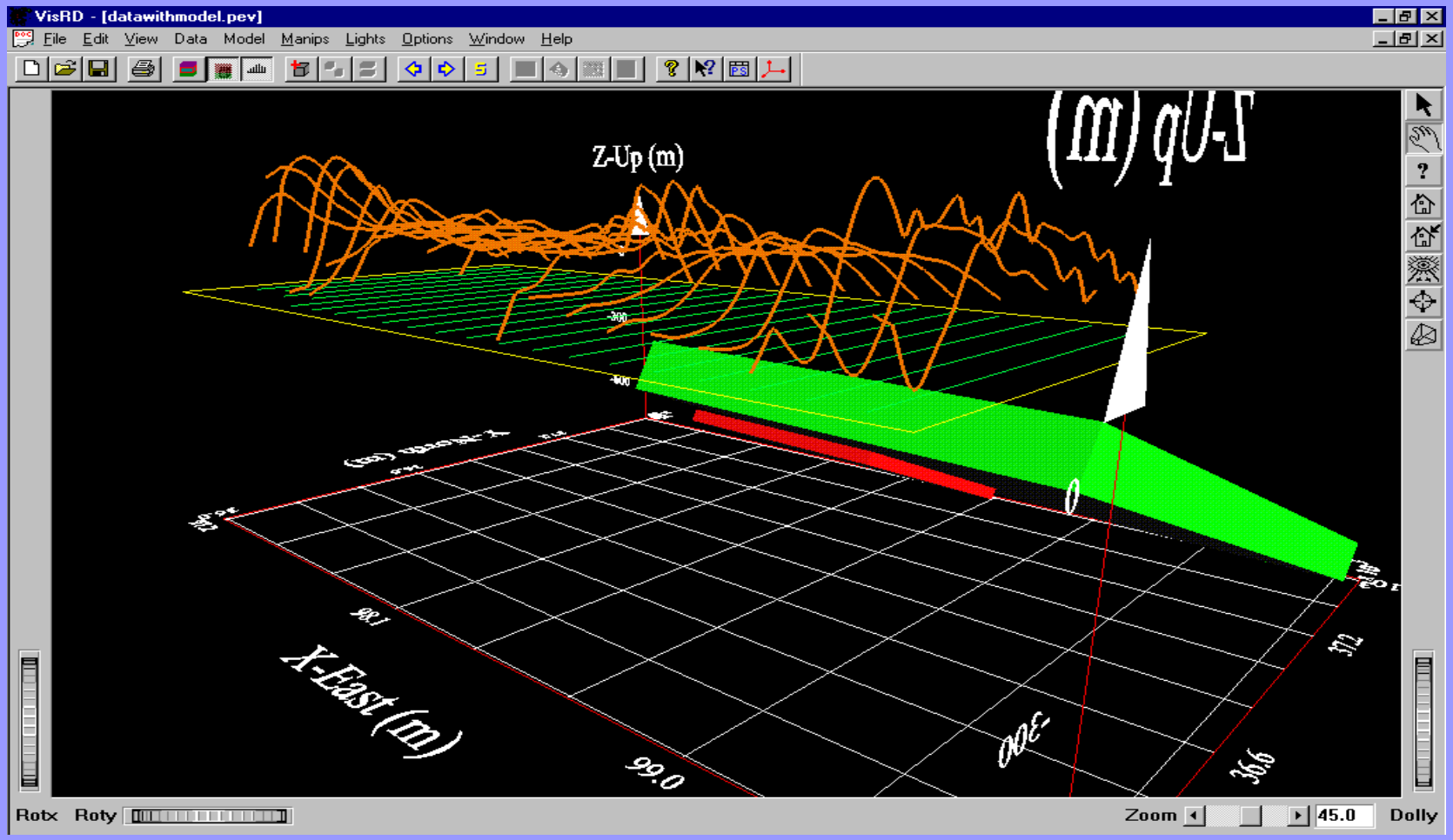
Experimental Systems

EMIGMA V8.1

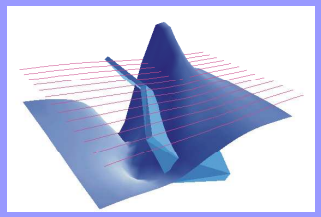
Sophisticated software
for the practicing Geoscientist



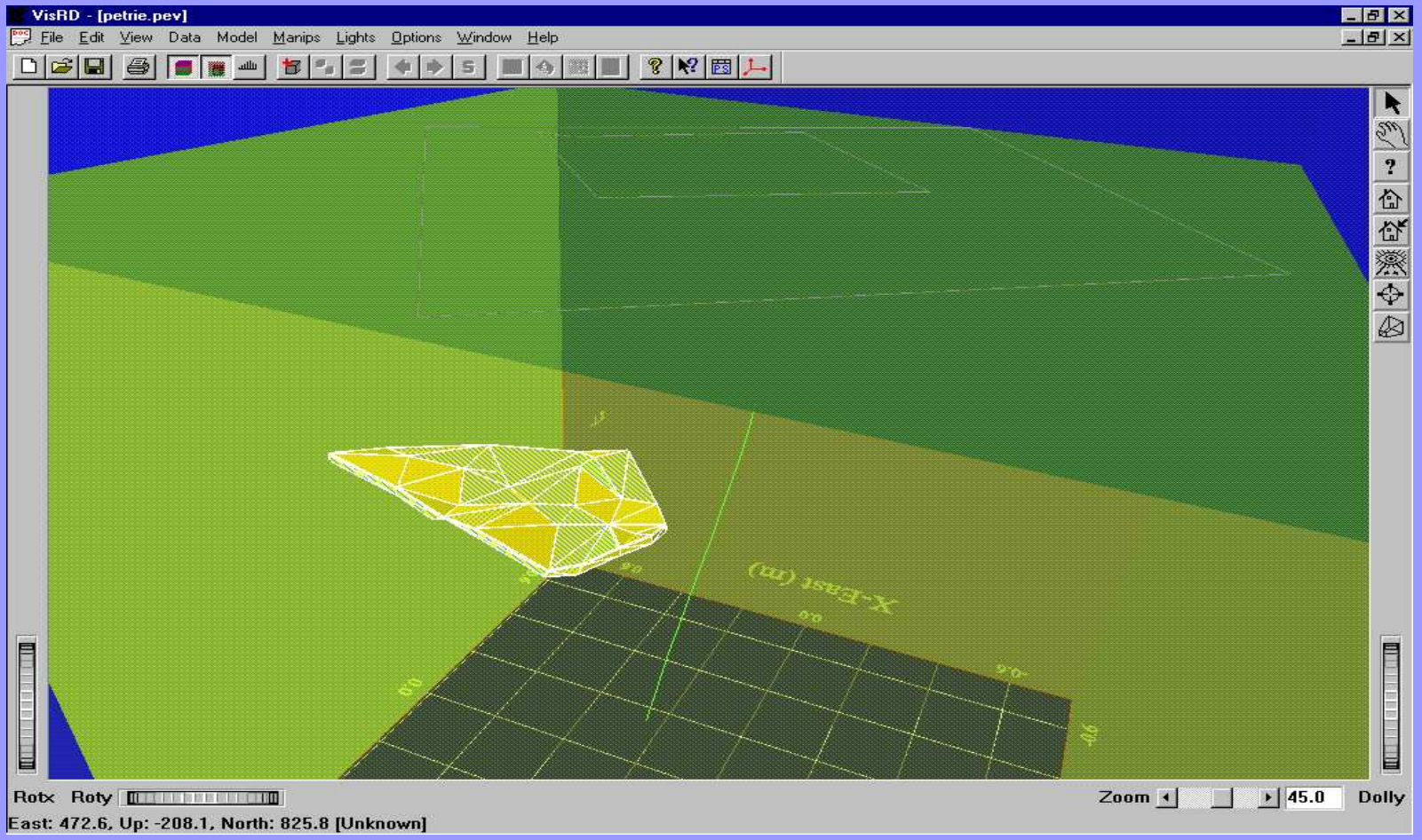
Data and Structure Representation in EMIGMA's 3D Visualizer



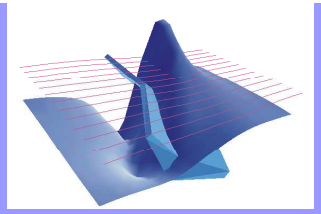
A fully integrated 3D visualization tool



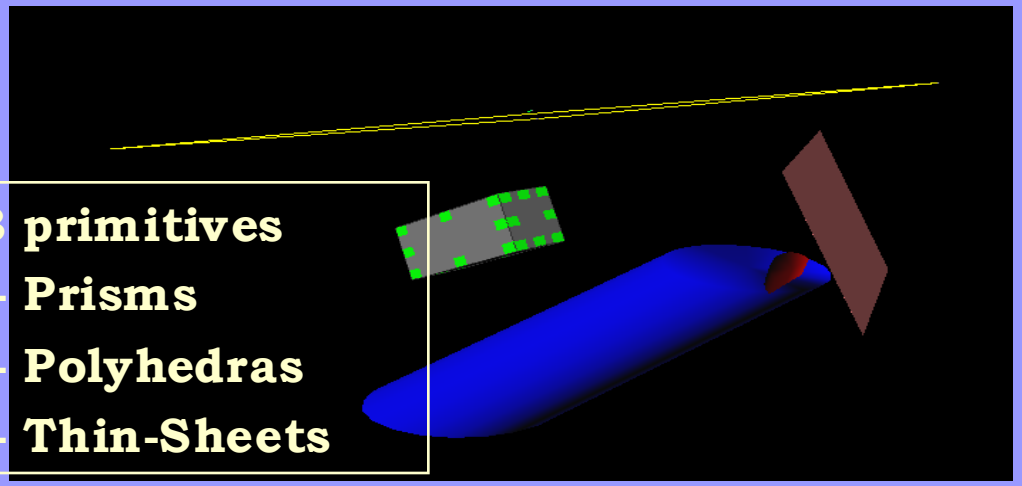
Geological CAD Models

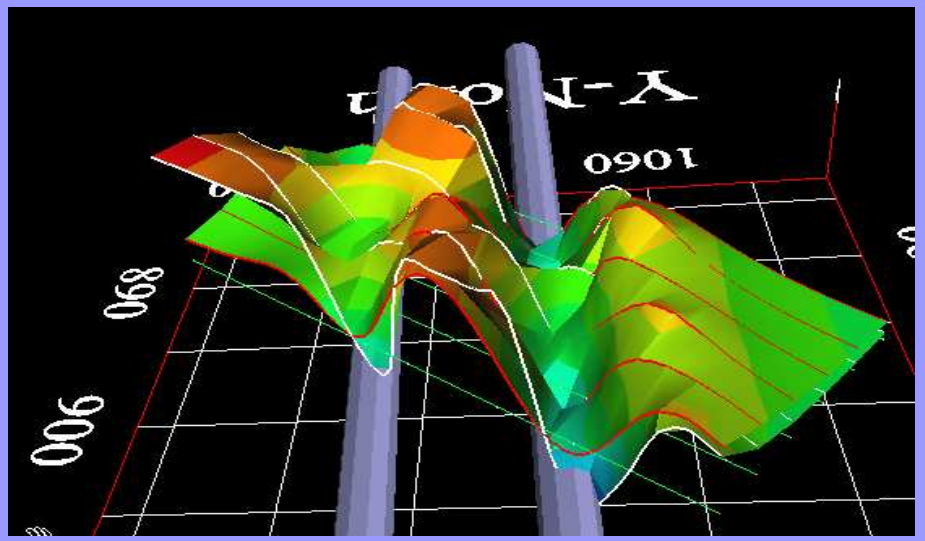


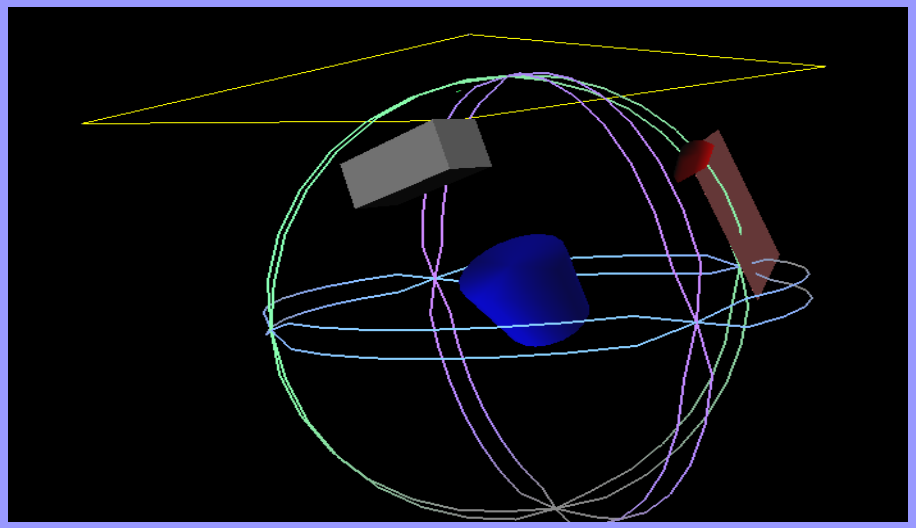
Complex 3D modelling capabilities including imports of geological models from CAD applications

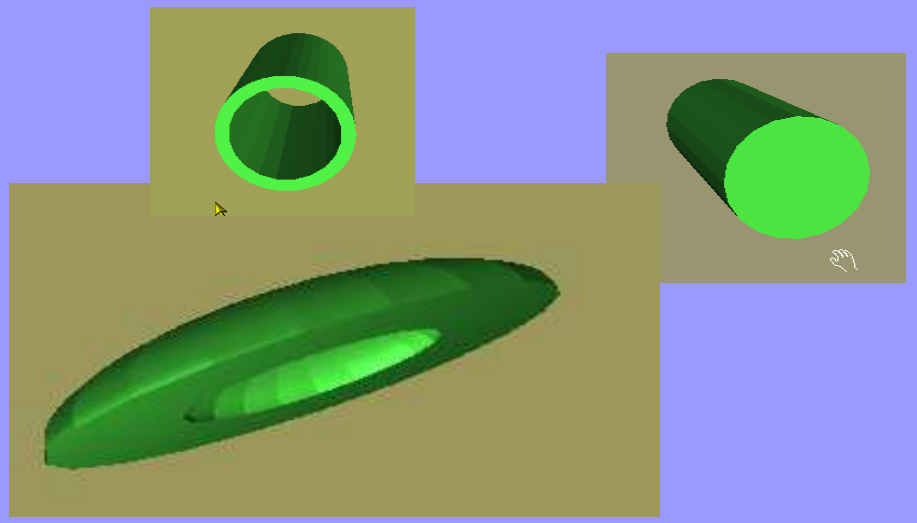


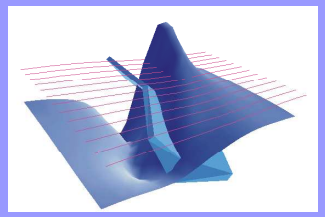
3D Visual Model Building



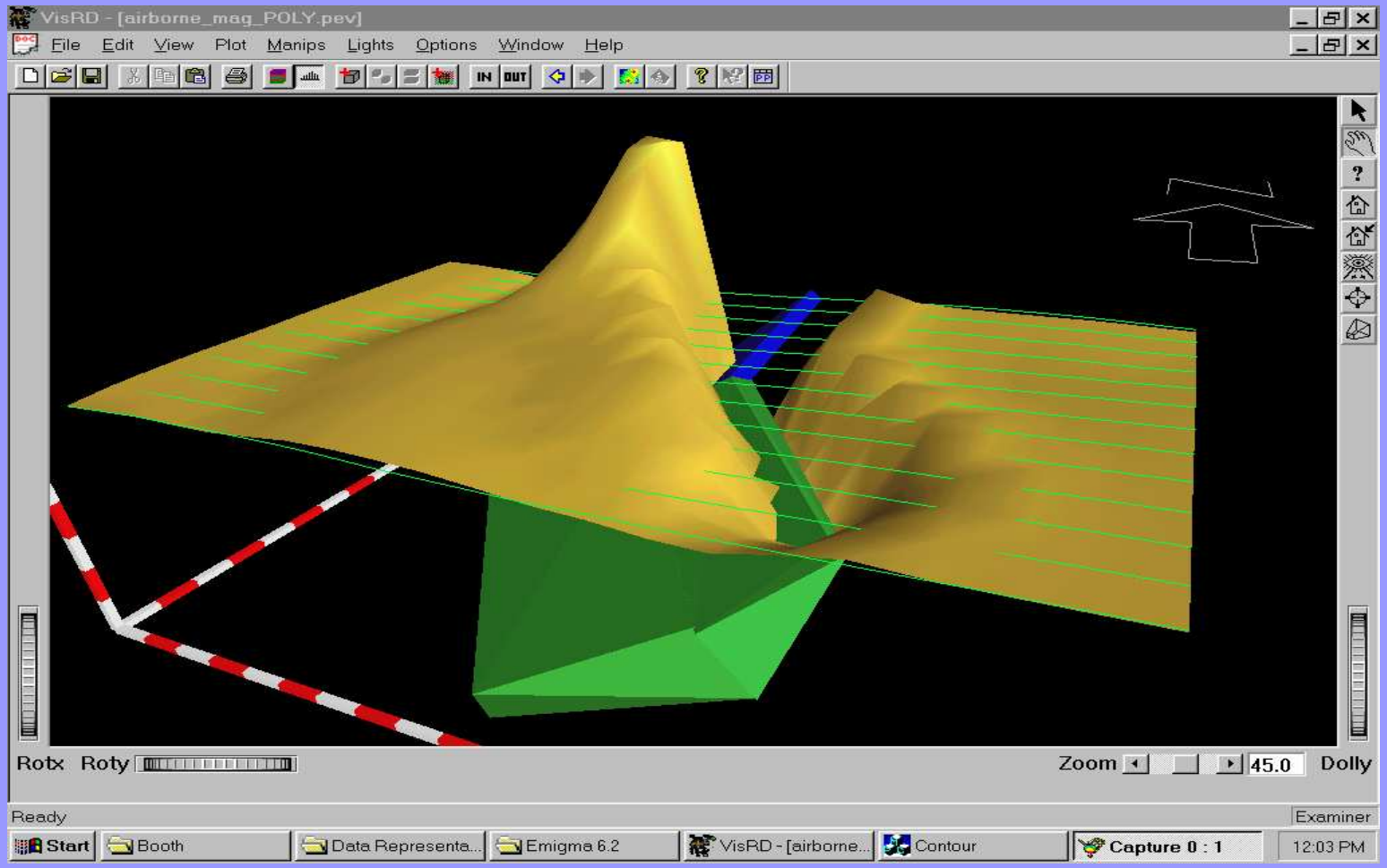








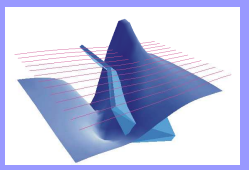
Complex Structure and Data Visualization



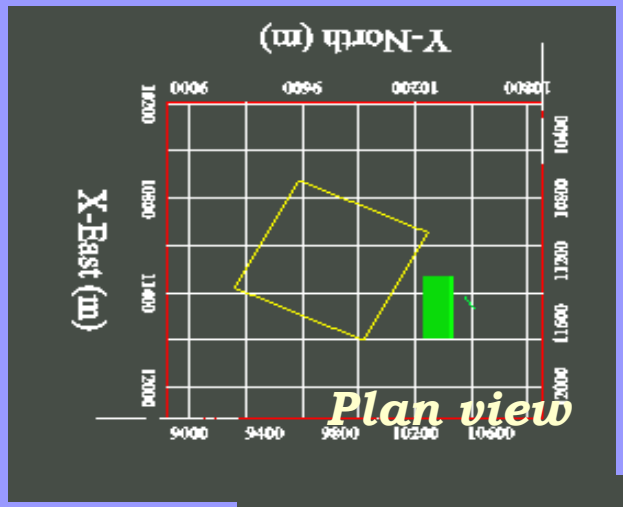
e.g Airborne Magnetic Field Modelling

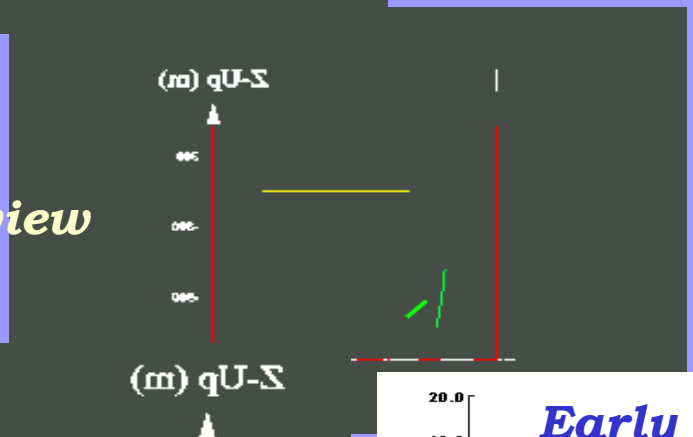
Simulation Calibrations

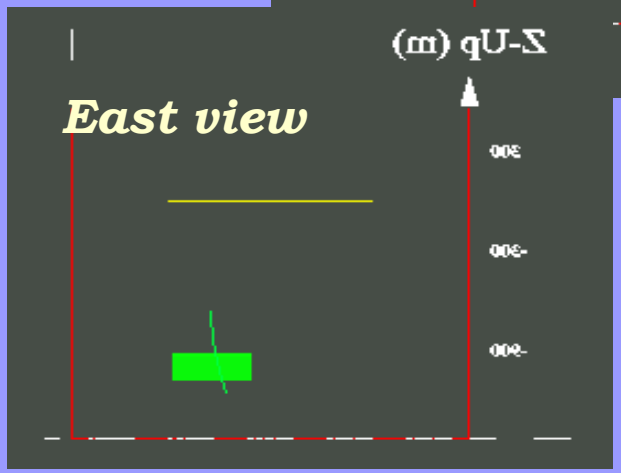
- to other algorithms
- to scale models
- to known geological targets

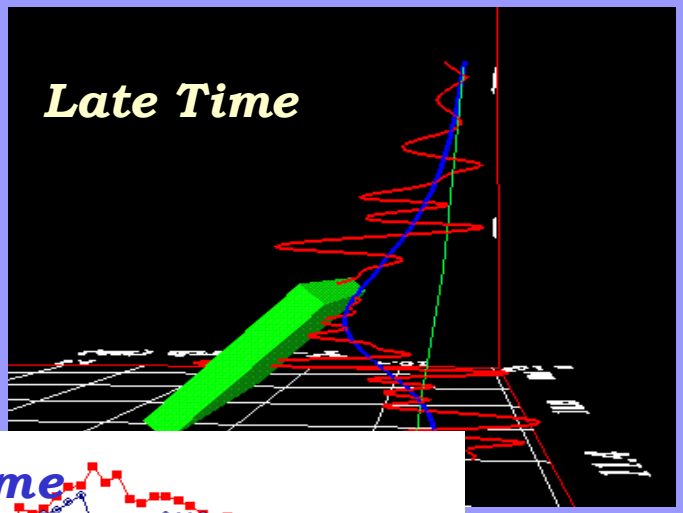


e.g TEM borehole response



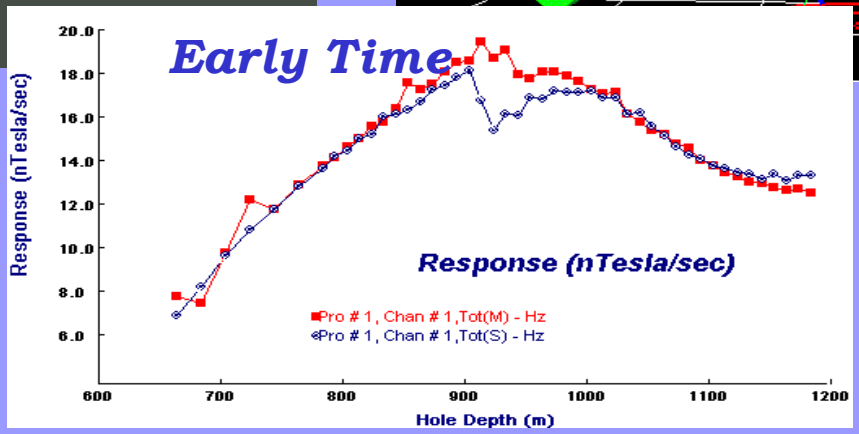


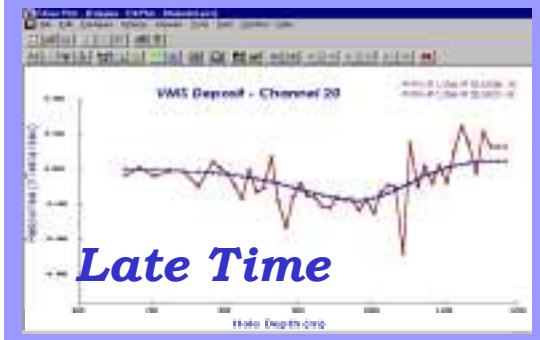




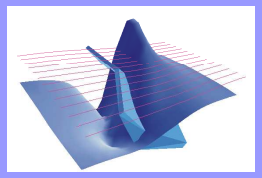
Blue line - simulated

Red line - field data





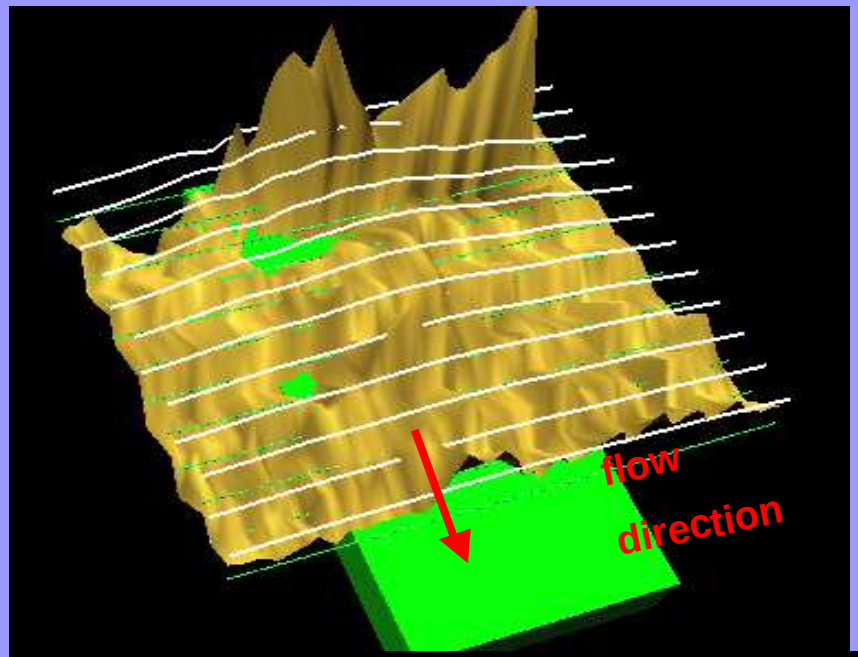
Model and Data Comparison

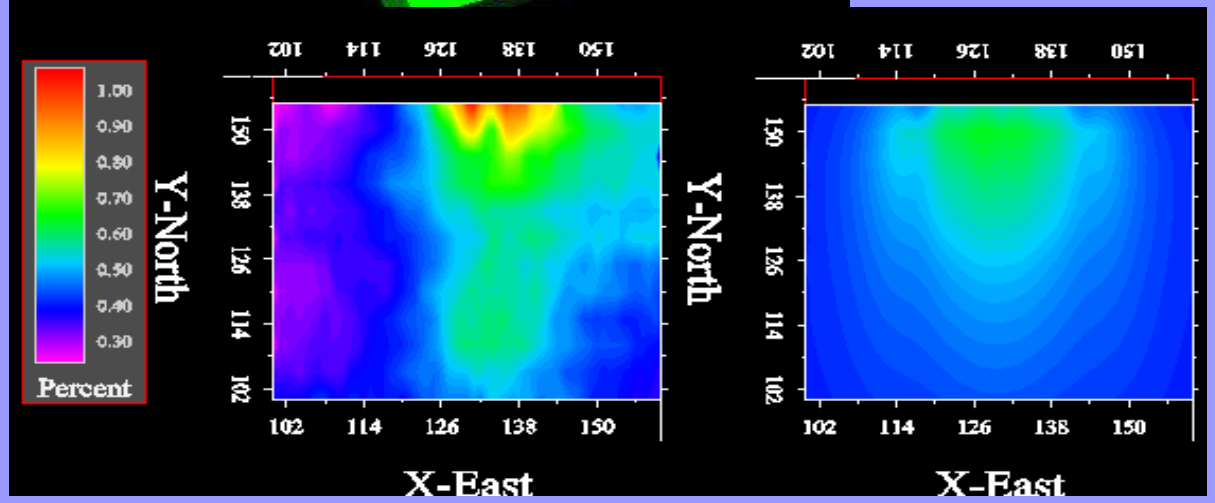


Contaminate Plume - EM31

Canadian landfill site

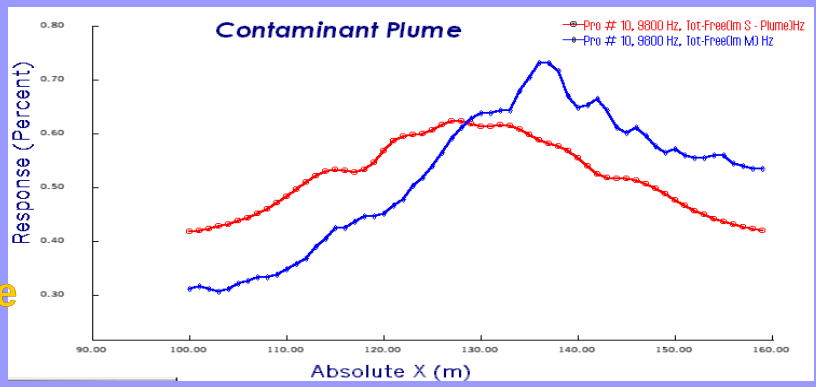
- 3D surfaces
- 2D contours
- 1D plots





Measured Plume Quadrature response

Simulated Plume Quadrature response

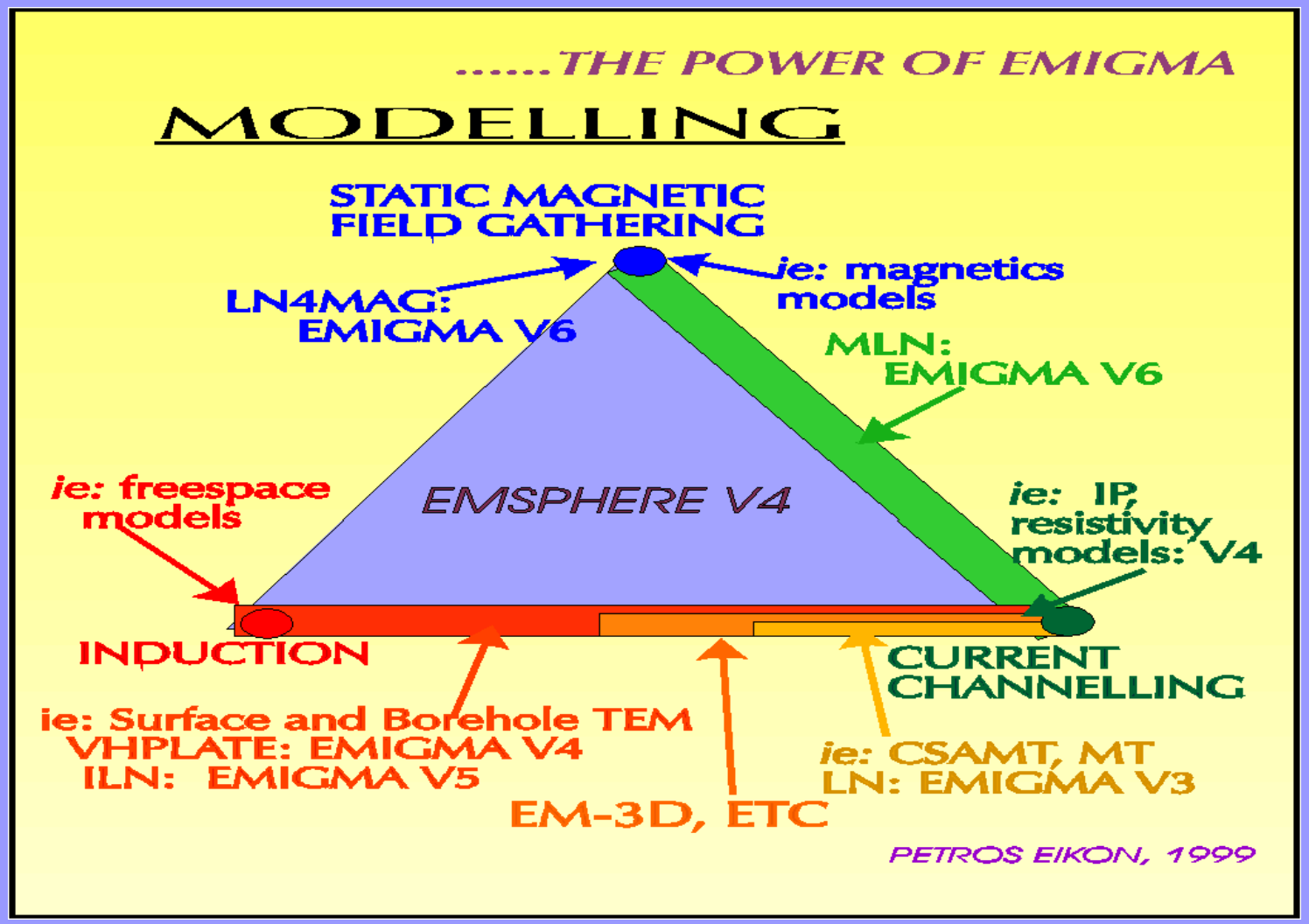


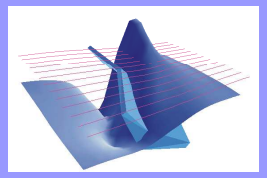
Extensive 3D Modelling Capabilities

6 algorithms
3 model primitives

Resistivity,
Permittivity,
Susceptibility
Contrasts

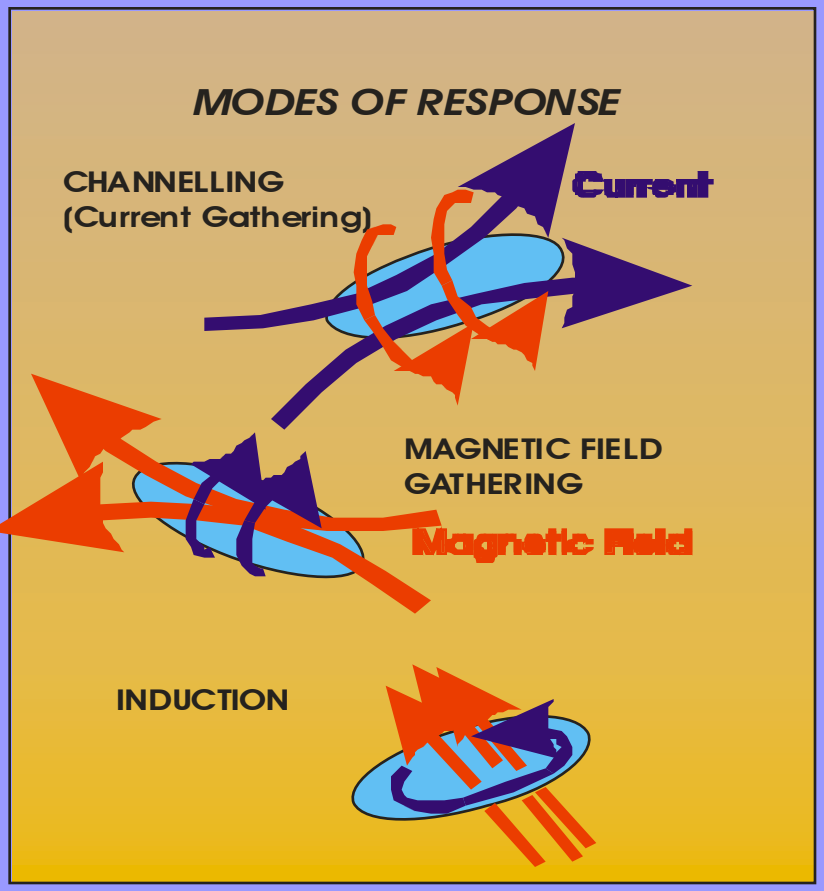
Static
TEM
FEM

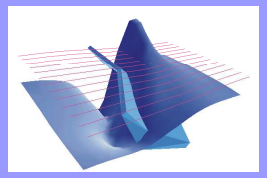




Geophysical Responses

- **EMIGMA Algorithms**
  - **LN (FEM,TEM,IP)**
  - **EiKPlate (FEM,TEM)**
  - **ILN (FEM,TEM)**
  - **MLN (Induced,Permanent)**
  - **3D Gravity (2 methods)**
  - **Born techniques**
  - **3D Resistivity (fast,flexible,accurate)**





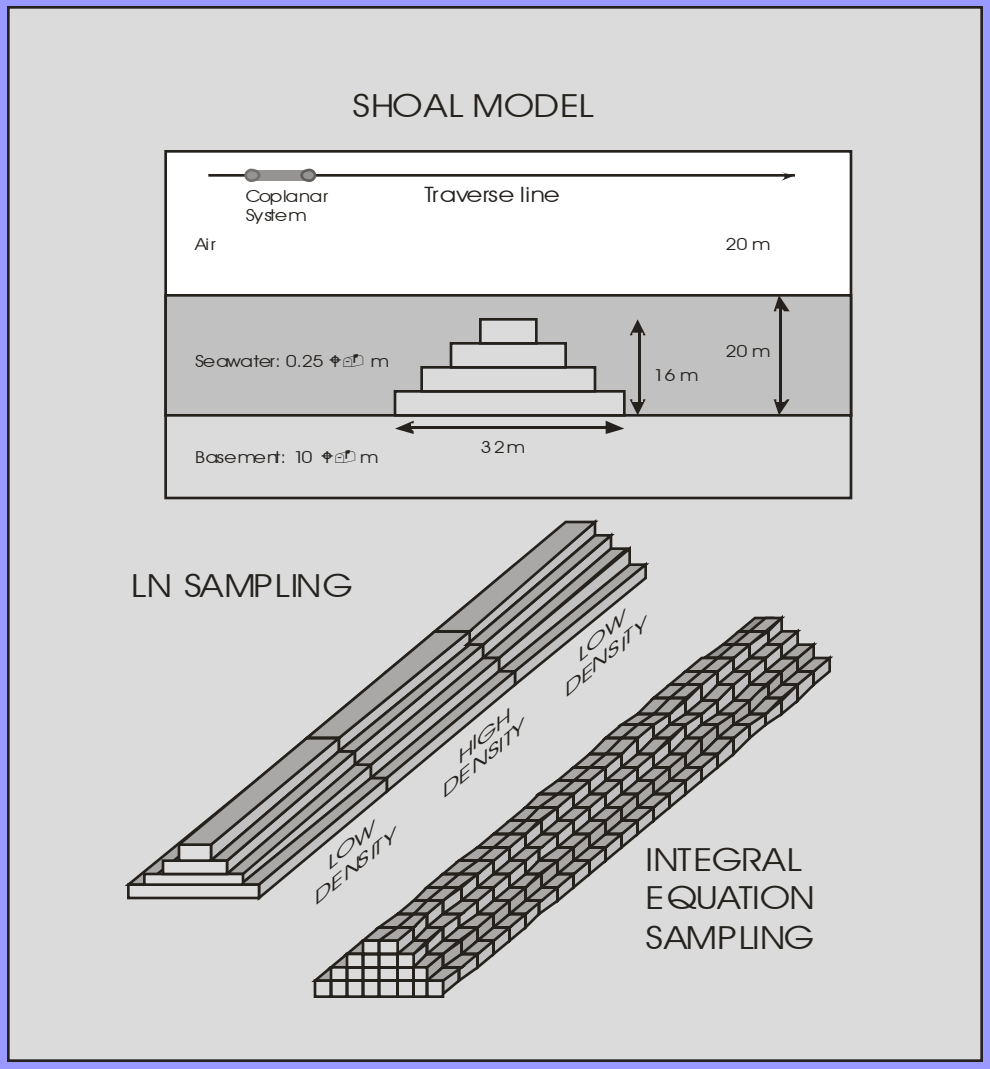
3D Modelling Capabilities 2

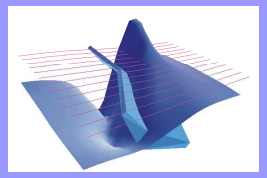
- **EMIGMA Algorithms**
  - **LN**
  - **EiKPlate**
  - **ILN**
  - **MLN**

Rapid Convergence

Flexible and

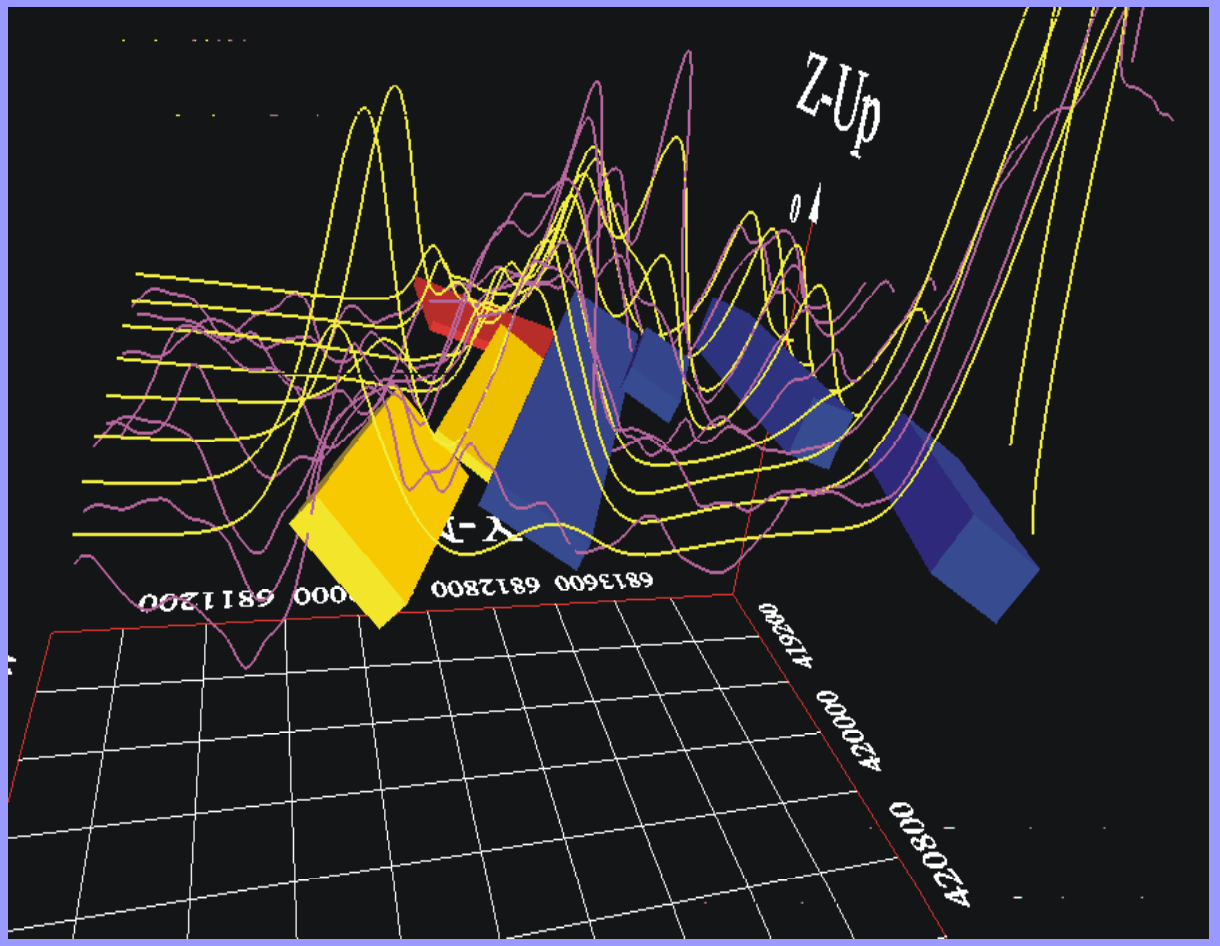
Easy-to-Use Grids





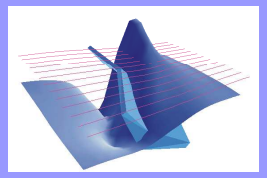
3D Modelling Capabilities 3

Complex Models



Full Range of Target Interactions

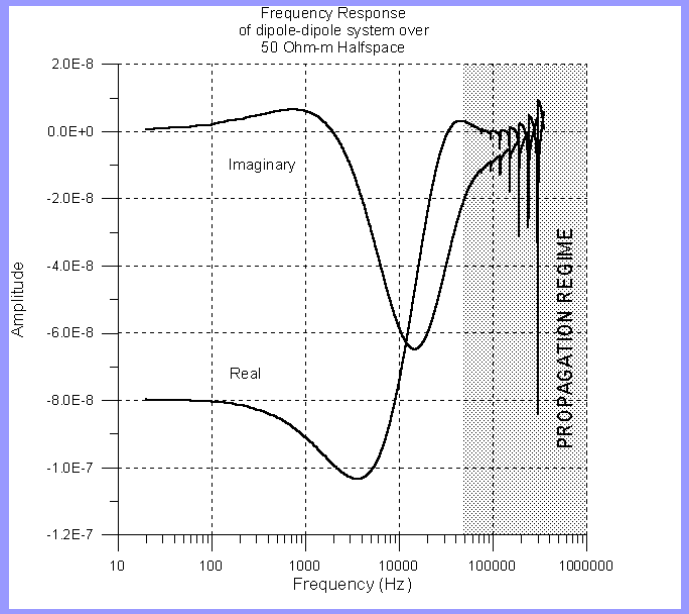
- **Superposition**
- **Near-Field (in contact)**
- **Interaction at a distance**



3D Modelling Capabilities 4

Frequency to Time-Domain Transform

- **Why**
- **How**
- **Waveforms**
- **Bandwidth**



Typical Magnetic Response

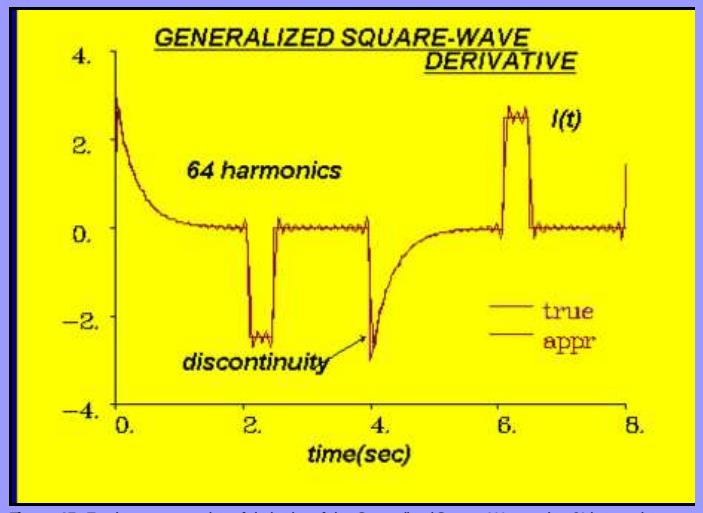
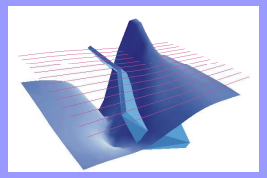


Figure 15: Fourier representation of derivative of the Generalized Square Wave using 64 harmonics.

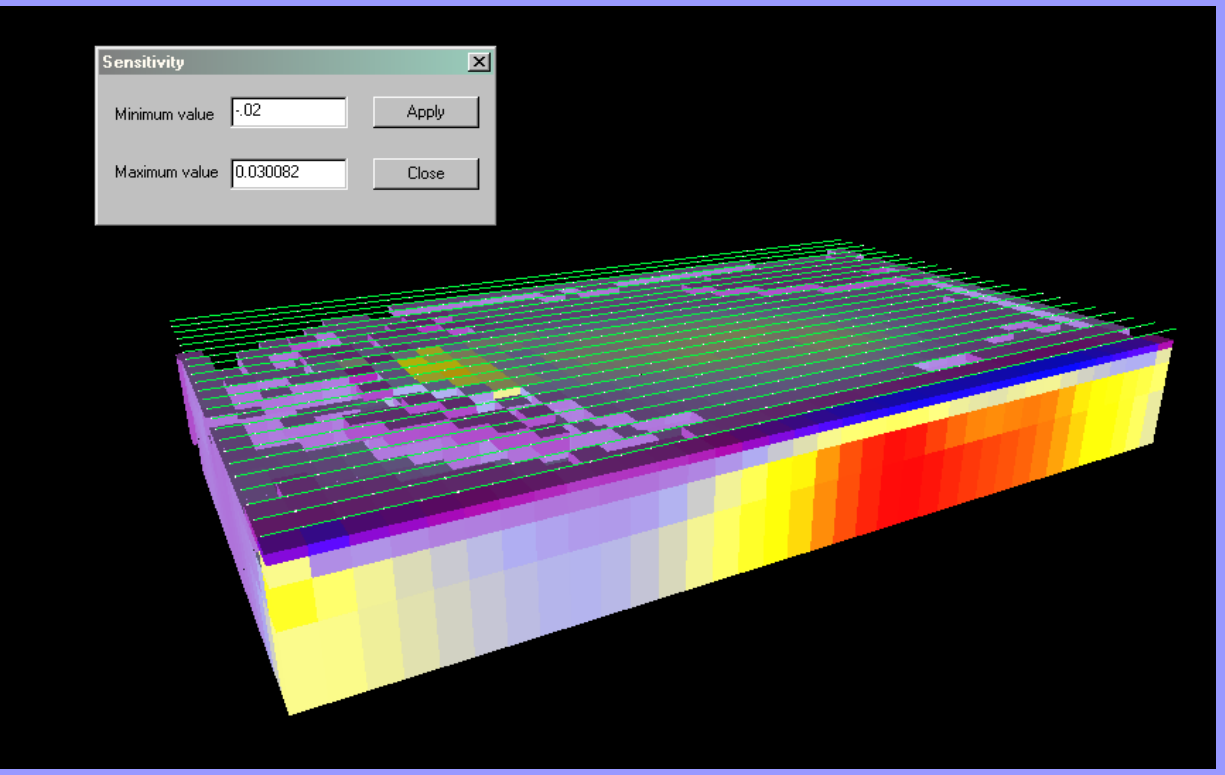
Band limited Coil Response

Incredibly accurate transforms



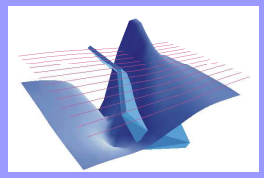
Inversion Capabilities 1

3D Magnetic field Inversion for Susceptibility

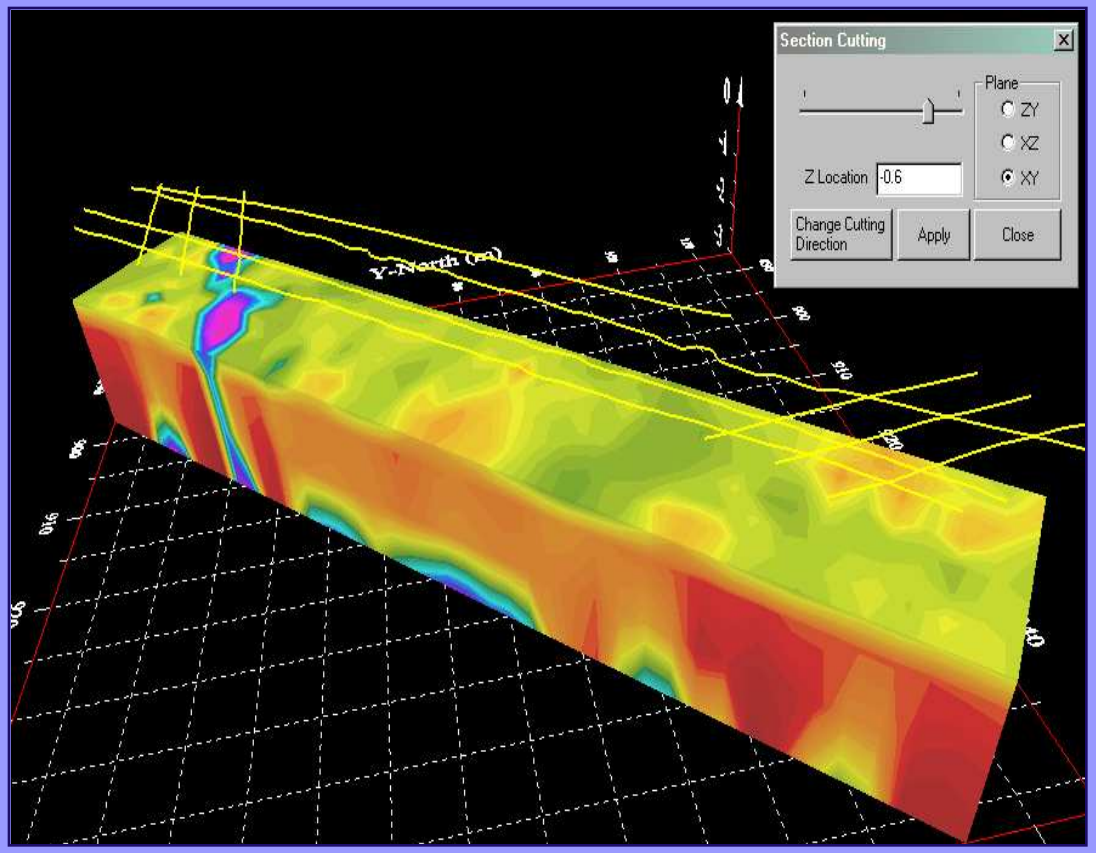


- Multiple levels
- Gradients
- Components
- Matrix
- Optimization
- Linear/ Non-Linear
- Simulation Starting Models
- Strike rotated inversion grids

- Magnetization Vector Inversions
- 3D Euler plus statistical processing



Inversion Capabilities 2



1D Inversion

TEM, FEM and Resistivity

FEM

– ground , HEM, fixed wing

joint resistivity and susceptibility

TEM – multiple base frequency capabilities

- in-loop, out-of-loop

- ground, airborne

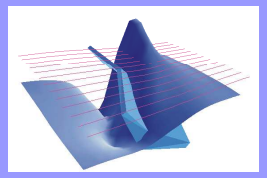
Resistivity: 1D Inverson

Sengpiel Sections:

HEM, Fixed-Wing

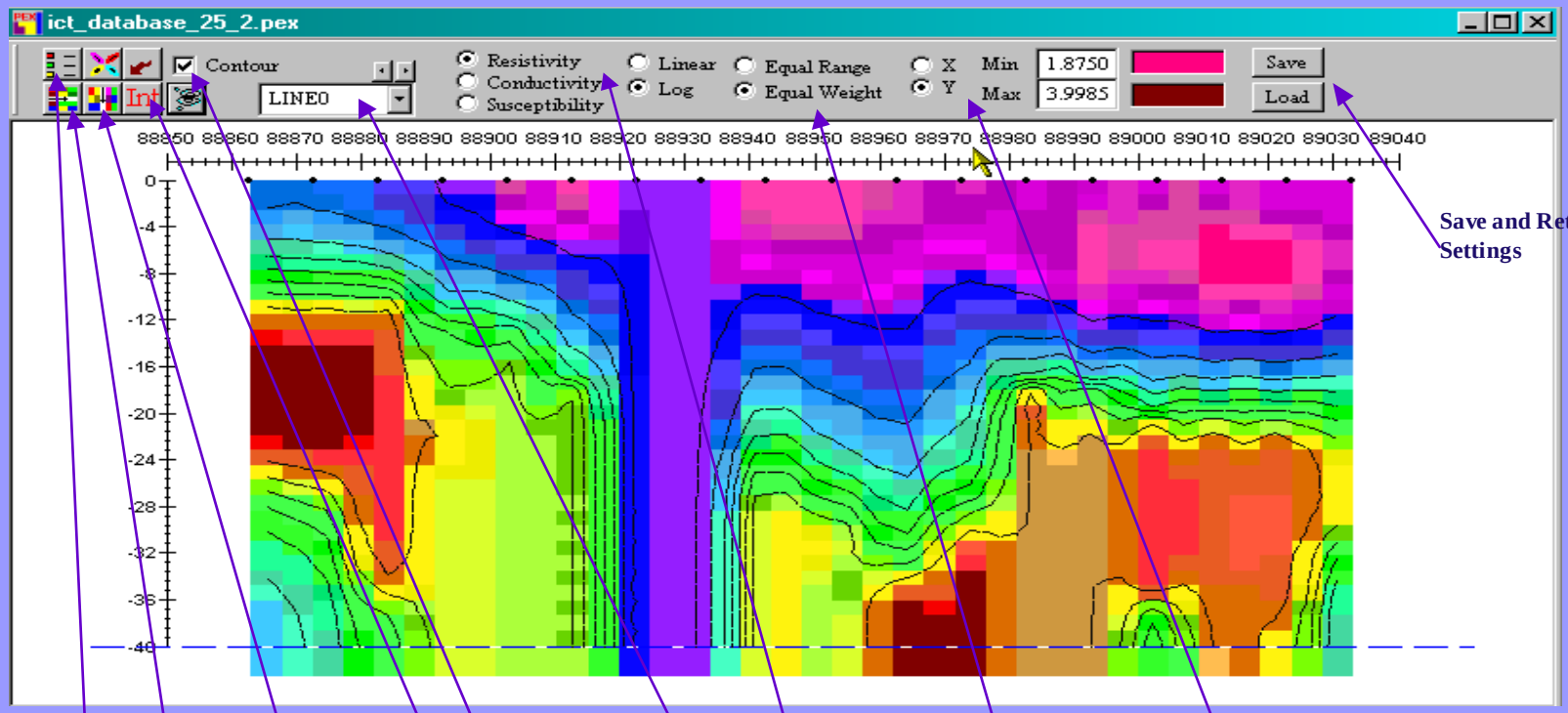
FEM, TEM Apparent Resistivity

HEM and Ground



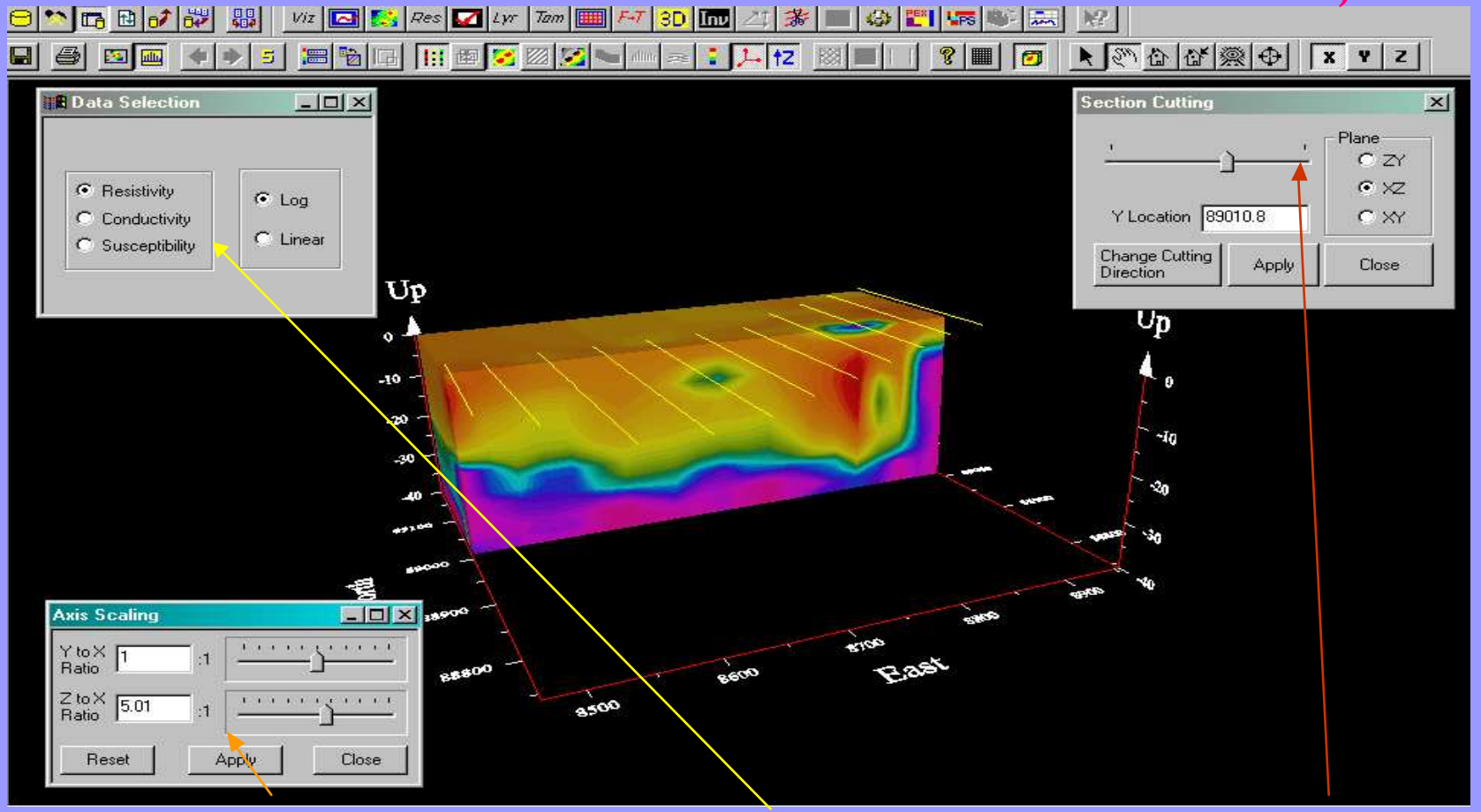
Inversion Capabilities 3

PEX- file Viewer

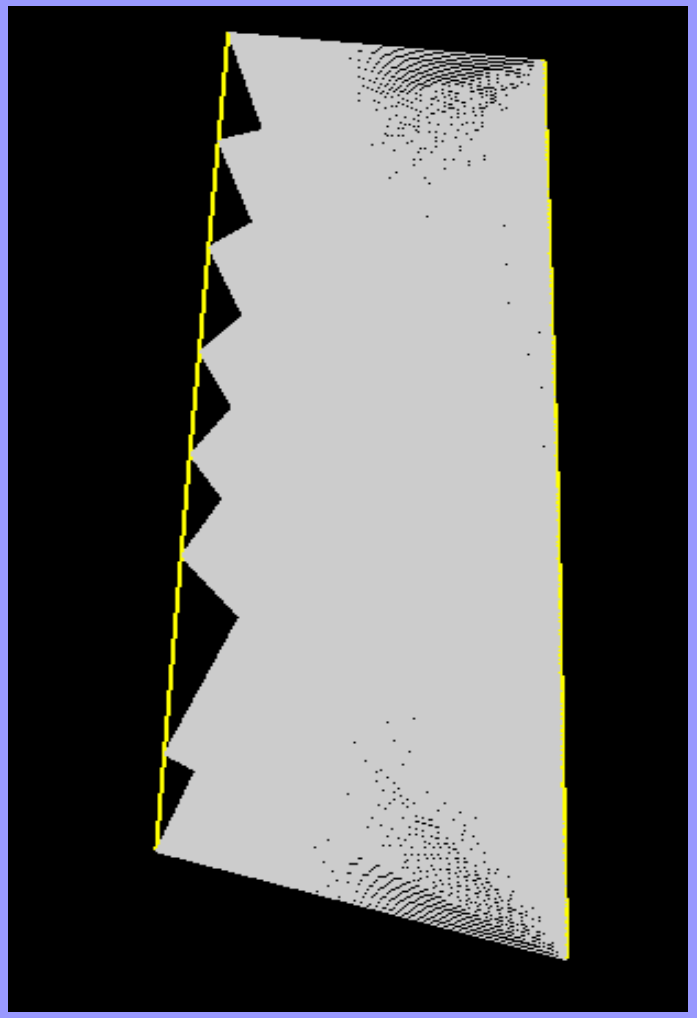


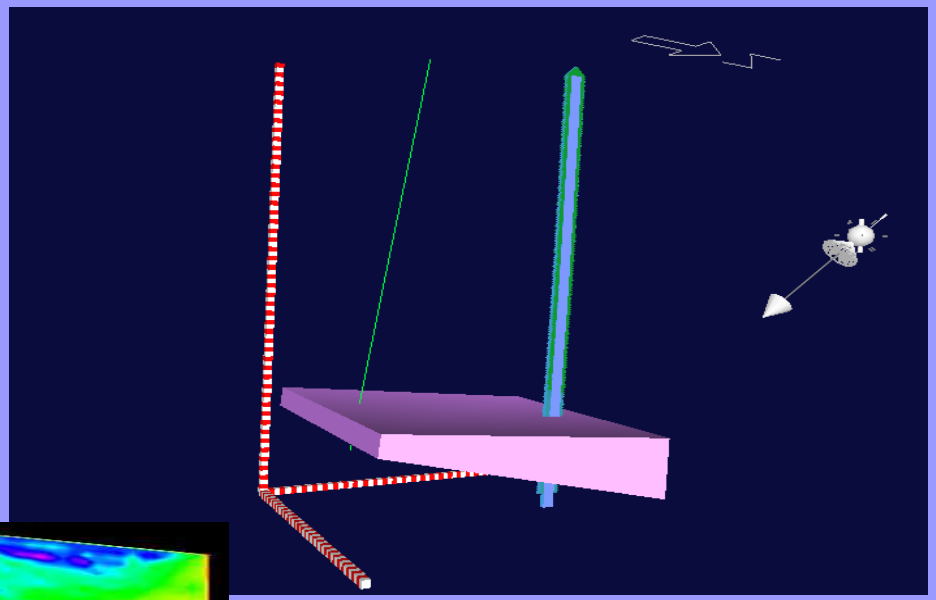
Inversion Capabilities 4

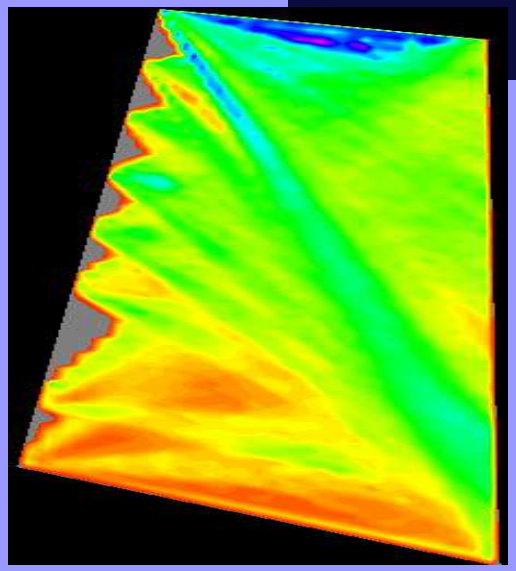
3D Volume Contour (with Inversion model dataset selected)



Crosshole Applications







RIM data – lead mine

EMIGMA Training Tools

- **Manual in Text Form !**
  - ***describes all the basic concepts***

- **Movie Tutorials**
- **extensive examples**

- **Tutorials as .ppt and .doc formats**
- **Technical References**
- **Support - e-mail, and online help**