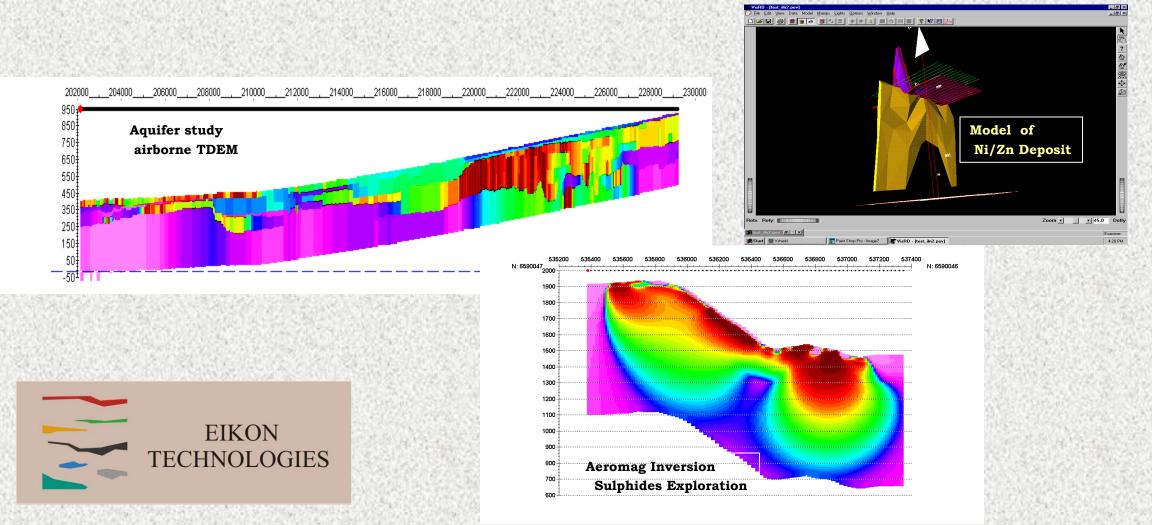
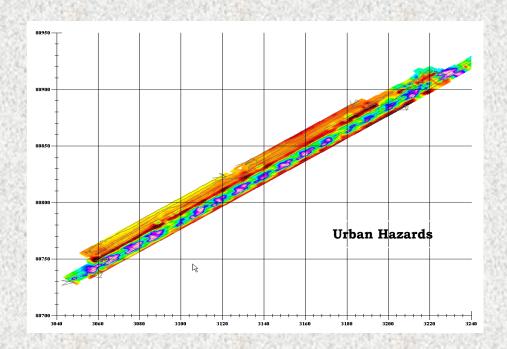
Eikon Technologies (Earth Imaging)

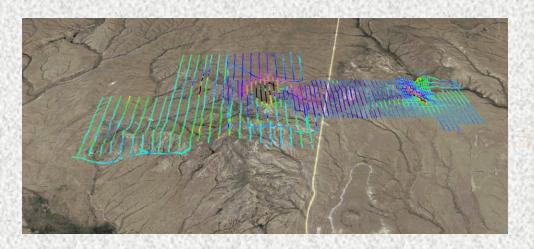
Software for Detection, Delineation, Exploration, Education and Quality Control



Developing Software for Interpretation of Geophysical Data Since 1994

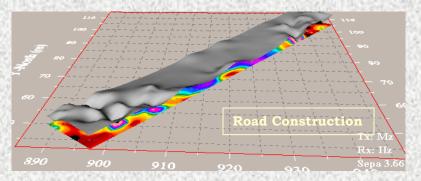






Mining Exploration

Modelling, Inversion, Data Analyses, Research



Applications

TEM

FEM

MAGNETICS

AEM

HEM

CSAMT/CSEM

IP

RESISTIVITY

GRAVITY

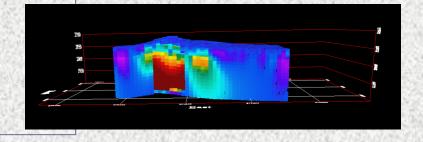
MT

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



EMIGMA Survey Capabilities



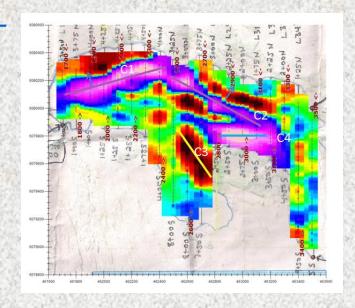
Design Aim:

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

- ❖ Data Types
 - *EM, Resistivity, IP, Magnetics, CSAMT, CSEM, MT
 - ❖ Gravity, MMR, VLF, VLF-R, MTEM

Survey Styles

- > surface
- > airborne
- > surface to borehole
- > borehole to borehole



not all combinations available

Data analyses and editing tools

EMIGMA 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, CSEM, VLF, MMR

3D Magnetic Inversion, 3D Euler, 2D Wenner

3D Resistivity Inversion

3D TDEM, FDEM thin-sheet inversions

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

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

FDEM, TDEM, 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

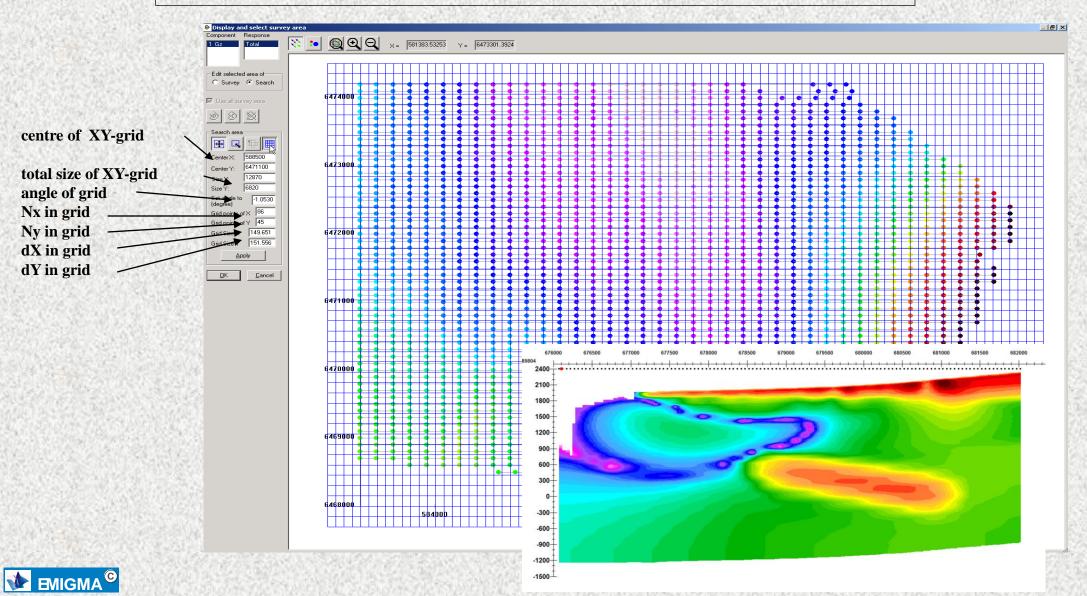
Gravity – 3D Modeling and Inversion 3D Euler and Post-Processing including 3D Visualization FFT tools



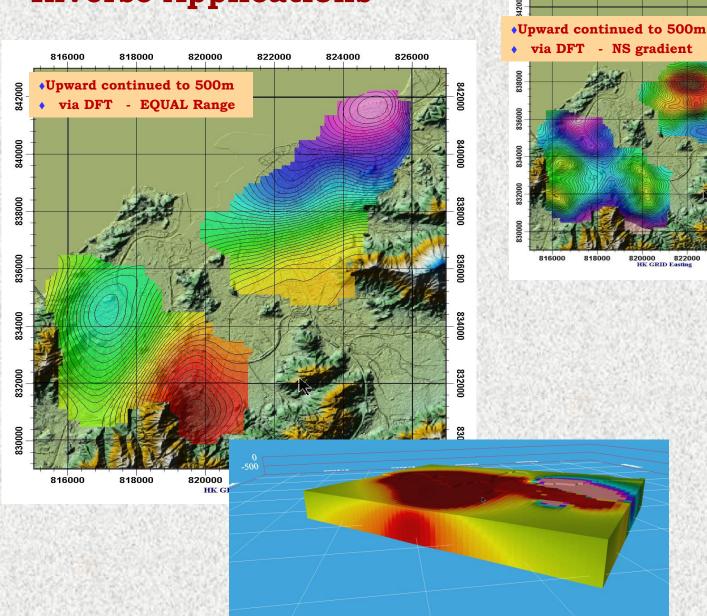
3D Gravity Inversion in EMIGMA

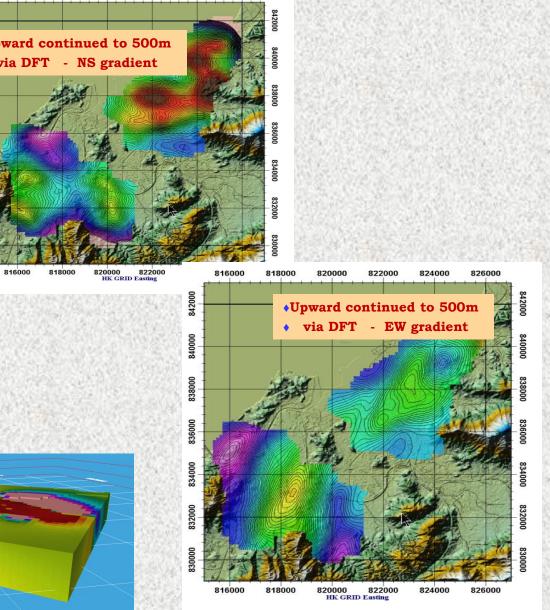
EMIGMA Tools

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



Fourier Processing and Inverse Applications

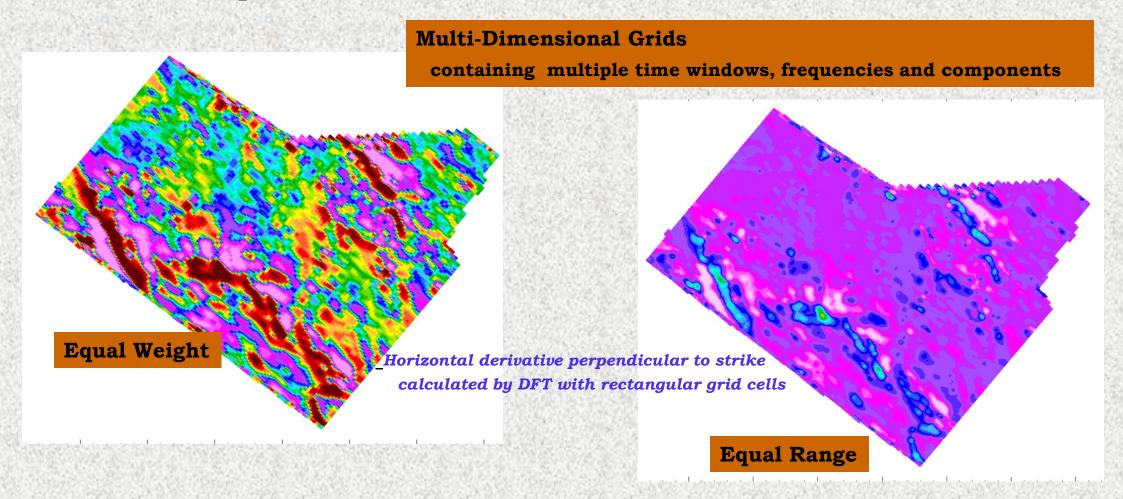




824000

Data Interpolation and Contouring 1

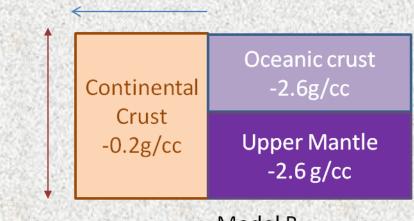
Local - Natural Neighbour, Shepard, Delaunay Global Splines -Minimum Curvature





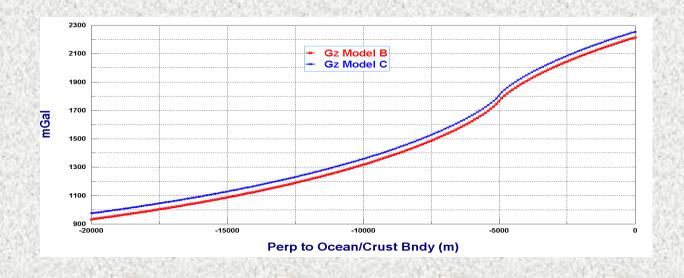
Rectangular grid cells
providing enhanced resolution especially for derivatives

Gravity Modeling 1



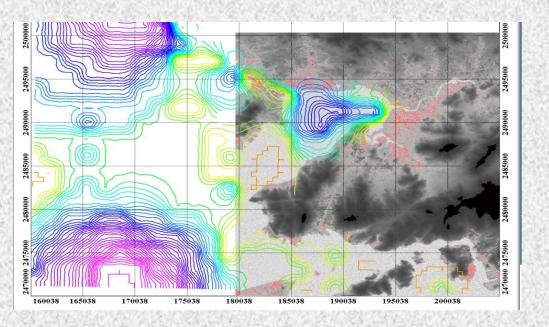
Inland Effects
of Oceanic Crust
and
Upper Mantle

Model B

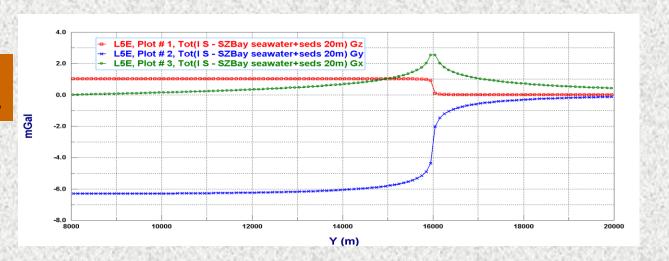


Gravity Modeling 2

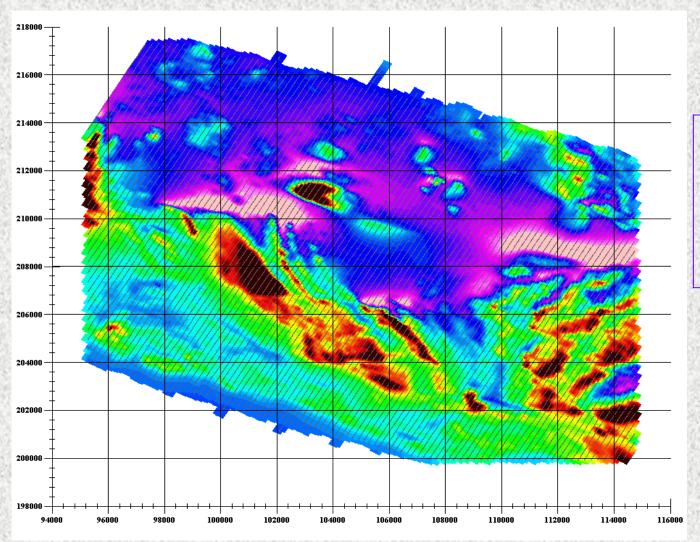




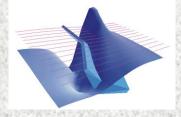
Effects of Seawater and Sediments



Data Interpolation and Contouring 2

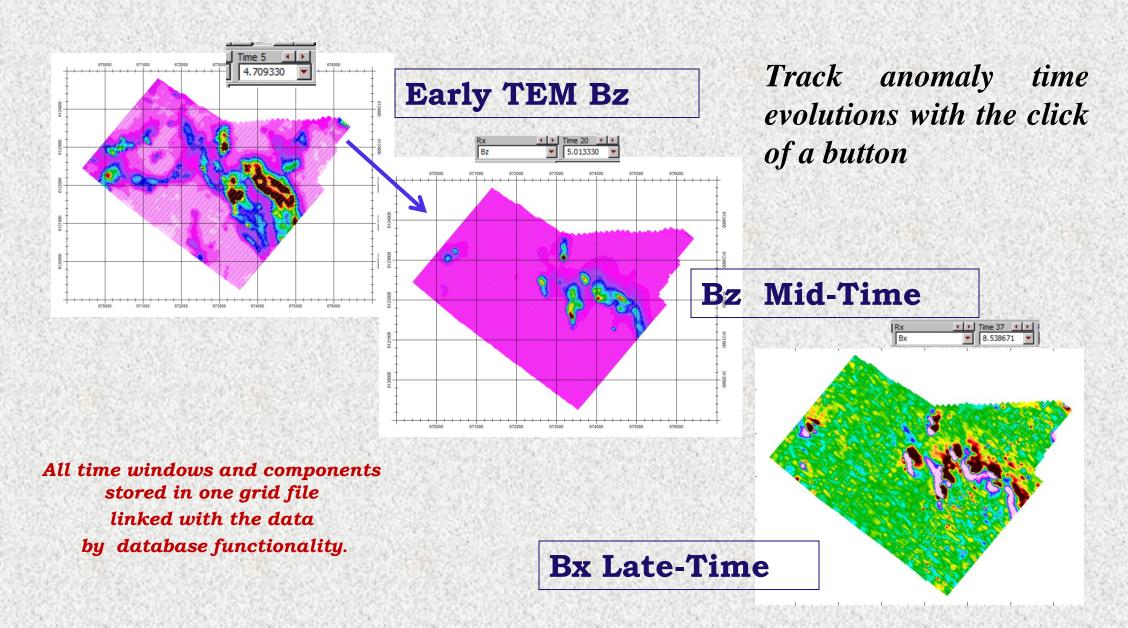


- ✓ Natural Neighbour Interpolation
- ✓ Delaunay Triangulation
- ✓ Shepard
- ✓ Minimum Curvature
- ✓ Splines



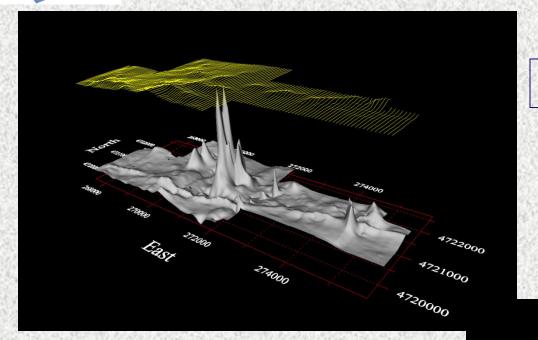


Track anomaly time evolutions with the click of a button





spatial display of anomalies



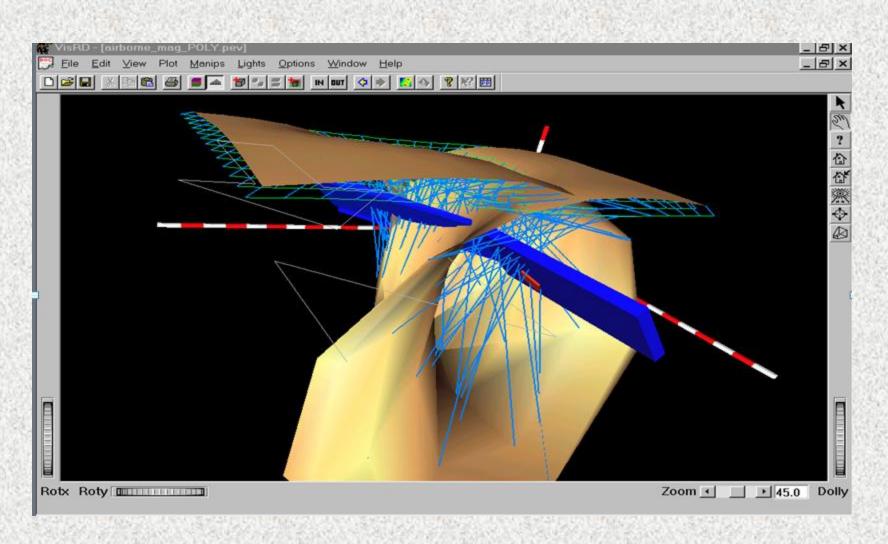
TMI

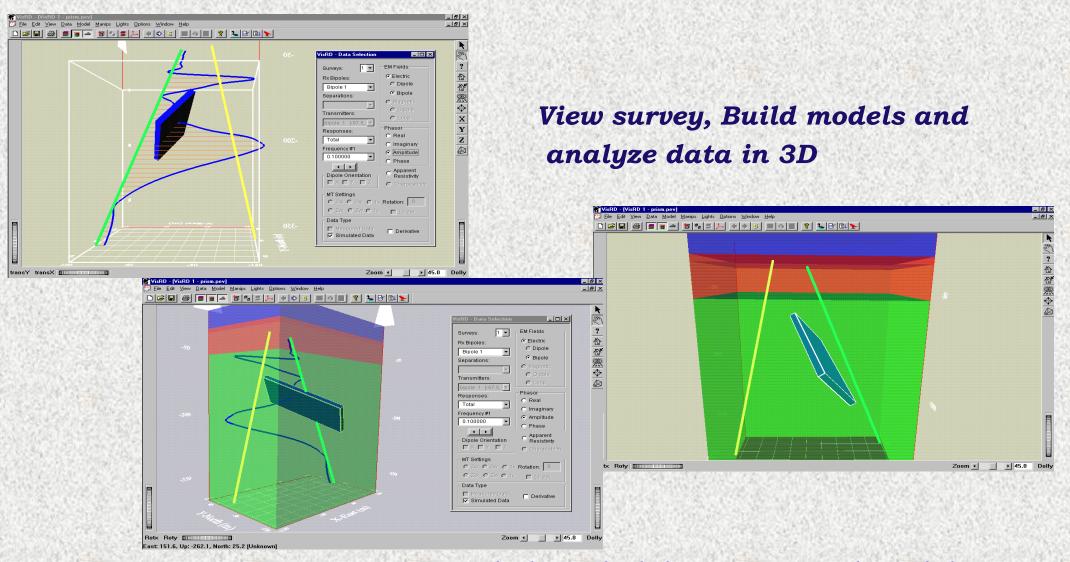
VMS Exploration US

Vertical Derivative TMI



A Range of 3D Data Representations



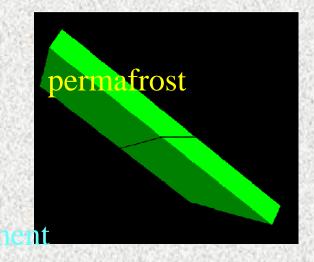


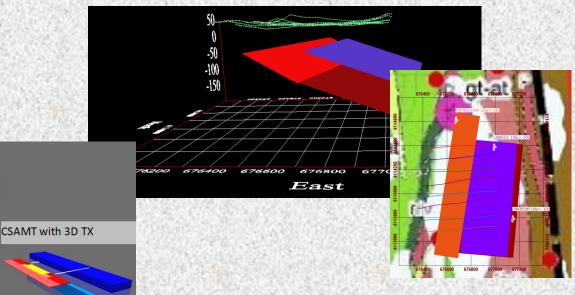
e.g. Crosshole resistivity survey and model – gold deposit delineation

EM -> TDEM and FDEM

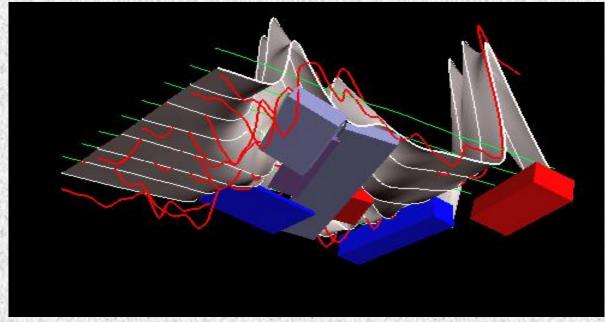
- -- 3 Algorithms 2D/3D integral equations in layered host
- + 2 Thin Sheet and 1 Spherical Harmonics algorithms
- Prisms, Plates, Spheres and Polyhedra
- Strong and Weak Interactions
- Industry defined and theoretical current Waveforms
- Airborne, Ground and Borehole
- □ Fixed, Moving and Stepwise Moving Transmitter
- Magnetic effects magnetostatic, inductive, galvanic
- IP effects
- direct comparisons to measured data
- super-engine multi-processing architecture for large models or surveys
- Model Suites
- Batch modelling
- Thin Sheet Plate Inversions







Pb/Zn exploration Helicopter FEM



Magnetics

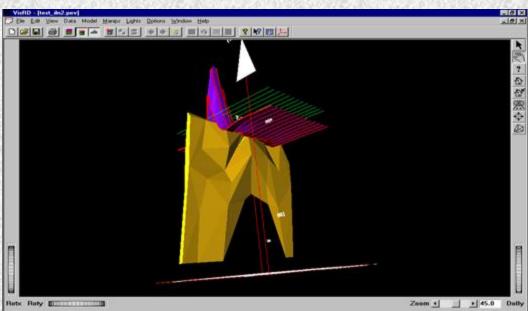
- 3 Algorithms 3D integral equation
 Born (weak), Strong (non-linear), Permanent
- Prisms and Polyhedra
- Strong and Weak Interactions
- Airborne, Ground and Borehole
- Gradients (up to 2nd order)
- 3-axis (i.e. Components)
- direct comparisons to measured data
- super-engine architecture for large models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

UXO cleanup



IP/Resistivity/MIP

- 3D integral equationBorn (weak) and Strong (non-linear)
- Drisms, Polyhedra, Sphere
- Strong and Weak Interactions
- TDEM and FDEM
- EM effects in IP (e-field pickup 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





Gravity - 3D

analytic solutions and traditional numerical integration

- Total field, gravity components,
gravity gradients to 2nd order tensors
airborne, ground, underground and borehole surveys

MT, CSEM/CSAMT (3D)

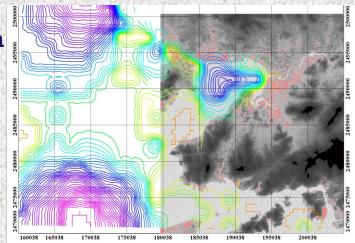
- -impedances for MT/CSAMT
- field responses for CSEM

- full current wire response (not just dipole sources) Strong and Weak Interactions between anomalies

Crosshole

electric (3 antennae types) or magnetic antennae

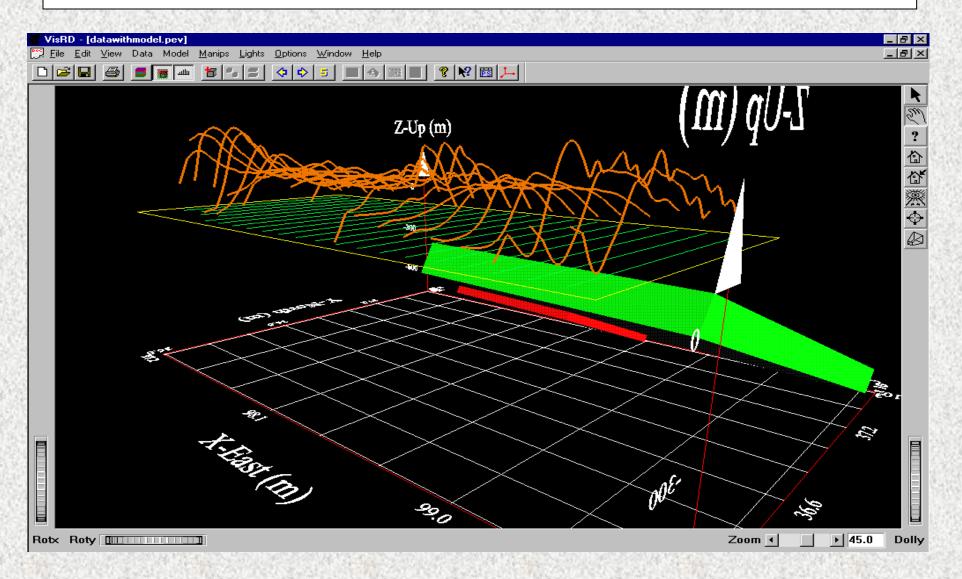
Experimental Systems



Gravity response of seawater plus sediments

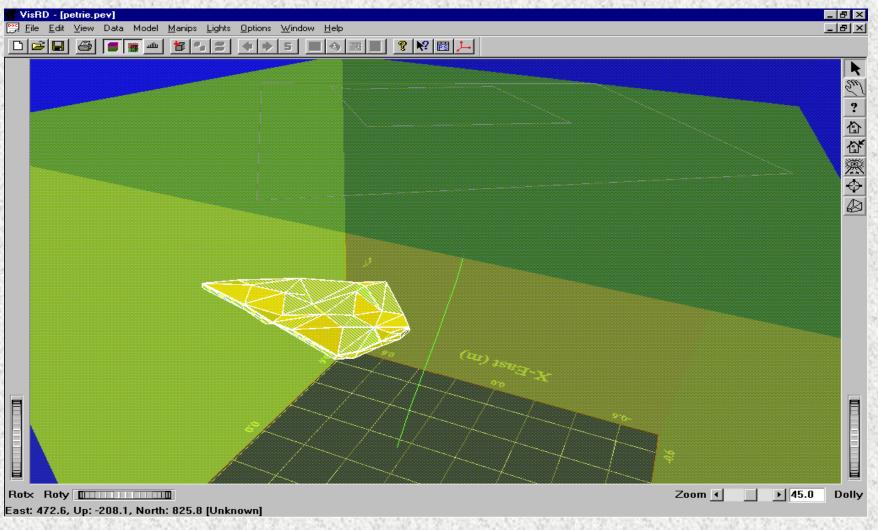


Data and Structure Representation in EMIGMA's 3D Visualizer



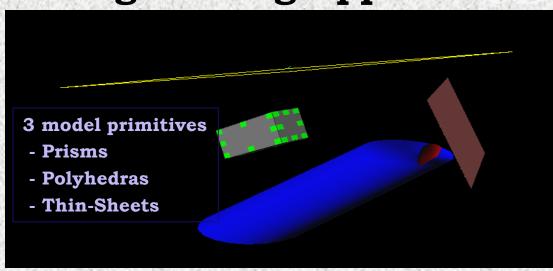
A fully integrated 3D visualization tool

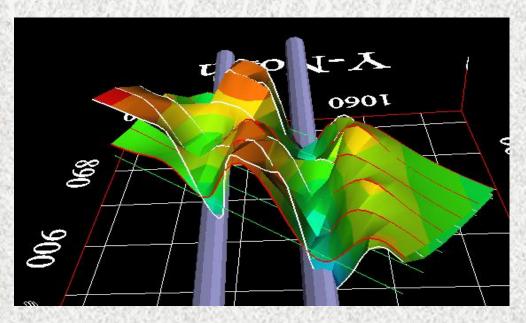
Geological CAD Models

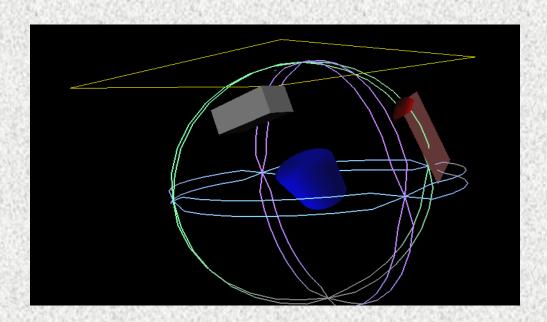


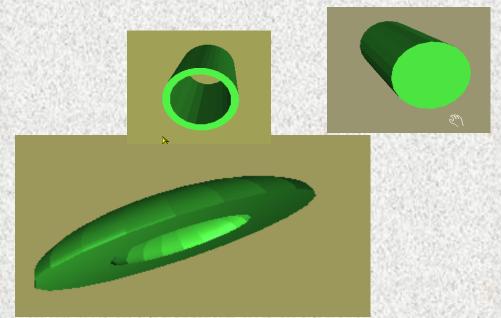
Complex 3D modelling capabilities including imports of geological models from CAD applications

Engineering Applications

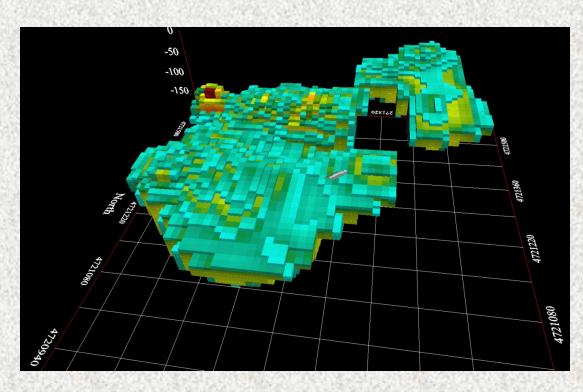




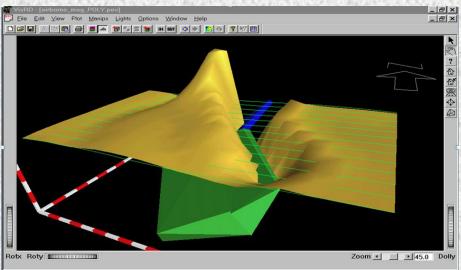




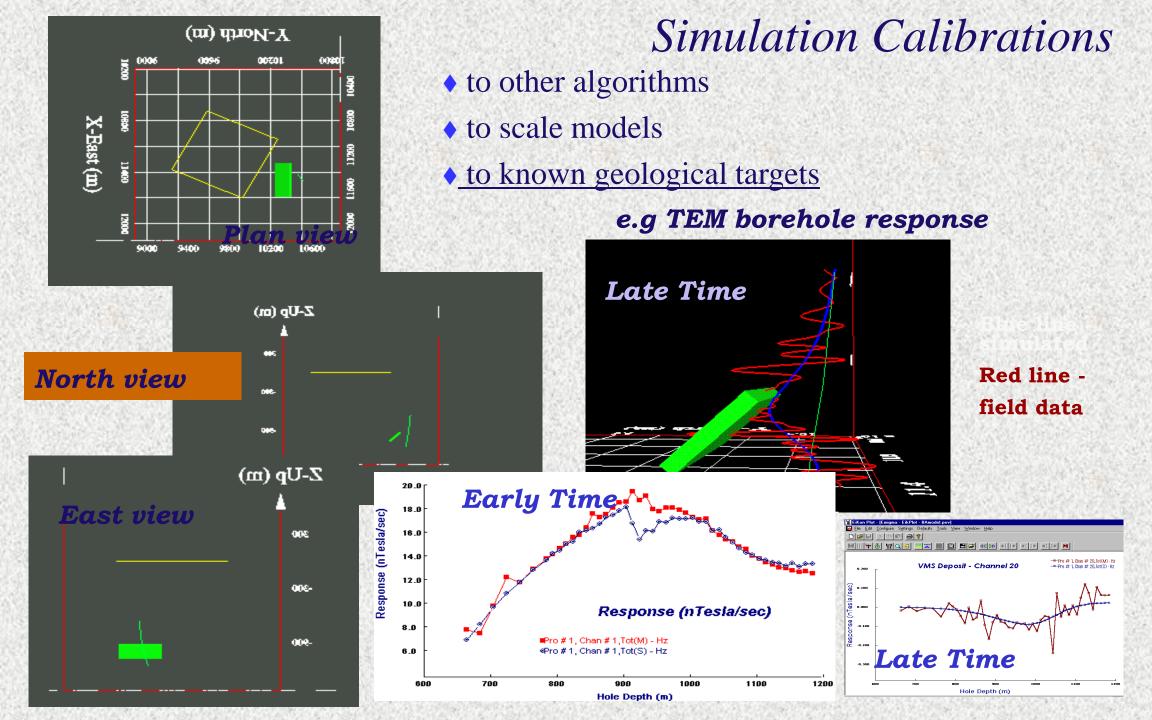
Complex Geological Structure Models

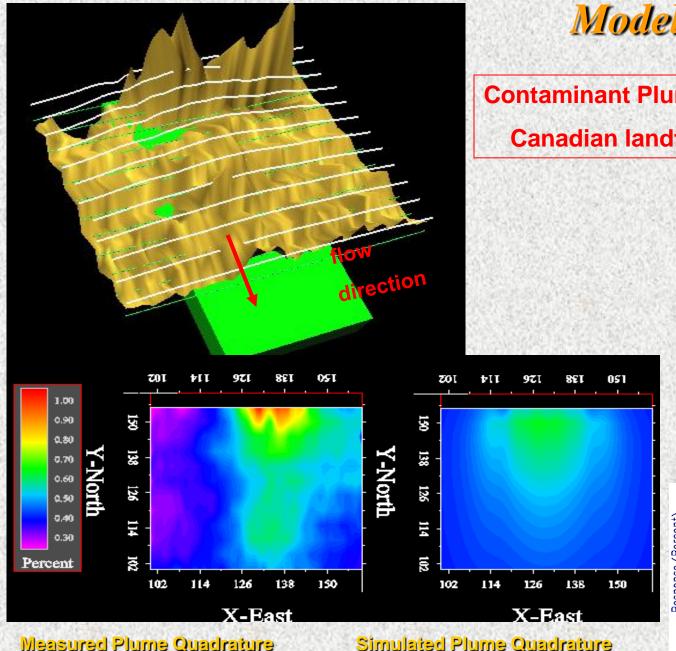


Magnetic Model with boreholes



Airborne Magnetic Field Modelling





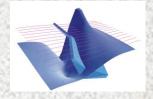
response

response

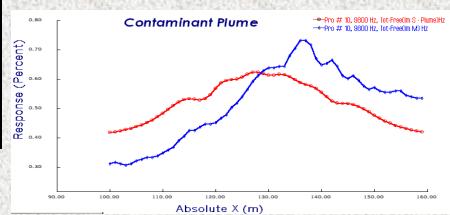
Model and Data Comparison

Contaminant Plume - EM31

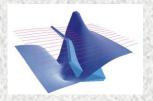
Canadian landfill site



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



3D Modelling Capabilities 1



EM Geophysical Responses

EMIGMA Algorithms

- ♦ LN (for FEM, TEM, IP, MT)
- ♦ EiKPlate1 (FEM,TEM,IP,MT) with interaction with host
- ♦ Eikplate2 (FEM,TEM) induction with superimposed layered models
- ♦ ILN (FEM, TEM)
- ♦ MLN Magnetostatic and Current channelling effects
- 3D Resistivity (fast, flexible, accurate)
- MMR ground and borehole

MODES OF RESPONSE **CHANNELLING** (Current Gathering) MAGNETIC FIELD GATHERING INDUCTION

SPHERE, New for 2025

- Now for Loop, Bipole and Dipole sources
- Fixed and Moving Surveys
- extremely accurate EM and IP responses [spherical harmonic solutions with 200 harmonics Debye]
- all effects of conductivity, permeability and permeability variations
- complete magnetic effects on inductive and current chanelling responses
- extremely high conductivity and permeability capabilities with frequency ranges from 10⁻⁵ Hz to 5MHz

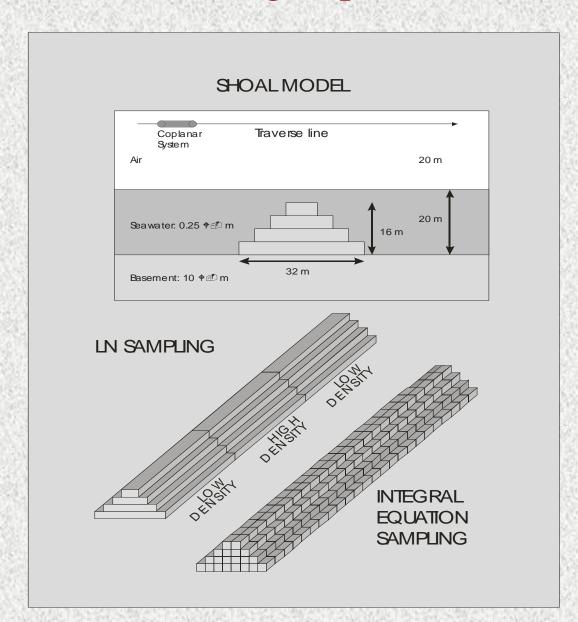
3D Modelling Capabilities 2

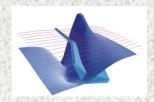
EMIGMA EM Algorithms

- ✓ LN (prism and polys)
- ✓ EiKPlate (2 thin sheet apps)
- ✓ ILN
- ✓ MLN (prism and polys)
- ✓ Sphere

IE Rapid Convergence

Flexible and Easy-to-Use Grids

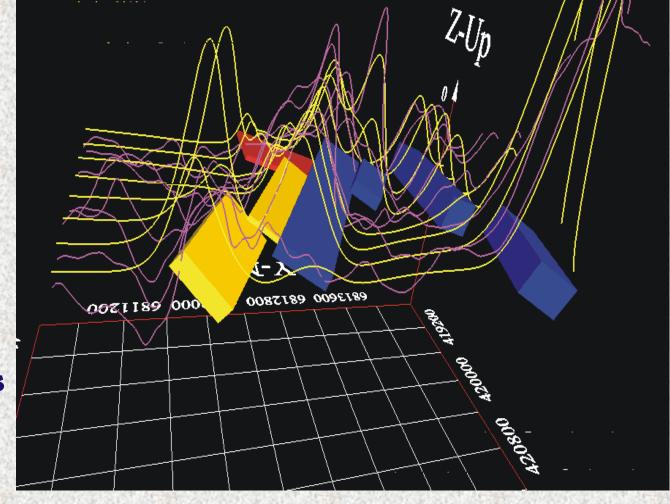




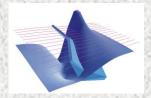
3D Modelling Capabilities 3 Complex Models

Full Range of Target Interactions

- Superposition
- Near-Field (in contact)

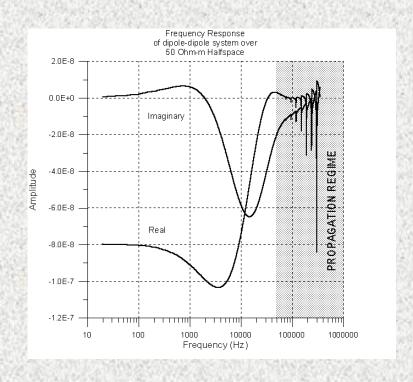


Far-Field (interactions between anomalies at a distance)



3D Modelling Capabilities 4

Frequency to Time-Domain Transform



Typical Magnetic Response

- **♦Why (periodic responses)**
- **♦**How (frequencyinterpolation)
- Waveforms (flexible)
- Bandwidth (controlled)

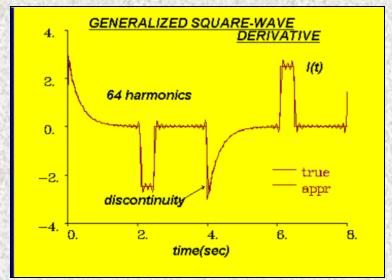
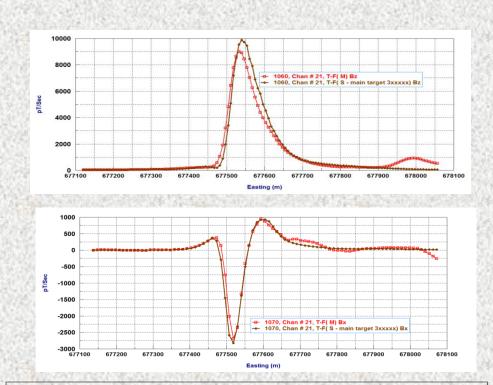


Figure 15: Fourier representation of derivative of the Generalized Square Wave using 64 harmonics.

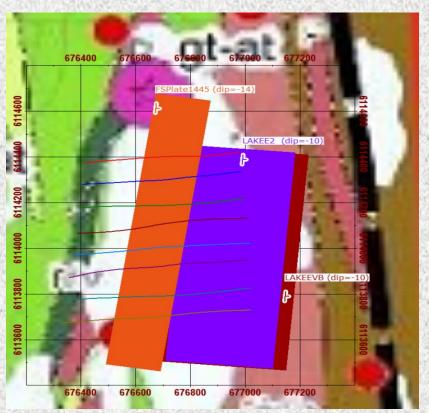
Band limited Coil Response

Incredibly accurate transforms



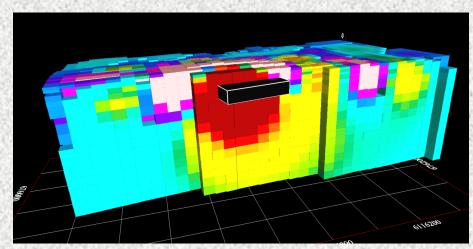
mid-time Inversion Model fits to AEM data

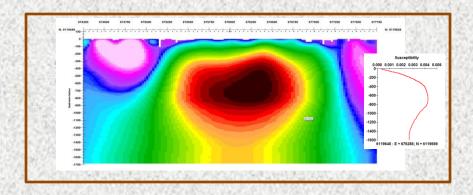
3D Modelling Capabilities Thin Sheet Inversions





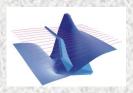
3D Magnetic field Inversion for Susceptibility





- Multiple survey heights
- Gradients
- Components (i.e. fluxgate data)
- Matrix Inversion
- Optimization
- Linear/ Non-Linear
- 3D Starting Models
- Strike rotated inversion grids

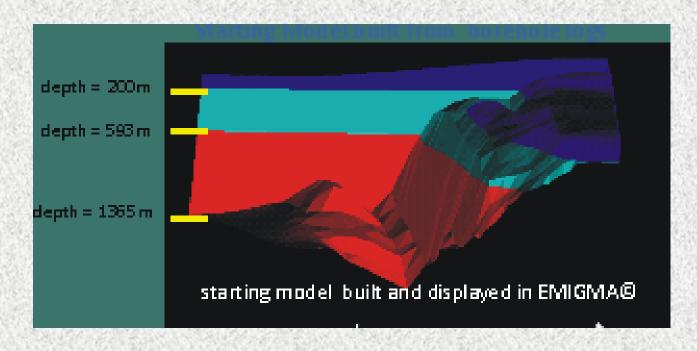
- **▶** Magnetization Vector Inversions (e.g. UXO imaging)
- > 3D Euler solution with statistical processing



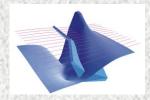
3D Gravity Inversion

Inversion Capabilities 2

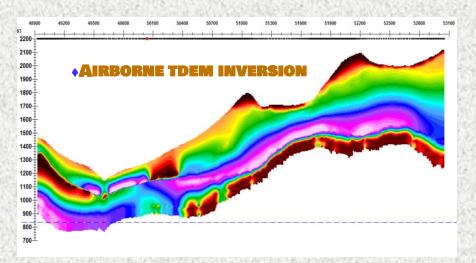
- Utilization of topography
- Gradient capabilities
- use of horizon and drill hole constraints
- Fast inversions through new compile and multi-core processing

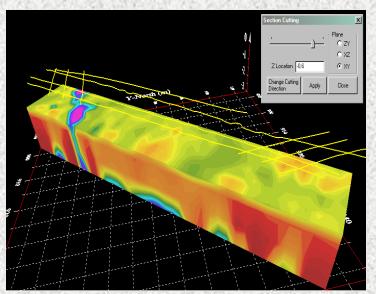


> 3D Extended Euler solutions plus statistical processing



1D Inversion TEM, FEM, Resistivity, CSEM, CSAMT





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

FEM: multi-frequency, multi-separation, - ground, HEM, fixed-wing

Resistivity: 1D Inversion

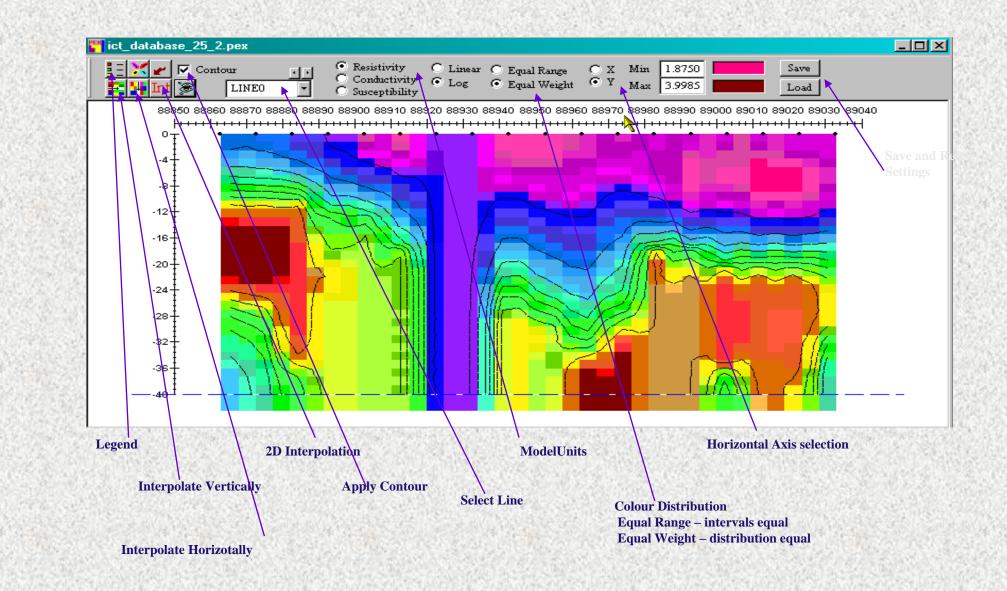
CSEM: electric and/or magnetic field inversions

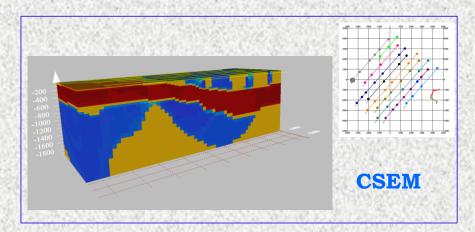
CSAMT: impedance inversions

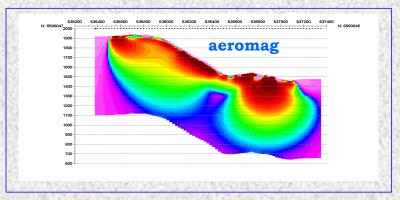
- apparent resistivity and phase

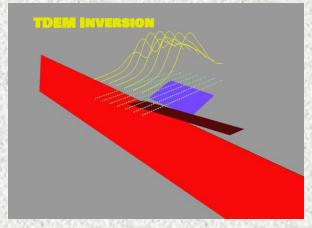
MT, VLFR - impedance/phase

PEX- file Viewer









3D Inversion

Gravity and Magnetics

Resistivity

CSEM – land based

CSAMT/MT

TDEM/FDEM - thin sheet inversion

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, gradient and pole-pole surveys -resistivity constraints and user-specified starting model -- strong constrat non-born techniques

CSEM/CSAMT

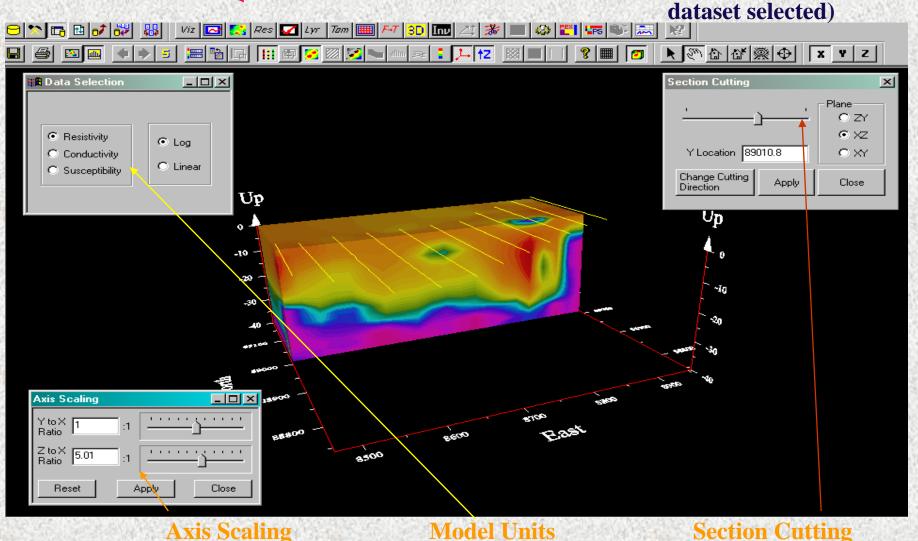
-3D inversion

-accurate 3D inversion (utilizing source geometry)

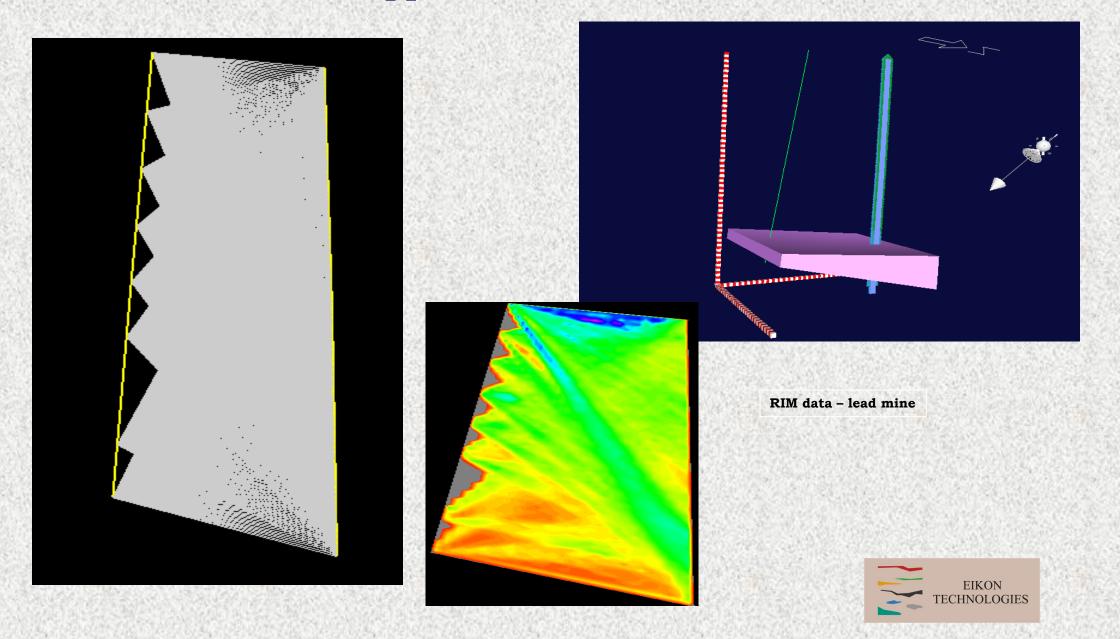
TDEM/FDEM - multi-plate inversions, multicomponents, constrained inversions

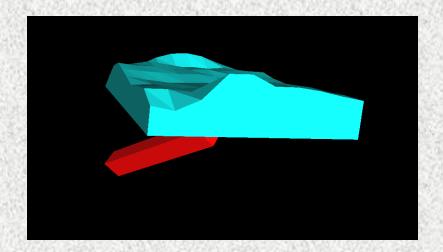


3D Volume Contour (with Inversion model



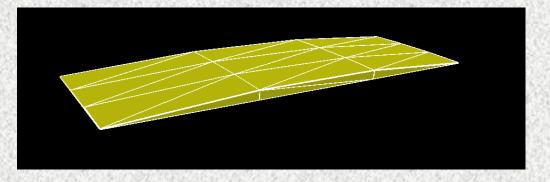
Crosshole Applications



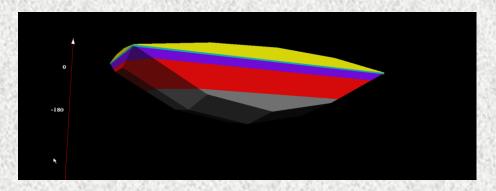


Topography plus Anomaly - MT project

Accurate simulation of strong effects on electric field field of topography (not Born approximations)



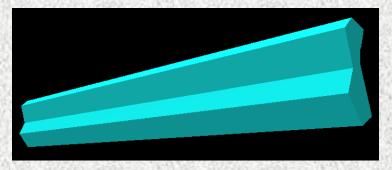
Anticline – MT plus gravity project



Waste Dump Modeling: for FDEM, Gravity, IP, and Magnetic surveys

•Magnetic Intrusions plus Topography plus Target for Airborne Magnetics and EM surveys





Conductor Model for TDEM Simulation:

Copper – Nickel project

Copper-Nickel Resource:

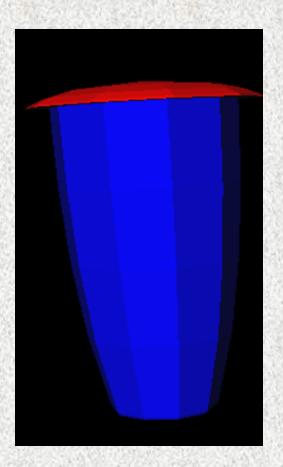
Simulation of CAD model for Magnetics, Gravity, EM



•Massive Sulphide Deposit CAD Model for simulation

- Borehole TDEM plus Magnetics

CAD Model Building Tools

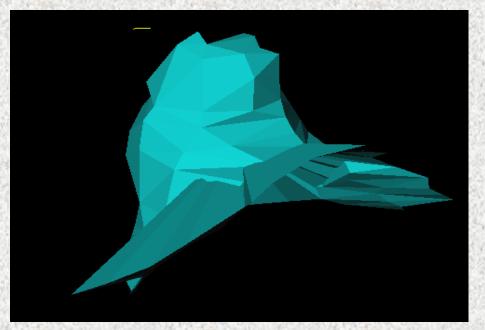


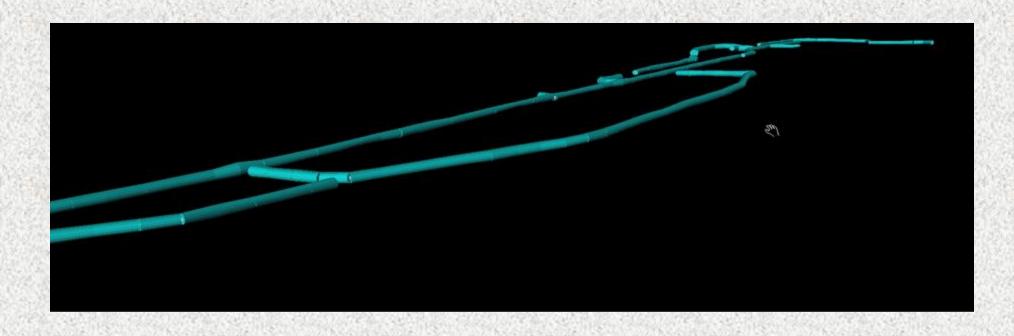
Classic Salt Dome Model - Gravity



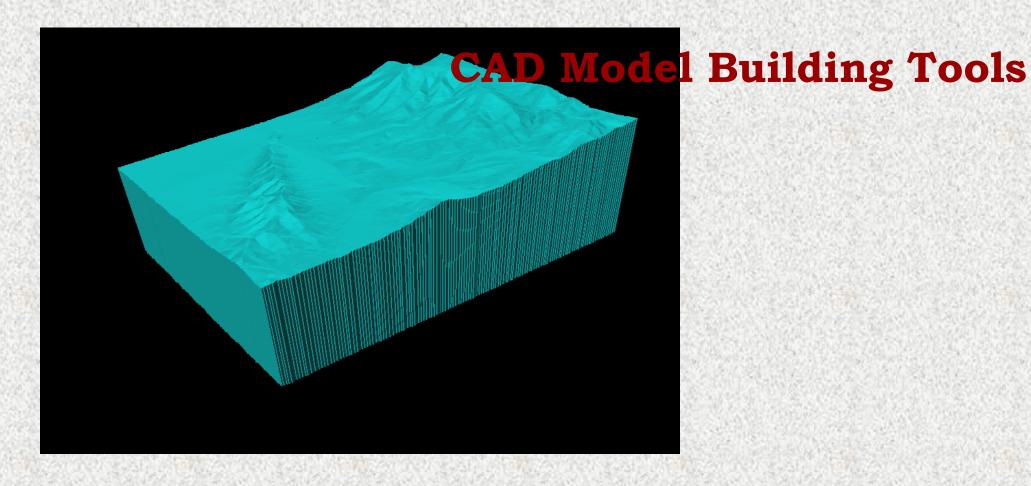
•Steel Utility Pipe Model - for simulation of towed FDEM ground array

•Gold Resource - IP, Gravity and Magnetics





•Underground Mine Workings:
Borehole IP and Ground TDEM studies



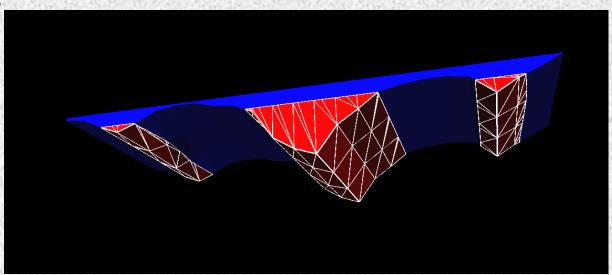
Complex Topography Model: Gravity

= satellite DEM models can be incorporated to models and inversions when gravity gradients are within the topography. This is especially important for geotechnical work and exploration in mountainous terrain.

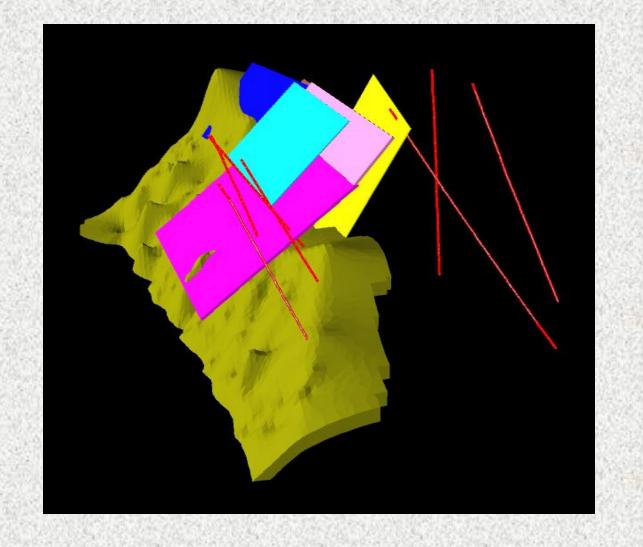


◆Basin Model: Gravity

- model derived from drill core results

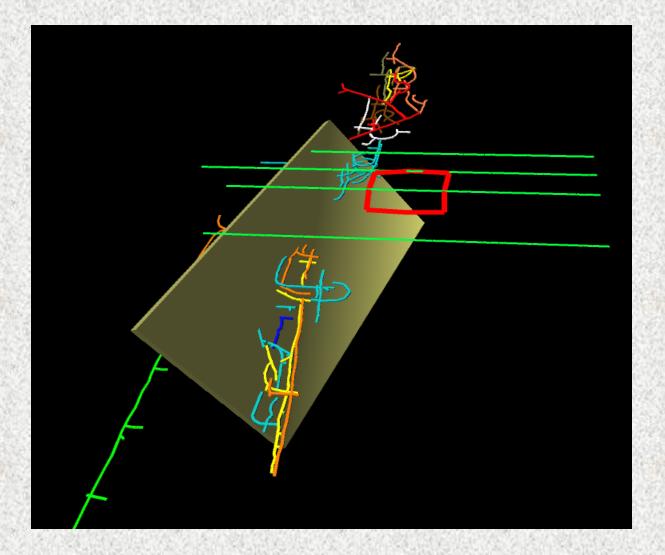


•Aquifers Model: Ground Gravity and Airborne TEM



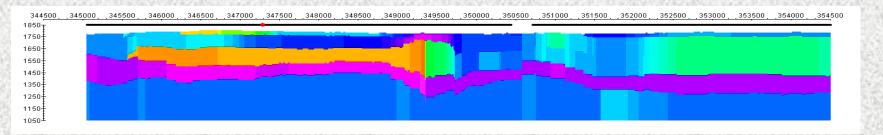
•Gold bearing sulphide zone CAD model

TDEM target models with boreholes

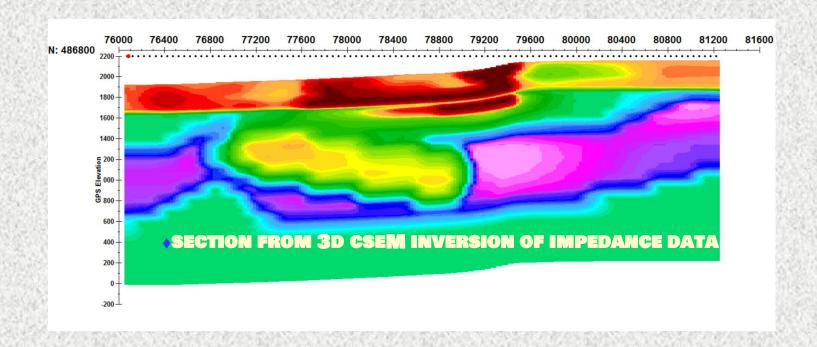


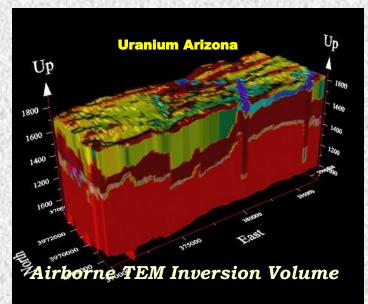
Ground TDEM
Survey

Underground Workings Shown with TDEM model

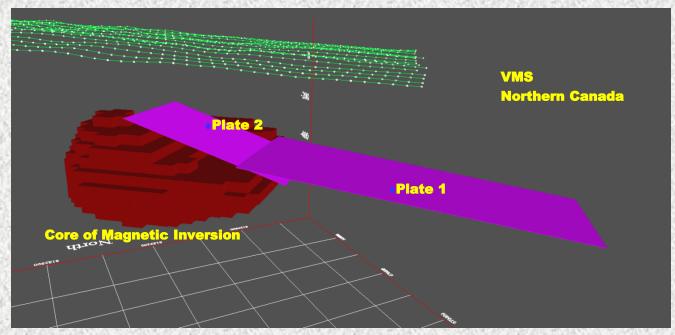


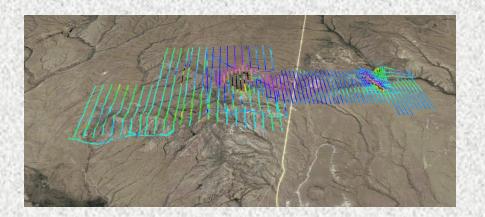
Airborne 1D Stacked TDEM Inversion





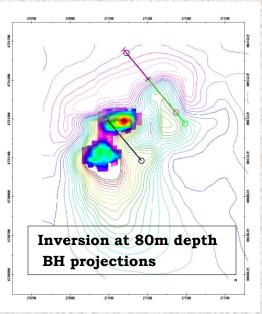
Visualization Tools

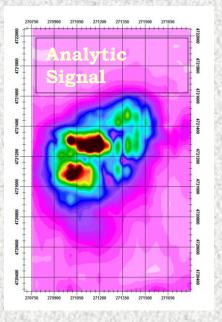


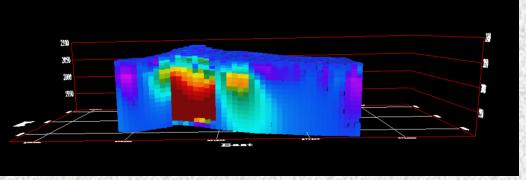


270700 270800 270900 271000 271100 271200 271300 271400 271500 271600 271700 271800 North **Derivative** 270700 270800 270900 271000 271100 271200 271300 271400 271500 271600 271700 271800

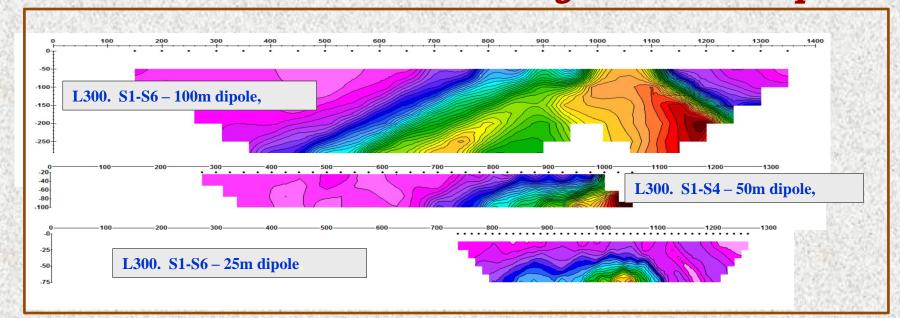
Ground magnetics VMS

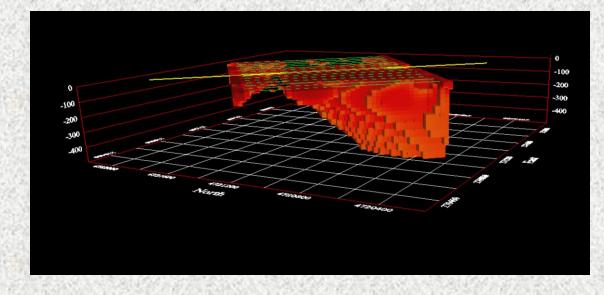






Resistivity Inversion Capabilities





EMIGMA Training Tools



- ➤ Manual in Text and Digital Form!
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- >extensive examples
- >Tutorials in .ppt and .doc formats
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