



## Q4-2011 Newsletter

### Introducing TechnoImaging

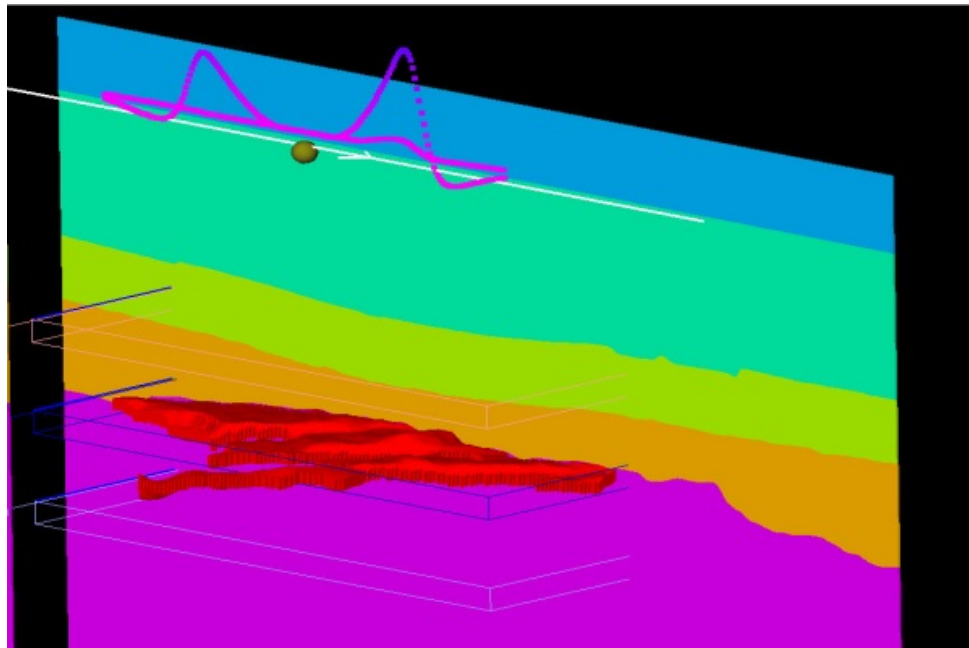
Founded in 2005 by Professor Michael S. Zhdanov as a spin-off from the University of Utah, TechnoImaging is an independent Salt Lake City-based company which provides commercial software products, inversion and interpretation services, contract research and development, and project management for all electromagnetic and potential field methods relevant to oil and gas exploration and production.

### BRIDGE with EMVision® – A plug-in for Petrel\* Now available from the Ocean Store!

Blueback Reservoir and TechnoImaging are now licensing the Petrel\* plug-in BRIDGE with TechnoImaging's EMVision® 3D CSEM modelling. This enables Petrel users to simulate CSEM data, and independently QC other 3D inversions.

BRIDGE is now available for download and licensing from the [Ocean Store!](#)

Alternatively, contact [Blueback Reservoir](#) for a free demonstration license of BRIDGE with EMVision®!



BRIDGE with EMVision® is a Petrel\* plug-in for analysis and interpretation of CSEM data, including 3D modeling.

**ITF proposal**  
**Formation Evaluation using Resistivity Modeling and Inversion**  
**(FERMI)**

TechnoImaging would like to advise that the proposal “**Formation Evaluation using Resistivity Modelling and Inversion (FERMI)**” has been submitted to the [Industry Technology Facilitator \(ITF\)](#) in response to the Innovations in Drilling Technologies call for proposals. The intent is to commence FERMI during 2012.

The abstract for the FERMI proposal is included below:

Tensor (or multicomponent) induction well logging (TIWL) products and services are being offered to oil and gas producers for formation evaluation and LWD/MWD applications. State-of-the-art TIWL interpretations are based on 1D models which fail to capture the realities formation complexity, such as 3D structure and induced polarization effects. This project will develop methods, know-how, and software for 3D formation evaluation using TIWL data. The project will develop generalized effective medium models for calculating anisotropic and frequency-dependent resistivities from rock and fluid parameters. These models will be validated with laboratory-based measurements and analysis of shale, carbonate, and clastic reservoir rocks, and drilling fluids. The project will develop 3D TIWL modelling and inversion software based on the 3D contraction integral equation method, and focusing regularization. Sponsors will be provided with a serial version of the software, and access to a parallel version of the software via a secured internet-hosted facility. Comprehensive model studies will be prepared for shale, carbonate, and clastic formations. The project deliverables could be used by oil and gas producers to understand the differences between different TIWL instruments, perform data QC, and optimize TIWL interpretation. The project deliverables could be used by service providers to optimize TIWL instrument design, and perform data QC. The project deliverables will provide a technical foundation for real-time 3D imaging of TIWL data.

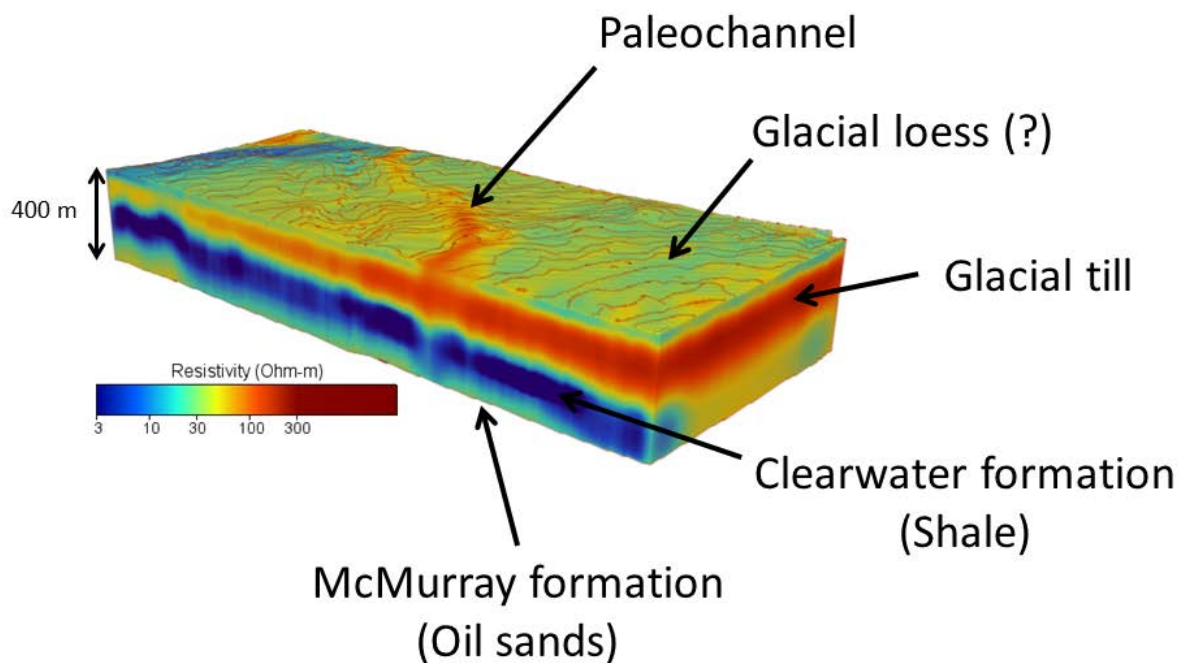
Contact [Glenn Wilson](#) if you would like to obtain further information about FERMI.

## Mega-cell 3D airborne electromagnetic inversion

Airborne electromagnetic (AEM) surveys can be used for near-surface characterization of oil and gas fields, environmental monitoring, and oil sands exploration and appraisal. Regarding the latter, AEM surveys are particularly useful for delineating near-surface paleochannels, which represent geological hazards for oil sands operations.

TechnoImaging offers the **only** 3D inversion for entire AEM surveys for **any frequency domain or time domain** AEM system using a unique moving footprint approach. We are now routinely inverting entire AEM surveys up to several thousand line km in size to 3D conductivity models with up to tens of millions of cells.

Since late 2010, over fifty 3D AEM inversion projects have been completed for Aerodat, AEROTEM, DIGHEM, GEOTEM, HELITEM, MEGATEM, RESOLVE, SPECTREM, TEMPEST, VTEM, ZTEM and AirMt data from Australia, Canada, Finland, Ghana, Peru, Sierra Leone, Tanzania, the US, and Zambia.



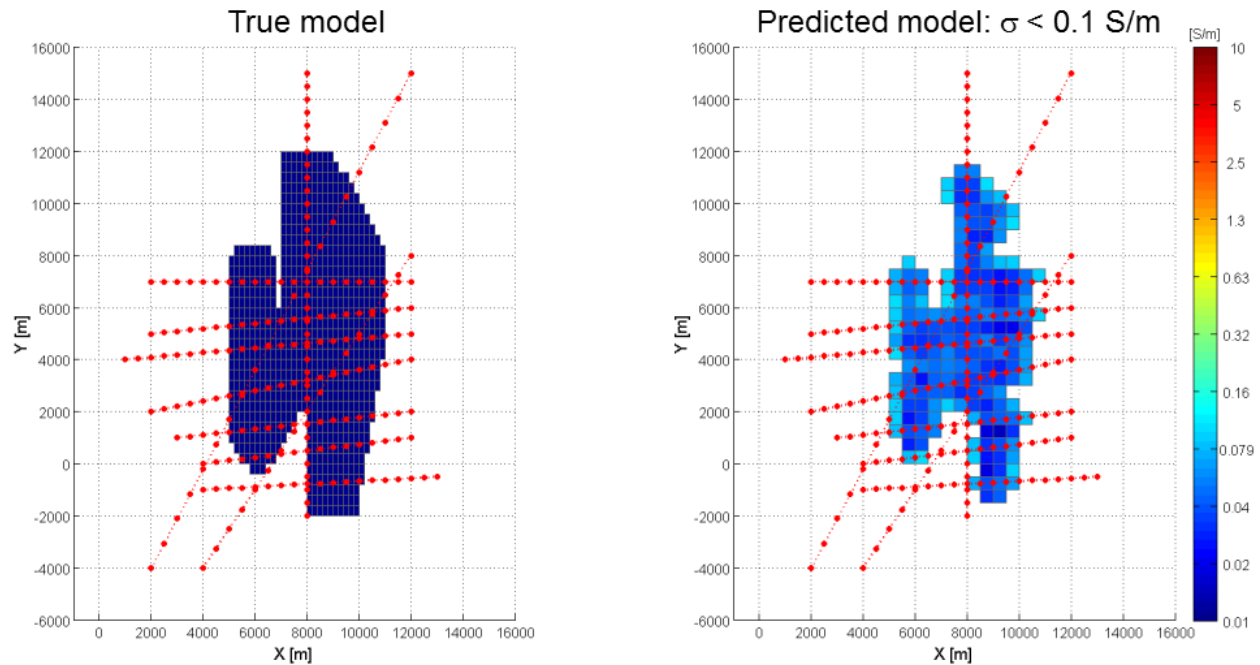
3D inversion of AEROTEM helicopter time-domain electromagnetic data (Courtesy of AeroQuest)  
for oil sands exploration in northern Alberta, Canada.

These AEROTEM data and 3D model are available from TechnoImaging on a non-exclusive basis.

## 3D towed streamer electromagnetic inversion

TechnoImaging has developed the **only** 3D inversion for towed streamer electromagnetic data in **both** frequency domain and time domain.

We will commercially offer 3D towed EM inversion services from early 2012.



**Model study for 3D towed streamer EM inversion of the Peon gas discovery; (left) horizontal cross section of resistivity model at 550 m depth, and (right) horizontal cross section of resistivity model at 550 m depth recovered from 3D inversion.**

## Simultaneous 3D joint inversion of geophysical data

TechnoImaging have developed an entirely new method and prototype software for the simultaneous 3D joint inversion of magnetic, magnetic gradiometry, gravity, gravity gradiometry, electromagnetic and seismic geophysical data.

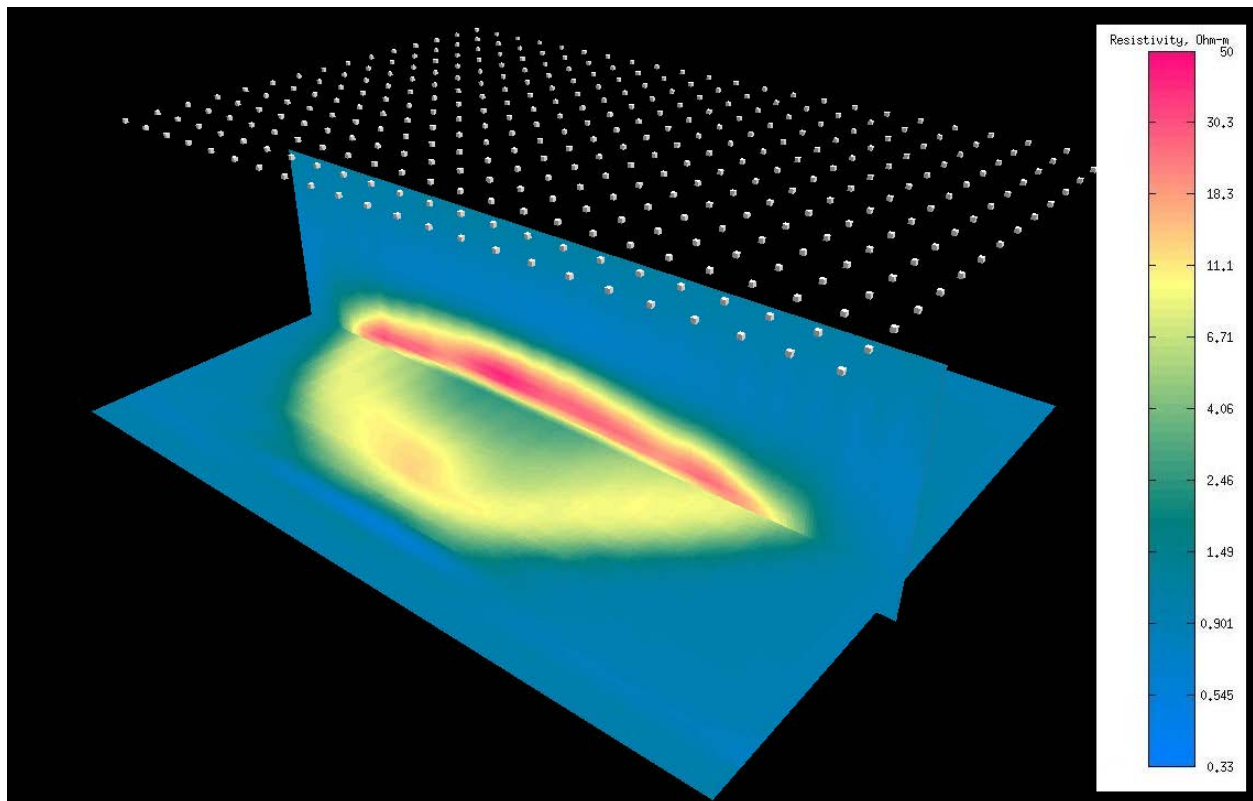
We are soliciting interest from companies or organizations to support this exciting development, particularly through the contribution of geological and geophysical data for case studies.

Please contact [Glenn Wilson](#) for further details.

## Mega-cell 3D migration & inversion of marine CSEM data

TechnoImaging offers an **independent large-scale 3D migration and inversion service and quality control** for multi-line marine controlled source electromagnetic (CSEM) surveys in **either frequency domain or time domain** – we are able to invert 3D CSEM surveys to mega-cell 3D conductivity models with anisotropy and inhomogeneous background conductivity. We are also able to jointly invert both CSEM and MT data.

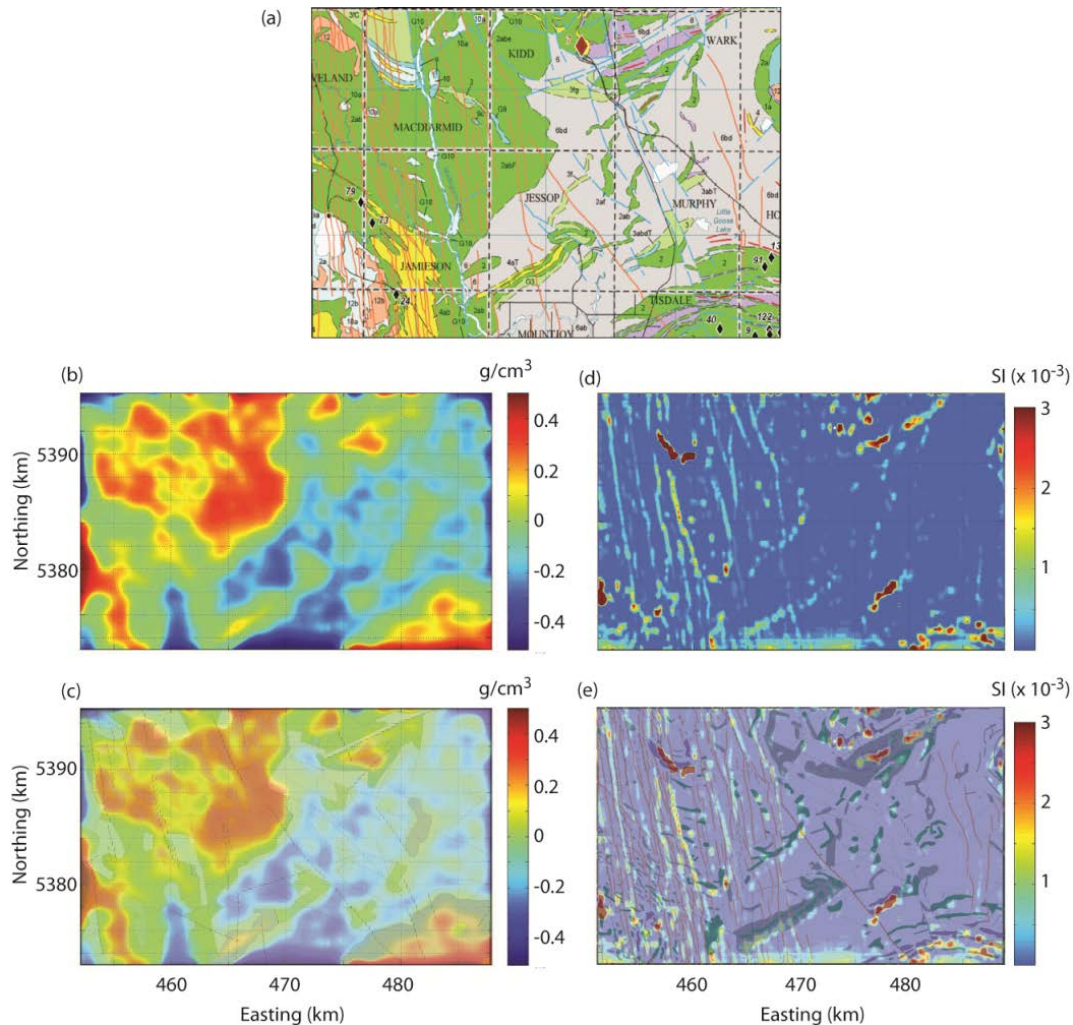
Our recent publication in [Geophysical Prospecting](#) describes our proprietary focusing regularization that recovers sharper and higher conductivity contrasts than traditional “smooth” regularization.



3D resistivity image of the Shtokman gas field obtained from the iterative 3D migration using the minimum vertical support stabilizer. For further details, we refer you to [Zhdanov et al. \(Geophysical Prospecting, 2011\)](#).

## Breaking the billion cell barrier Giga-cell 3D potential field inversion

TechnoImaging offers the **only** massively parallel 3D inversion for gravity, gravity gradiometry, magnetics, and magnetic gradiometry data. Our software is unprecedented in the unlimited scale of both survey and model that can be inverted – we are now routinely inverting entire surveys to mega- and giga-cell 3D density models. For continental-scale 3D inversions, we have developed our 3D inversion in spherical coordinates.



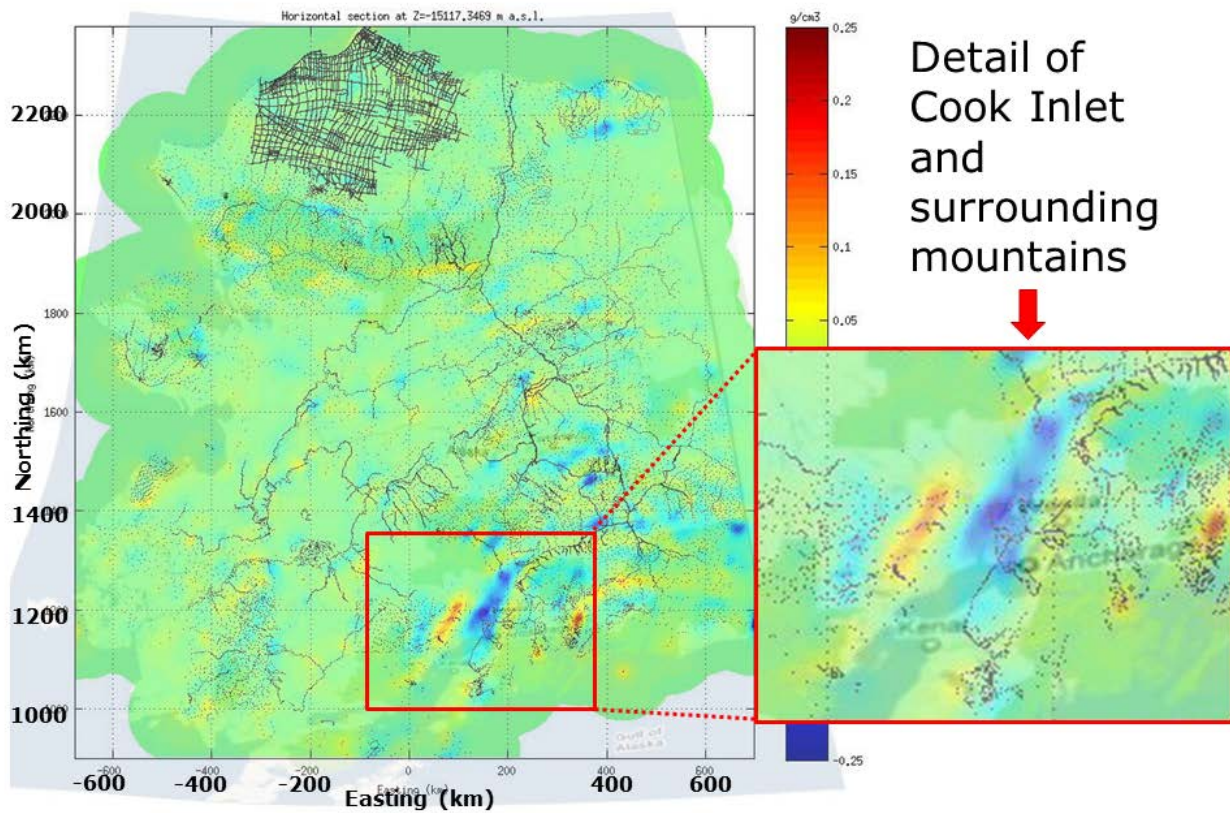
Comparison of (a) geology of the Timmins survey area; (b) a horizontal cross section through the 3D density model obtained from joint inversion of all FALCON gravity gradiometry data at -1213 m ASL, i.e., 1500 m depth from topographic peak; (c) structural interpretation (courtesy of Fugro Airborne Surveys) superimposed on the same horizontal cross-section through the 3D density model; (d) a horizontal cross section through the 3D susceptibility model obtained from inversion of TMI data at -63 m ASL, i.e., ~300 m depth from topographic peak; and (e) structural interpretation (courtesy of Fugro Airborne Surveys) superimposed on the same horizontal cross section through the 3D susceptibility model. Further details are described in [Wilson et al., 2011, Massively parallel 3D inversion of gravity and gravity gradiometry data, Preview](#), and Cuma et al., 2012, [Geophysical Prospecting](#) (accepted).

## Non-exclusive 3D inversion products

TechnoImaging is developing a suite of non-exclusive 3D inversion products based on open file data.

At present, we have the following 3D models available for licensing:

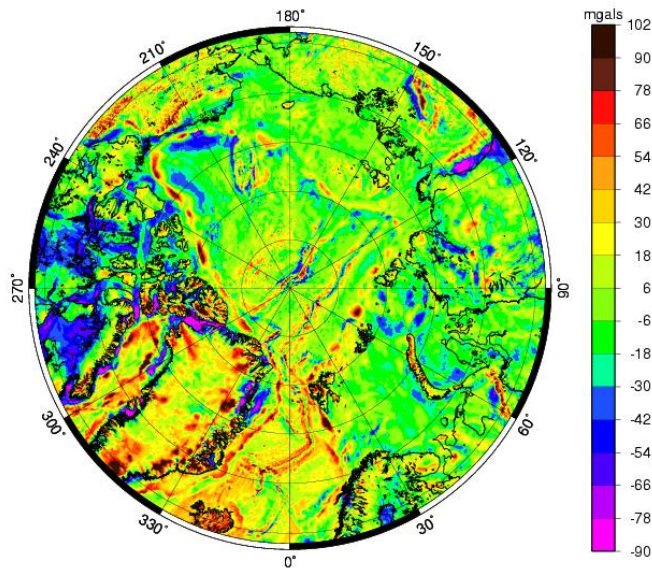
**Alaska:** A suite of 3D density models to depths of 50 km, 100 km, and 150 km, discretised to 500 m horizontal resolution, recovered from 3D inversion of 90,000 stations of USGS complete Bouguer gravity data.



Horizontal cross section at 15 km depth from the 3D density model of Alaska, discretised to 500 m horizontal resolution and depth of 150 km. This model is part of a model suite available for licensing on a non-exclusive basis.

**Canada:** Data and 3D resistivity models recovered from 3D inversion of AeroTEM data for oil sands exploration in northern Alberta, Canada. Refer to our prior section on Mega-cell 3D AEM inversion.

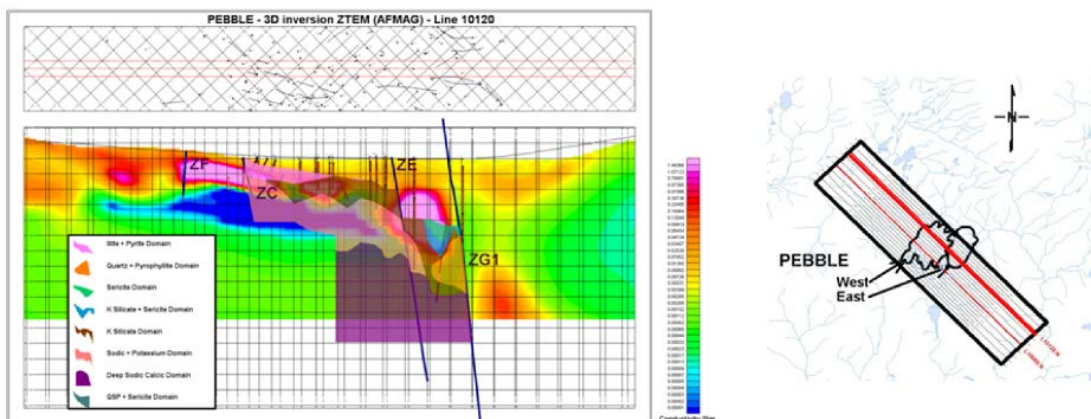
**Arctic:** We are now soliciting expressions of interest for the licensing of 3D density models for the Arctic which we are planning to develop during 2012.



The entire Arctic free air gravity map is to be inverted to a suite of 3D density models during 2012.

## Mega-cell 3D inversion of magnetotelluric (MT) data

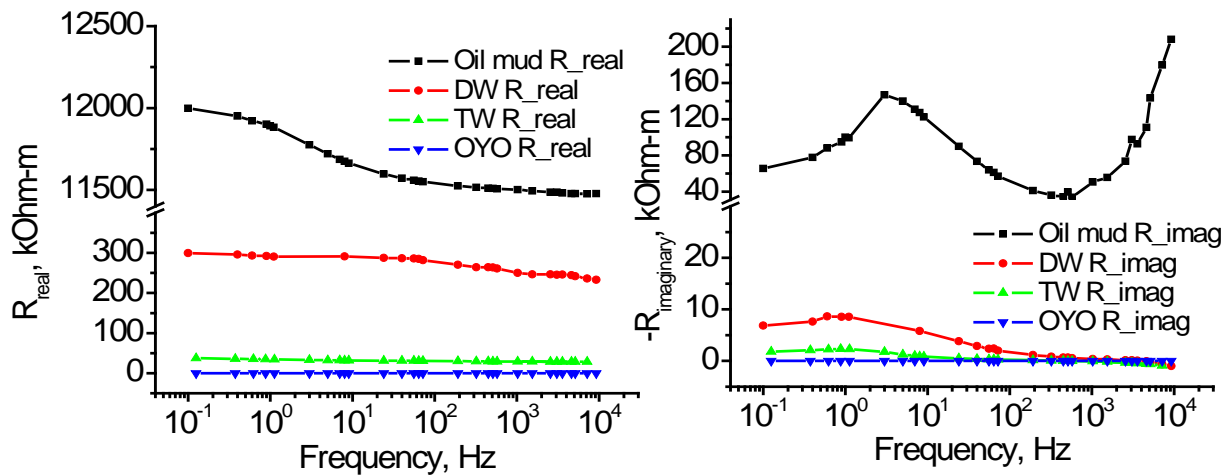
TechnoImaging offers large-scale 3D inversion for magnetotelluric (MT), magnetovariational (VM) and audio-frequency magnetic (AFMAG, e.g., ZTEM, AirMt) surveys. We are now routinely inverting regional-scale MT surveys to mega-cell 3D conductivity models. Our recent 3D inversion of EarthScope MT data from Yellowstone National Park has been featured on BBC and National Geographic.



3D resistivity model obtained from inversion of 250 line km of ZTEM data from the Pebble Cu-Au-Mo porphyry deposit, Alaska, with alteration patterns superimposed (from Pare et al., 2012). The 3D ZTEM inversion was unconstrained, yet the 3D resistivity model captured geological complexity such as alteration patterns, faults and overburden.

## Complex resistivity measurements

TechnoImaging is now able to provide complex resistivity measurements of any type of rock and/or fluid samples from DC to 10 kHz. As we have been demonstrating since 2008, this is particularly important for understanding the effects of induced polarization in electromagnetic measurements for hydrocarbon formations. Contact [Glenn Wilson](#) for further information regarding this service.



Real (left) and imaginary (right) resistivity measurements for oil-based mud (OBM) (black), tap water (TW) (green), distilled water (DW) (red), and OYO electrodes (blue).

## Web-hosted cluster computing services

TechnoImaging offers web-hosted cluster computing services for access to TechnoImaging's software or for hosting client's proprietary software. Clients have secure access to TechnoImaging's cluster resources, including:

- Mega-cell 3D modeling and inversion for multi-line marine CSEM surveys in either frequency-domain or time-domain
- Mega-cell 3D MT modeling and inversion
- Giga-cell 3D modeling and inversion for any potential field, including gravity, gravity gradiometry, magnetics, and magnetic gradiometry

## **Contract R&D**

TechnoImaging offers contract R&D services and custom software solutions for:

- Marine electromagnetics
- Borehole-to-surface electromagnetics
- Induction well logging
- Land electromagnetics
- Potential fields
- Induced polarization
- Airborne electromagnetics
- High performance computing

Contact us to discuss our contract R&D services.

## **Recent publications**

M. Čuma, G. A. Wilson & M. S. Zhdanov, 2012, Large-scale 3D inversion of potential field data: Geophysical Prospecting, to appear.

M. S. Zhdanov, X. Liu (U. Utah), G. A. Wilson & L. Wan, 2011, [Potential field migration for rapid imaging of gravity gradiometry data](#): Geophysical Prospecting, **59**, 1052-1071, doi: 10.1111/j.1365-2478.2011.01005.x.

M. S. Zhdanov, M. Cuma, G. A. Wilson, E. P. Velikhov, N. Black & A. V. Gribenko, 2011, [Iterative electromagnetic migration for 3D inversion of marine controlled-source electromagnetic data](#): Geophysical Prospecting, **59**, 1101-1113, doi: 10.1111/j.1365-2478.2011.00991.x.

## **Recent patents**

TechnoImaging has recently been awarded the following US patents:

E. P. Velikhov & M. S. Zhdanov, 2011, Systems and methods for measuring sea-bed resistivity: US patent 7,969,152.

M. S. Zhdanov, 2011, Method and apparatus for gradient electromagnetic induction well logging: US patent 7,937,221.

## Upcoming Events

TechnoImaging will be represented at the following events during 2012:

- International Workshop on Geophysical Monitoring, Riyadh, Saudi Arabia, 8-11 January 2012

Keynote address: *4D monitoring of hydrocarbon reservoirs using electromagnetic and gravity methods*, by Professor Michael S. Zhdanov

M. S. Zhdanov, G. A. Wilson, A. V. Gribenko, L. H. Cox, M. Cuma, M. Endo, N. Black & L. Wan: *New advances in large-scale inversion of electromagnetic and potential field data for oil and gas exploration and production*.

- [22<sup>nd</sup> ASEG Geophysical Conference and Exhibition](#), Brisbane, Australia, 26-29 February 2012

Keynote address: *Recent advances in large-scale 3D inversion of airborne geophysical data*, by Professor Michael S. Zhdanov

M. Combrinck, L. Cox, G. A. Wilson & M. S. Zhdanov: *3D VTEM inversion for delineating sub-vertical shear zones in the West African gold belt*, presented by Magdel Combrinck (Tau Geophysical Consultants)

S. J. Fraser (CSIRO), G. A. Wilson, L. H. Cox, M. Čuma, M. S. Zhdanov & M. A. Vallee (Fugro): *Self-organizing maps for pseudo-lithological classification of 3D airborne electromagnetic, gravity gradiometry and magnetic inversions*, presented by Steve Fraser (CSIRO)

P. Pare (Anglo American), A. V. Gribenko, L. H. Cox, M. Čuma, G. A. Wilson, M. S. Zhdanov, J. Legault (Geotech), J. Smit (Anglo American) & L. Polome (Spectrem Air): *3D inversion of SPECTREM and ZTEM data from the Pebble Cu-Au-Mo porphyry deposit, Alaska* (Poster), presented by Jean Legault (Geotech)

Natural Fields EM Forum, 26 February 2012

3D EM Inversion – An Update on Capabilities and Outcomes, 1 March 2012

- [Saint Petersburg 2012](#), Saint Petersburg, Russia, 2-5 April 2012
- [74<sup>th</sup> EAGE Conference and Exhibition](#), Copenhagen, Denmark, 4-7 June 2012
- [82<sup>nd</sup> SEG Annual Meeting and Exhibition](#), Las Vegas, Nevada, 4-9 November 2012

## **Contact**

For further information on our 3D non-seismic interpretation products and services, please contact:

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