CSIRO
Exploration and Mining
PO Box 136, North Ryde NSW 1670 Australia
www.em.csiro.au

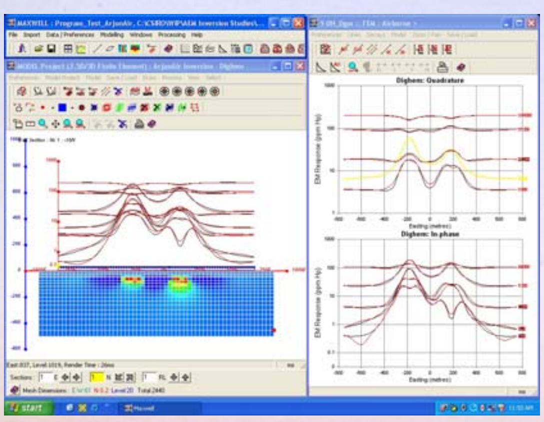
2.5D inversion of airborne electromagnetic data

Glenn Wilson   Art Raiche   Fred Sugeng

2.5D electromagnetic (EM) modelling computes the response of a 3D source from an arbitrary 2D geoelectrical model which has an infinite strike length. As such, it is practical for airborne EM (AEM) data to be inverted using 2.5D modelling provided that the geoelectrical cross-section is relatively constant along a strike length that exceeds the AEM system footprint.

The program *ArjunAir* is introduced for modelling and inversion based on a 2D finite-element method that enables the accurate simulation of 3D source excitation for full domain models inclusive of topography, non-conforming boundaries and very high resistivity contrasts.

Inversion is based on an iterative Gauss-Newton method that is solved using the damped eigenparameter algorithm. This is very efficient, with 2.5D inversions completed in the order of hours.



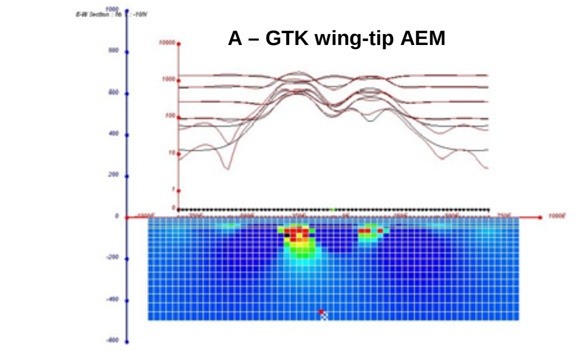
GRAPHICAL USER INTERFACE

Maxwell is a graphical user interface that enables EM interpreters to import field data, construct 1D, 2.5D and 3D models, perform inversions, compare results to field data and export models in a variety of industry standard formats.

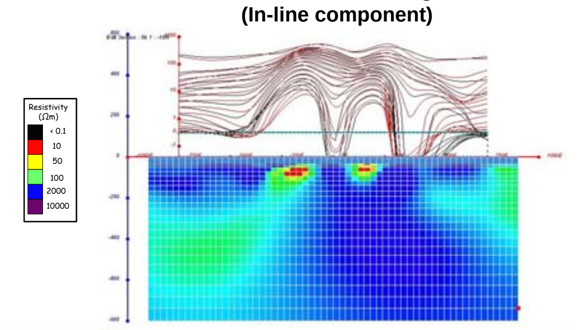
SYNTHETIC MODEL STUDIES

To demonstrate 2.5D inversion, synthetic models of two conductive blocks (1 Ωm and 10 Ωm) embedded in a uniform half-space (1000 Ωm) were simulated for a variety of AEM systems and configurations. In each case, the initial model for inversion was a uniform half-space (1000 Ωm).

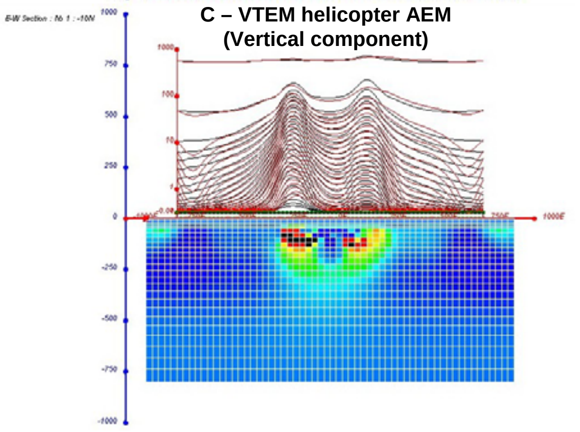
A – GTK wing-tip AEM



B – TEMPEST fixed-wing AEM
(In-line component)



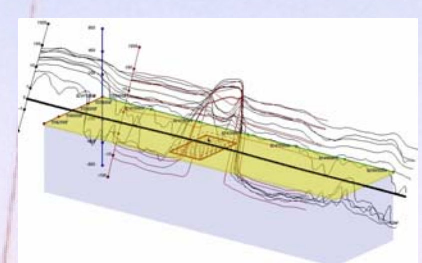
C – VTEM helicopter AEM
(Vertical component)



CASE STUDY – NICKEL EXPLORATION

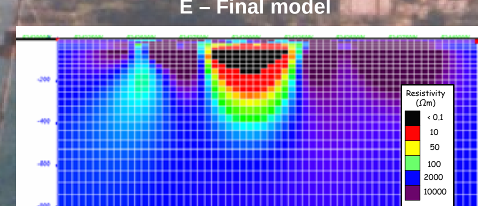
As extremely conductive targets embedded in highly resistive hosts, the Ni-Cu-Co deposits in the Voisey's Bay area of Canada have been subject to numerous AEM inversion studies. In the course of exploration, INCO acquired DIGHEM[V] data over the Ovoid. This was first inverted using the 3D thin sheet program *LeroiAir*, based on the same damped eigenparameter inversion method (Panel D).

D – 3D thin sheet inversion



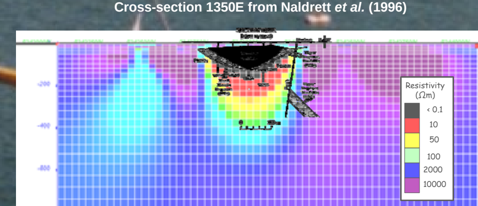
Subsequent 2.5D inversion used an initial model of a two layered half-space. A very high contrast model was recovered (Panel E) which corresponds quite well with the known geology (Panel F).

E – Final model



F – Final model with geological section overlain

Cross-section 1350E from Naldrett *et al.* (1996)

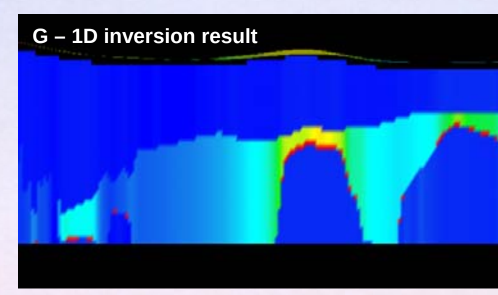


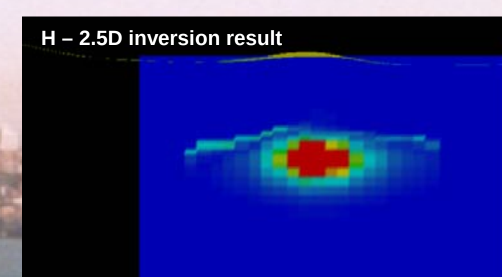
Courtesy of INCO and Condor Consulting

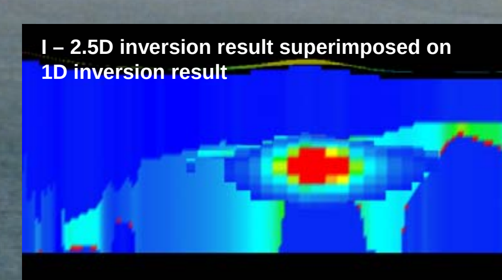
CASE STUDY – GOLD EXPLORATION

Barrick Gold Corporation recently acquired VTEM data over one of their current gold prospects. In April 2006, the data were inverted to 4 layered earth models (Panel G) using the program *Airbeo*, based on the same damped eigenparameter method.

In July 2006, the same data were inverted using 2.5D modelling with an initial model of a uniform half-space (Panel H). The recovered 2.5D model superimposed over the stitched 1D models are shown in Panel I. The agreement between the two inversion results has served as the basis for the continued exploration of the prospect.





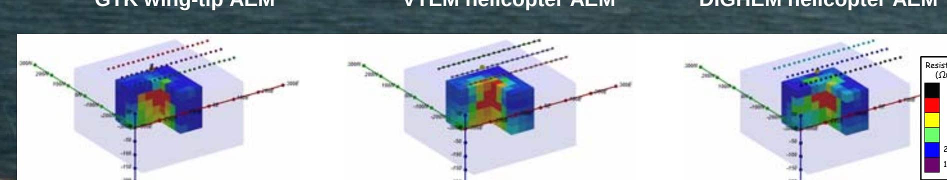


Courtesy of Barrick Gold Corporation

EXTENSION TO 3D AIRBORNE ELECTROMAGNETIC INVERSION

The damped eigenparameter method has been extended to 3D AEM inversion using the edge-element compact finite-element method (CFEM). The inversion results presented below are for the synthetic data generated from a 1 Ωm block embedded in a 1000 Ωm half-space, where the starting model was a uniform 1000 Ωm half-space.

GTK wing-tip AEM | VTEM helicopter AEM | DIGHEM helicopter AEM



ACKNOWLEDGEMENTS

This work is supported by AMIRA International Project P223F and is sponsored by Anglo American, the British Geological Survey, BHP Billiton, Cameco Corporation, the Co-operative Research Centre for Predictive Mineral Discovery (pmd*CRC), DeBeers Consolidated Mines, the Defence Science and Technology Organisation (DSTO), Fugro Airborne Surveys, the Geological Survey of Finland (GTK), INCO, Placer Dome (now Barrick Gold Corporation), Sumitomo Metal Mining Company and WMC Exploration (now BHP Billiton).

Graphical user interface support was provided by *Maxwell*, a commercial software product of Electromagnetic Imaging Technology Pty Ltd.

GW acknowledges support of the CSIRO Postdoctoral Fellowship Scheme.