CompGeoInc.com
Computational Geosciences Inc.

3D Inversion of Airborne Time-Domain EM Data

Introduction

Airborne time-domain electromagnetic (EM) surveys are effective tools for mineral exploration, geologic mapping and environmental applications. These surveys can be an economical way to explore large prospective regions. Traditionally, the data from such surveys have been interpreted using time constant analysis, conductivity to depth imaging (CDI) or possibly 1D inversions. These methods assist in a simple interpretation of the data, however because they do not fully model the physics in 3D, they can fail to accurately represent environments such as real world structures and geological targets. Airborne EM datasets are characterized by large volumes of data, as each EM sounding implies a new transmitter location. As a result, inverting this data in 3D is a computationally difficult problem that until recently has not been possible for the exploration community. Computational Geosciences Inc. (CGI) utilizes advanced mathematics and computer science to allow us to solve problems which were previously deemed too difficult. This is done using multiple meshes, each spanning the full model domain. By using adaptive OcTree mesh refinement each mesh is optimally designed for computational efficiency on the local domain defined by a subset of transmitters. This methodology maximizes the value of your airborne electromagnetic data by enabling fast and accurate 3D inversions of large domains.

Handling Large Surveys

The key to handling large airborne datasets is to work with multiple meshes, each of which is optimally designed to model only a small sub-domain of the full region, containing only a few EM soundings. Because large conductivity structures can still influence electromagnetic data far from the EM sensor, it is critical that each sub-domain mesh does not ignore conductivity structures far away.

The semi-structured OcTree mesh is ideally suited to this task. Given a model, the OcTree mesh will locally refine the cell size such that it is able to accurately represent varying model structure (see example in Figure 1). In regions where the model is smooth, fewer cells can be used without loss of resolution. This efficient refinement results in less cells, allowing for both larger and faster inversion results.

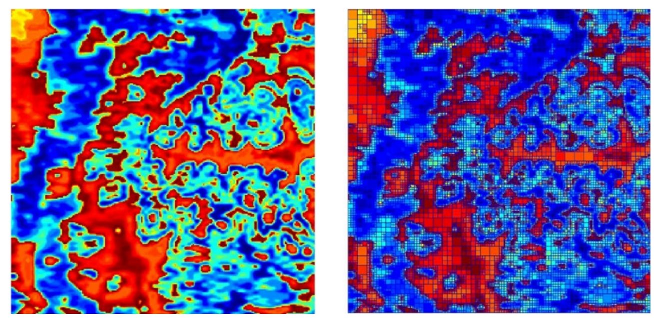

Figure 1: **Left:** Synthetic model **Right:** Efficient OcTree discretization of multiple scales of model structure.

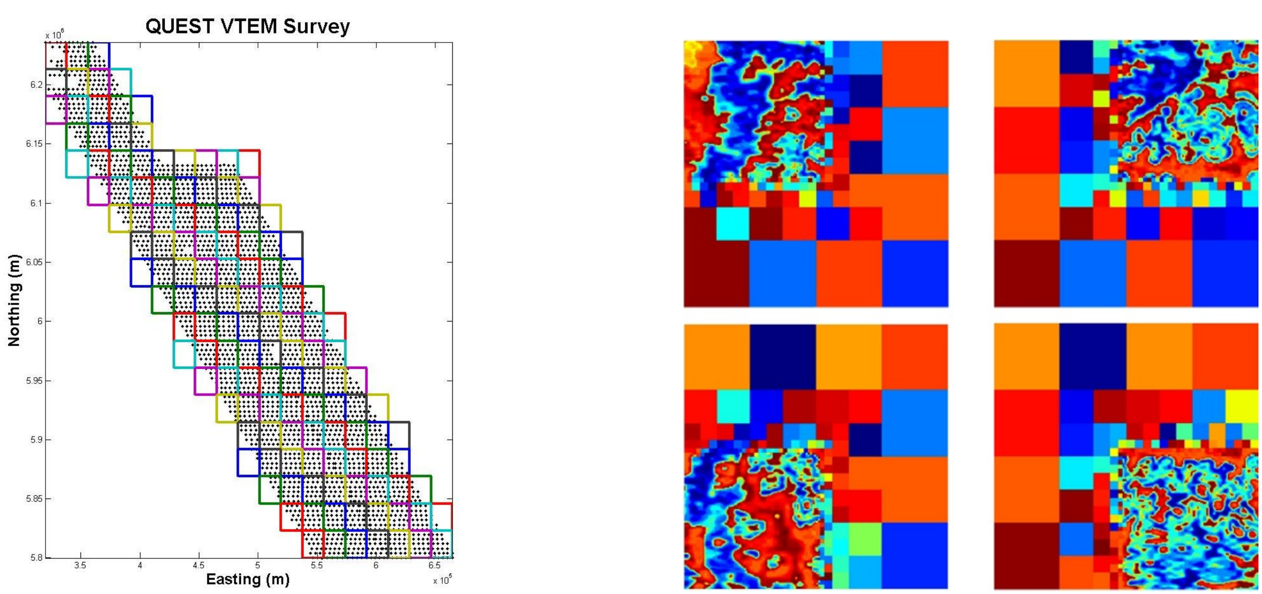

Figure 2: **Left:** Partitioning scheme used to invert the 350 x 450 km block of VTEM data collected by Geoscience BC as part of the QUEST project. **Right:** Resulting discretization of model in Figure 1 using four sub-domain OcTree meshes.

Tel: + 604 827 5777
2386 East Mall, Suite 112B
Vancouver British Columbia Canada V6T 1Z3

Computational Geosciences Inc.
www.compgeoinc.com

Partition Data

By applying multiple OcTree meshes, we are able to decompose large model domains into a number of smaller, more manageable partitions, while still taking into account effects from structures in the far field. Since the sensitivity to a given conductivity structure drops off with distance, only large-scale features will have a strong impact on local data, and therefore large coarse OcTree cells can be used further from the core region.

Field Data and Inversion - Mt Milligan Porphyry Deposit

In October 2008, a VTEM survey was flown over the Mt. Milligan porphyry deposit for Geoscience BC. The Mt. Milligan deposit owned by Thompson Creek Metals Company Inc., is a Cu-Au porphyry deposit located within the Quesnel Terrane in British Columbia. From the Terrane Metals Corp. 2009 43-101 report, Mt. Milligan is a tabular, near-surface, alkalic copper-gold porphyry deposit that measures some 2,500 metres (m) north-south, 1,500 m east-west and is 400 m thick. The Main Zone is spatially associated with the MBX monzonite stock and Rainbow Dyke. The mineralization and associated alteration are primarily hosted in volcanic rocks. Mineralization consists of pyrite, chalcopyrite and magnetite with bornite localized along intrusive-volcanic contacts. Copper-gold mineralization is primarily associated with potassic alteration which decreases in intensity outwards from the monzonite stocks. Pyrite content increases significantly outward from the stocks where it occurs in association with propylitic alteration, which forms a halo around the potassic-altered rocks. The Mt. Milligan copper-gold porphyry deposits contain Proven and Probable reserves of (Terrane Metals Corp, 43-101, 2009) 482 million tonnes (Mt) averaging 0.20% Cu and 0.39 grams per tonne (g/t) Au totaling 2.1 billion pounds copper and 6.0 million ounces gold.

The 2008 Mt. Milligan infill survey was part of the larger Quest survey and consisted of 13 VTEM lines for a total of 37.5 line-km of data. The airborne EM data were inverted using a new time-domain EM ocTree based inversion code. Using multiple meshes (as discussed on the front page), CGI was able to subdivide the area into 144 partitions, each of which consisted of $(25m)^3$ cells, resulting in a total of 8.4 million cells. The inversion ran to completion in several hours and produced the high resolution model shown below in Figure 3. The inversion result (center) clearly images the Great Eastern Fault and the associated conductive sediments as well as the associated higher conductivity alteration.

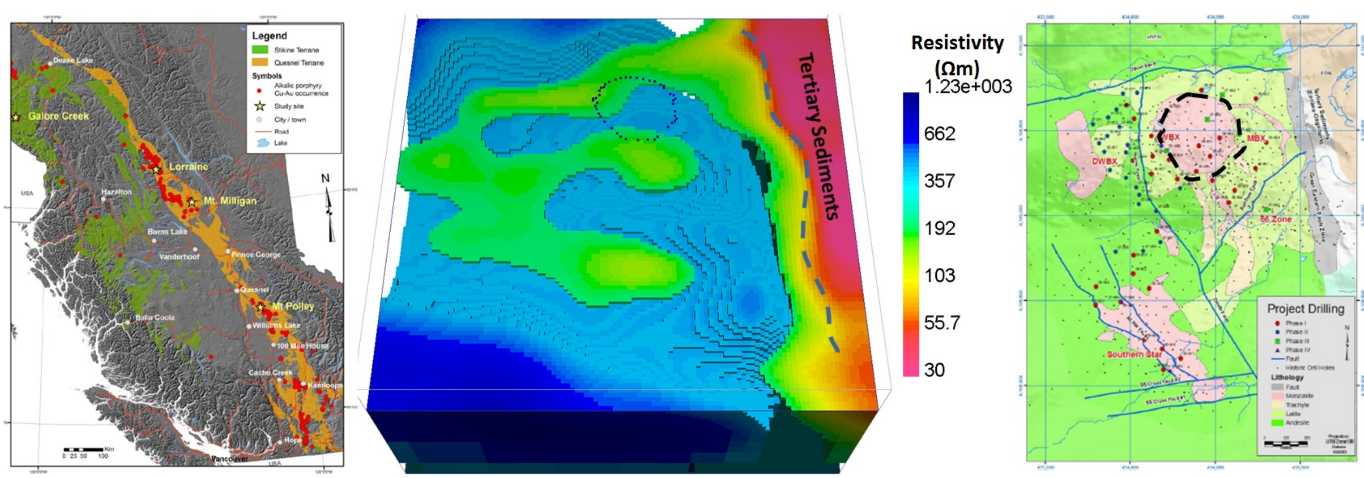

Figure 3: **Left:** Mt. Milligan location in British Columbia in the Quesnel Terrane (Devine, 2011). **Center:** Inverted VTEM conductivity model at an elevation of 965 m showing the more conductive and resistive units. **Right:** Mt. Milligan general geology taken from the 2009 Terrane Metals Corp. 43-101 report.

Tel: + 604 827 5777
2386 East Mall, Suite 112B
Vancouver British Columbia Canada V6T 1Z3

Computational Geosciences Inc.
www.compgeoinc.com