

3D Inversion of Time-Domain Electromagnetic Data for Thin Dipping Conductors

Introduction

Airborne time-domain electromagnetic (AEM) surveys have been shown to be an effective tool for imaging conductive metal-rich targets. The data are difficult to invert in 3D because of the number of sources and the size and scales of the computational domain. To solve the 3D AEM inverse problem we partition the forward problem into multiple meshes. Each mesh spans the full computational domain but uses fine mesh cells around the selected transmitters and receivers. This mesh refinement methodology results in a forward modelling mesh that has far fewer cells than the full inversion mesh. Since the forward modelling operation is the bottleneck for AEM inversions, this procedure results in a highly parallel algorithm that can handle arbitrarily large datasets and can deal with many scales of detail in the data. The advanced 3D inversion capabilities of Computational Geosciences Inc. (CGI) are demonstrated with a VTEM-35 field dataset from Geotech Ltd. over the Caber deposit.

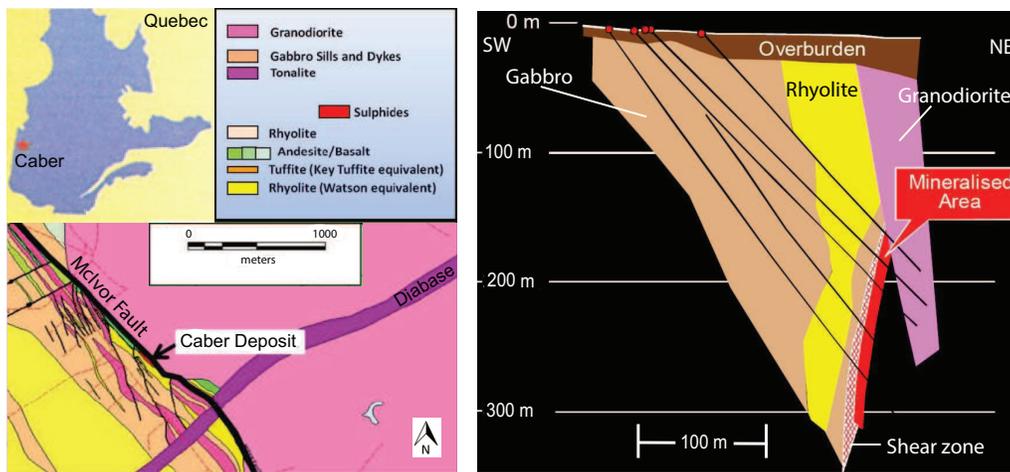


Figure 1: Left) Location and regional geology of Caber deposit. Right) Simplified stratigraphic cross-section through the deposit (modified from (Geotech, 2012))

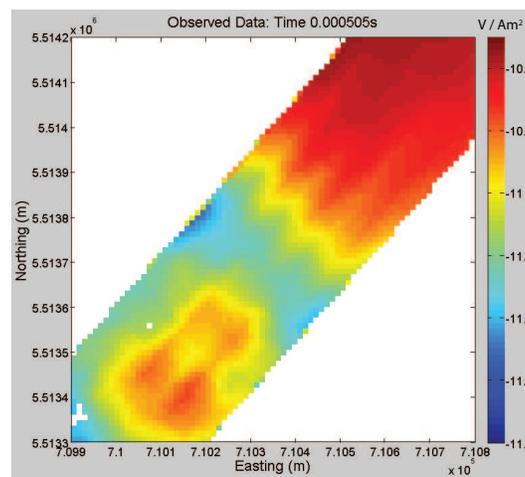


Figure 2: Observed data from VTEM-35 over the Caber deposit. Z component $\frac{dB}{dt}$ data at 505 μs

Caber is a zinc and copper rich volcanogenic (VMS) deposit in the Matagami camp of the Abitibi Greenstone belt as shown in Figure 1. The deposit itself is thin and steeply dipping to the south-west underneath a layer of conductive overburden. A simplified cross-section through the deposit in Figure 1 shows the thin nature of the mineralized zone, which is traditionally a difficult target to invert for in 3D. A plan view image from the 505 μ s time channel is displayed in Figure 2, and depicts an asymmetric double peak response in the z-component $\frac{dB}{dt}$ data. This electromagnetic signature is typical for a dipping conductor.

Caber VMS Dipping Conductor Inversions

Recent advancements in inversion capabilities have made it possible to image such complex targets as the Caber deposit, and a cross-section through a corresponding 3D inversion is displayed in Figure 3. The target is clearly imaged with a steep dip to the south-west below conductive overburden as understood by previous geologic mapping and drilling. The inversion shows that the overburden thickens to the north-east and the Caber anomaly dips at roughly an 80 degree angle compared to the vertical axis. With the same cross-section view, if only the conductive mesh cells are viewed, then the deposit is even more clearly displayed, as in Figure 4.

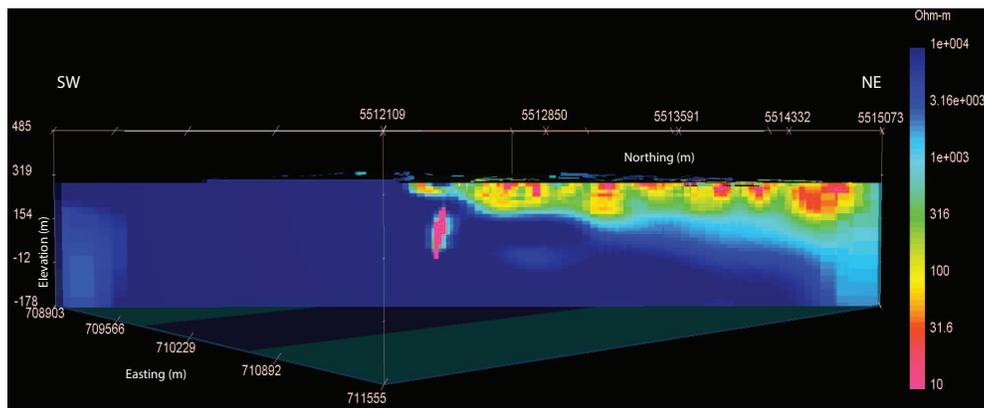


Figure 3: 3D Inversion of VTEM-35 data. The central conductive anomaly is the Caber Deposit, which dips to the south-west with a near-vertical dip of 80 degrees.

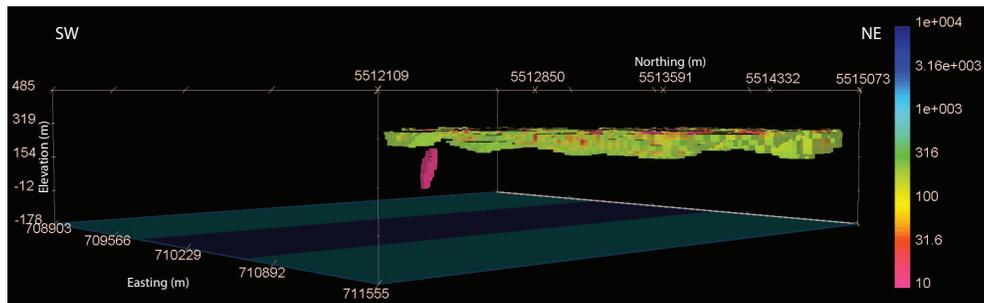


Figure 4: 3D Inversion of VTEM-35 data with only conductive cells less than 175 Ω m shown.

References

- Geotech Ltd, Technical Report on VTEM 35m Test Results over the Caber and Caber North Deposits, October 2012
- Zorayda Consulting Ltd, Technical Report on Resource Calculation for the PD1 Deposit, Matagami Project, Quebec, Prepared on behalf of Donner Metals Ltd, February 2011