An Integrated Approach to Geophysical Exploration

No one physical property can tell the entire story in any exploration setting. In order to extract the maximum value from your geophysical exploration, multiple types of geophysical data must be inverted and examined simultaneously. Computational Geosciences Inc. (CGI) offers unique capabilities to help achieve this goal. CGI can provide 3D inversions of:

- Ground & Airborne electromagnetics
- DC resistivity
- Z-Axis Tipper Electromagnetics (ZTEM)
- Induced polarization (IP)
- Magnetotellurics (MT)
- Potential fields (Magnetics & Gravity)

The OcTree Advantage

Accurately discretizing topographic relief in a survey area is critical when trying to extract the most information from your ground geophysical surveys. Fixed cell sizes required in regular meshes limit the accuracy and resolution of the recovered model while increasing the computational run time. This lack of resolution makes the correct placement of electrodes and receivers difficult and can reduce the integrity of the results.

The OcTree meshes used at CGI allow topography and small geologic features to be modeled accurately without dramatically increasing the total number of cells in a model.

An Integrated Example

The following study of a South American Au-Cu porphyry deposit presents a case in which multiple geophysical datasets were inverted in 3D by CGI. Datasets included dipole-dipole and pole-dipole DC resistivity and induced polarization, controlled source audio magnetotellurics (CSAMT), and ground magnetics collected over a 3 km square area. Each survey was performed separately between 1997 and 2008 and had previously been inverted in 2D.

The data was re-inverted by CGI in order to gain a better understanding of the physical property distributions on the property. To accomplish this, three-dimensional models of conductivity, chargeability, and magnetic susceptibility were recovered on the same mesh. This allowed for the practical interpretation of correlations of different physical properties with each other, as well as with known geologic structures.

Topography on the property was extreme, with approximately 1 km of vertical relief over three kilometers. With OcTree meshing, the topography was modeled to within 5m using only 1 million cells. This would have required approximately 15 million cells on a regular mesh and would have drastically increased the computational requirements.
Inversion Results & Physical Property Correlations

When magnetic susceptibility, electrical conductivity, and chargeability models were compared with available geologic information and with each other, correlations were noticeable. Two sources of geologic information were drawn from drilling results: a three dimensional volume estimating the extent of zones though to be associated with mineralization, and a surface approximating the depth to the basement interface.

Figure 3 shows a geologic section with drilling locations and a section from CGI’s recovered chargeability model. Excellent correlation is apparent between chargeable zones in the inversion result and mineralization intercepts. The boundary of the estimated mineralized zone closely corresponds with the extent of large, highly chargeable body on the left of the section.

Figure 4 shows the three different recovered physical property models cut along the same traverse, along with the estimated depth to basement interface (dashed white line). Strong positive and negative correlations are apparent throughout the three. The basement interface correlates best with the magnetic susceptibility and electrical conductivity models, where it seems to be a controlling structure delineating boundaries between relative highs and lows.