EMIGMA for CSAMT/CSEM

The CSAMT/CSEM package is available as part of EMIGMA Premium Complete or EMIGMA EM for Oil and Gas, as a standalone product or an add-on to other EMIGMA licenses. The most important aspect of EMIGMA for CSAMT is that data interpretation is treated as a controlled source technique utilizing the geometry of your source wire and injections.

Issues for Traditional CSAMT
For CSAMT, there is **NO NEED TO CONSIDER ONLY THE FAR-FIELD**! With EMIGMA, the user may work in the Near Field, the Far-Field and the intermediate zone. Additionally, you may work with your electric fields, your magnetic fields, or both as fields or as ratios (impedances). In addition, you may utilize the standard inline, Ex, and perpendicular Hy as well as Ey and Hx.

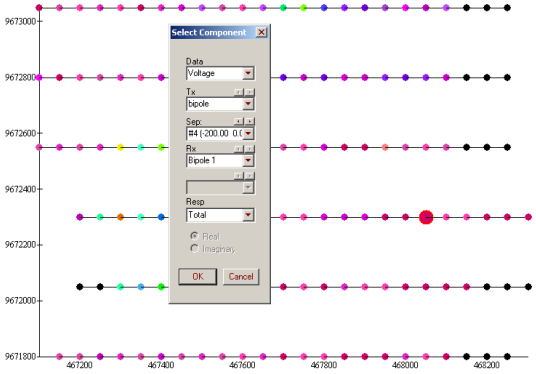
The use of impedances for CSAMT is historically based on 2 incorrect issues. Proper transmitter/receiver control does not allow for E and H to be used independently and lack of software to treat as a controlled source. Rather the data is treated as magnetotelluric plane wave sources. In the far field, both E and H fall-off geometrically with same 1/r rate and thus the distance from the source is identical and thus E/H is independent of the rate of fall off. This poses several problems: **a)** it is appropriate only when E and H are in the far field which depends upon the frequency, thus limiting which frequencies can be used **b)** the source is still NOT a plane wave **c)** the use of far-field is limited to only certain azimuths from the source **d)** the far-field does not incorporate the effects of structure between the near field and the far-field. Thus, this approach is not only limited but it is difficult to determine when it is appropriate without proper 3D source computations.

Issues for Land-Based CSEM
In this instance, we are considering new land-based CSEM mirrored on marine CSEM. Marine CSEM typically consists of an array of E-field receivers with the transmitter positioned numerous locations above tailing the ship. For land-based CSEM, there are a number of fixed grounded current sources and array of E-field and H-field receivers synchronized to the transmitters. In EMIGMA, you may utilize multi-component E or H receivers or both.

Unlimited survey size with Premium!

DATA IMPORT

- ASCII and QCTool imports
- Native Zonge and Phoenix imports



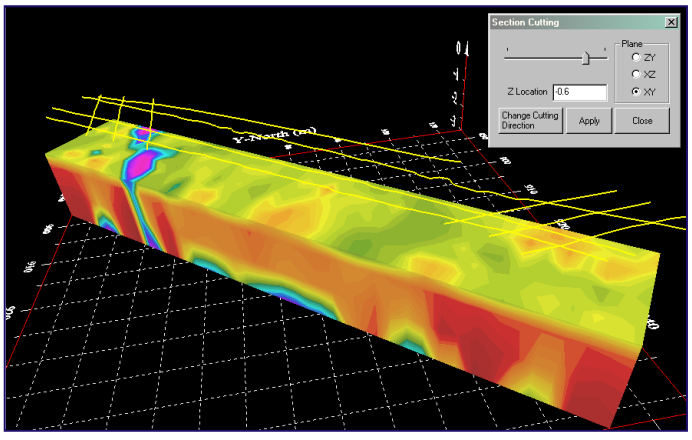
DATA PROCESSING AND CORRECTION

- All of our processing and data correction tools are available for CSAMT surveys.
- Additionally, QCTool can be used for basic QC/QA and then the resulting processing imported to EMIGMA for interpretation purposes. Specialized imports for your land-based CSEM can be provided as part of any purchase.

3D MODELING

EMIGMA's tools for 3D modeling of CSAMT/CSEM are excellent. The solutions are stable for electrodes near or inside anomalies; they are fast and accurate and also allow the important abilities to include IP effects, inductive effects of the current along the wire and several important magnetic effects.

- Fast and accurate 3D simulations: model suite generation and batch mode
- Unlimited prism, plate and polyhedra targets
  - *Polyhedra: pipes (hollow cylinders with or without lids), ellipsoids, shells, bullets, landmines, drums, spheres, general polyhedra...*
- Multiple body interactions
- Modeling of topography effects
- Magnetic effects
- Variations in resistivity and Cole-Cole parameters
- Ability to handle full contrast between host and bodies
- Interactive 3D model building tool
- CAD model imports and exports



3D CSAMT/CSEM INVERSION

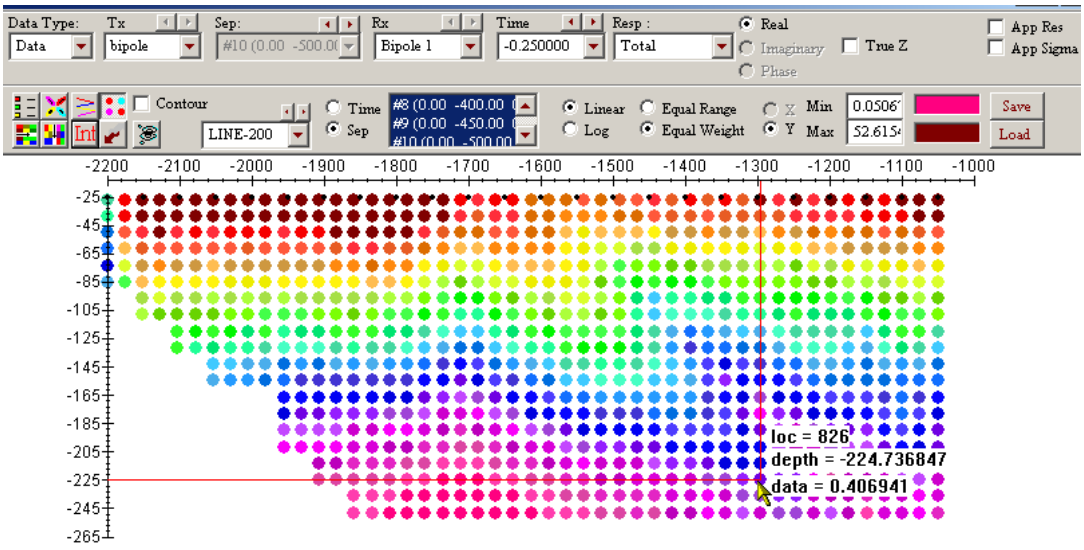
- Our 3D inversion for CSAMT became available in 2013 and for land-based CSEM in 2016
- Inversion includes not only the INVERSION algorithm but also a corresponding forward algorithm used in the inversion process. Two forward algorithms are provided for weak and strong scattering.
- Inversion may be done for CSAMT on impedances or E-fields or H-fields.
- For CSEM, E-field inversion or H-field inversion is provided
- Joint inversion of E and H is coming soon as is inversion for multiple transmitters

1D Resistivity INVERSION

- Utilization of the 3D source characteristics, no need to be in the far field
- Inversion for E, H or Z
- Smooth Occam technique with fixed layer thickness
- Underparametrized Marquardt technique with full resistivity and thickness constraints
- User-defined starting model and inversion parameters

DATA DISPLAY AND ANALYSES

- 3D data display as profiles, vectors, true 3D surfaces or contoured surface with 3D structure representation
- Section cutting of 3D model displays in the 3D Visualizer



- Pseudo-sections, depth images
- PEXShow tool - 2D representation of 1D inversions with easy switching between susceptibility and conductivity sections
- PseudoSection tool

- Grids: Natural Neighbor, Delaunay Triangulation, Minimum Curvature and Thin-Plate-Splines
- Contours: 2D and 3D surfaces
- Line plots
- Residual plots

For more detailed data display capabilities, see EMIGMA Complete

Updated: February, 2017