Inductive Thin-Sheet Inversion

Eikon's thin-sheet simulation algorithm with only an inductive response is based upon the mathematics presented by P.Annan in his PhD thesis. Our algorithm is not a re-work of the old UofT Plate program written by Bloore and Dyke in the 1980's and improved by Groom in the 1990's... However, initial calibration tests were made against the 1990's version as well as our modified version of P.Walker's VHPlate algorithm which had had basic checks against several other thin sheet algorithms during the 1990's.

In EMIGMA, a non-interacting layered background was enabled some years ago to allow the inclusion for weathered and conductive cover during interpretation as well as an only moderately resistive host. This app allowed for utilizing either a direct in time domain solution for the plate or a frequency to time transform solution if the bandwidth was critical to interpretation. The forward application is also provided from FEM data.

This latter version is the forward basis of Eikon's plate inversion app which allows both TDEM and FDEM data. In the app, for TDEM, the user may select the two types for forward approaches and the band width in the transform version. The background field is to be set by the user (*see suggestions below*) and the inversion is then performed on the secondary field. If no background is required then this is allowed. There are two completely different inversion algorithms provided. The first is based upon the traditional simplex approach and the second our well used and proven Trust Region approach.

Multiple sources and multiple receiver components are allowed and each TX-RX component may have its own selection of time windows or frequencies. The user may also select for each component the portion of the survey which will be utilized in the inversion. All of this may sound more elaborate than necessary but we have been developing and testing the application for more than 3 years now and many implementations were found necessary while testing with survey data from surveys around the world. Some implementations are made specifically for certain specialized survey configurations.

The application is enabled for ground, borehole and airborne data and allows for up to 6 plates in the inversion model. We suggest using our forward and inverse 1D modeling for setting the background. The 1D inversion allows to invert for a best 1D model for many stations which is very practical when working particularly with airborne data. We also suggest some preliminary forward modeling to utilize as starting models in the inversion. All parameters of the plates may be constrained.

We tested the software on data from a wide range of equipment for ground, borehole and airborne surveys. We have waited for release until we had sufficient experience utilizing the app in our consulting work for the past six months. For airborne data, we have utilized it for VTEM, Xcite and SkyTEM all collected within the last five years.

We now offer this as a service.

One Dimensional Layered Earth Models from a 3D source

These algorithms are fundamental to all of our EM algorithms and inversions including IP, Resistivity, CSEM, FDEM and TDEM. Not only do they provide the background fields for the computations but for algorithms which provide interactions with the background, they produce the Greens functions to produce the secondary fields at the receivers due the buried structures.

We have made a huge leap in the accuracy and speed of these computations. This affects such things as receivers near a loop or grounded wire as well as receivers near 3D models. Also, this improves the accuracy of low frequency calculations as well as receivers far from the source of the secondary fields. With regard to computation speed, in many cases, computation times are dramatically reduced due to the user of multi-cores and other computation aspects of the new generations of CPU's.

3D Magnetic Inversion

The new generation of processors such as the AMD Ryzen processors, extend substantially the potential size and speed of inversion applications. Our inversion applications including the magnetic inversion utilize a direct matrix approach rather than the more common "hunt and seek" approaches. Therefore, we have upgraded this algorithm to enable much larger inversion problems.

For example, our FFT and DFT algorithms for generating derivatives produce a very accurate vertical gradient. Combining this gradient with the total field produces better depth estimates from the inversion but requires an increased size for the inversion app. Also, drone surveys produce much higher spatial resolutions and can sometimes produce very large datasets larger than towed or stinger helicopter surveys. These developments have required us to enhance our magnetic inversion app to handle such situations. Additionally, new magnetic vector drone surveys can be even larger.

We will soon be adding inversion capabilities for borehole magnetic surveys which will lead to the ability invert borehole data with ground and/or airborne data. At present, you can jointly invert your ground and airborne data.

CSEM Processing, Modeling and Inversion

We have augmented our 3D CSEM inversion in our EMIGMA V11 release.

We continue our work on land based CSEM to provide a comprehensive set of tools to allow proper processing and interpretation of geophysical surveys with a grounded transmitter utilizing both magnetic and electric measurements. This includes proper processing and interpretation of so-called CSAMT.

Along with these developments, you have been able for the past few years to utilize our 3D inversion allowing for: a) multiple transmitters b) multi-component magnetic and electric measurements without the need to contract to an impedance and c) many receivers on multiple survey lines. The inversion is multi-core and utilizes array processing techniques and new techniques in inversion.

The non-linear approximator (LN) algorithm offers improved results in areas of high background resistivities. Most electric field inversion applications only provide a Born scattering approach whether intentionally or not. In V11, we have reached out more towards the full potential of this algorithm in an inversion app. The algorithm is very fast and accurate for forward results but applying this approach to inversion is not as straightforward as it may seem. Thus, we are happy with our progress in this direction and find it now much more useful in our consulting work.

Visualization

EMIGMA is constructed upon a relational database structure. As such, it was intended for joint interpretation of multiple data types. As the inversion techniques have improved in their usefulness, it has become necessary to improve the visualization inversions as well as integration in the visualizer of inversions and models from different types of survey data. For example, visual integration of IP and TDEM models with magnetic inversions. It has also become necessary to improve the speed and stability of visualization large inversions.

We have also added processing of inversions in order to reduce the inversions to the critical portions for visualization in EMIGMA as well as export to CAD models for the geologists. We have also added the ability to produce cross sections for viewing in EMIGMA and depth sections for viewing QCTool.

There has also been improvements and extensions to our 2D section viewer, Survey Editor viewer and Grid Presentation tools.