EMIGMA/QCTOOL News July 2026

Borehole Magnetic Data Inversions and Joint Ground/Air/Borehole Inversions

3D magnetic field inversions have been augmented for borehole data. Of course, the data utilized will primarily be vector component data but total field data is allowed for those unusual cases. The vector data may be in traditional borehole components of axial, azimuthal and horizontal specified at depths along the borehole from the collar. Or the data that has been converted to northing, easting and downwards components with data positions in a X,Y,Z grid convention (e.g. local or GNSS). The inversions have been enabled for the joint inversion of such data combined with ground and/or airborne data (drone, helicopter, fixed wing).

The user may define the inversion grid with a horizontal rectangular grid at a chosen azimuth and then a regular or irregular depth grid defined relative to depths below ground or relative to GNSS elevations. The grid may be defined to start at a chosen depth and extend to a desired depth thus allowing to focus on the active zones of the borehole data. The susceptibility parameters may be constrained as well as the user's choice of the smoothing controls. The required inversion precision and sensitivity may also be specified. Initial models derived from forward or CAD modeling or drilling results may be utilized as well as constraints to drilling results.

The inversion technique is a full matrix approach allowing direct use of the sensitivity functions and is not an iterative search along individual inversion parameters. The inversion algorithms are multi-threaded allowing for full use of modern chips. These two significant developments allow for extremely fast inversions even on a standard laptop. Rough inversion results may be utilized as starting models, inversion grids may be edited either for visualization or to provide starting models or for use with other types of survey data. The inversion settings are saved to individual log files for recovery of previous inversion settings and the log files are linked by the app to each survey in the database.

EMIGMA algorithms have long provided joint inversion of ground and airborne data but now there is the capability to include any combination of fixed wing, helicopter, drone, ground and borehole data in the inversion. Ground and airborne data may be total field, vector or gradient data whether measured or computed by FFT or DFT techniques. Any combination of data types are allowed.

Again, the multi-threaded, multi-core, array processing techniques allow the use of an almost unlimited amount of data and extremely large, detailed grids while still providing quick computation allowing many iterations in relatively short amounts of time.

Datums and Projections

We have augmented the datum utilization in EMIGMA and QCTool for the most recent datums for Australasia and eastern Asia for both horizontal and vertical datums. Additionally, Gauss-Kruger projections have been implemented for modern East Asian datums (e.g. China, Mongolia, Japan, Korea, southeast Asia).

FDEM Tools for QCTool

The use of the standard LIN approximation for imagining and evaluation FDEM data is quite limited because of its limited accuracy and the extension of new equipment to higher frequencies with larger offsets as well as its limitation regarding elevation above ground. A half space inversion algorithm has been implement in QCTool which utilizes the actual altitude of the data and is suitable for higher frequencies and larger offsets. The algorithm is quick and will image even an airborne survey quickly.

Several imaging tools for dipole-dipole FDEM data have been implemented in QCTool. These include conversion of data to apparent conductivity/resistivity and vice versa.

Gravity Inversions

Combined borehole and ground data inversions are in development and will be available in the next few months.
