2.5D VS 1D AEM FORWARD AND INVERSION METHODS AT A SURVEY SCALE : A CASE STUDY

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The McArthur basin/EMU fault study has a classic 2D fault feature and a buried conductor with an off-end effect with other 2D/3D effects away from the EMU fault. The collected AEM data has demonstrable AIP effects. This has stimulated an investigation of a simple 2D geology cross-section of a dipping fault with a strong conductor on one side of the fault.

A forward model of the predicted response near the EMU fault represents a synthetic observed signal from the cross-section in agreement with the AEM data. Our modelling shows that the 1D inversion gives results which do not reproduce the survey data whereas 2.5D performs well reconciling the inverted section with the observed EM response. Away from the 2D geology region and other 2D/3D EM effects, 1D does perform well as expected. Therefore 2.5D gets it right in significantly more situations by honouring the information in the observed data raising questions about the use of 1D.

Emerging AEM systems can provide estimates of economic rock unit thicknesses, dips, faults and anticline/syncline definition at an accuracy that mitigates the need for pattern drilling. The use of 2.5D allows marker beds of more conductive material to stand out at a depth of 500 m or more on sections created beneath individual flight lines. Routine treatment of all survey data is now possible without supercomputing capability.

CSIRO has also recently undertaken comparative studies of the available AEM 1D, 2.5D and 3D inversion codes. Their work raises some stark reminders of what is different in the methodologies and how the progression to higher-order geophysics methods requires not just careful test work but also effective education of the user community.

We explain the fundamental differences between 1D and 2.5D and point out issues with the 1D forward modelling and inversion technology. Importantly, Maxwell’s equations are used to constrain 2.5D whilst empirical methods are commonly used in 1D.

This leads to the situation where a near zero average misfit using stitched 1D models can be achieved with families of 1D inversions, whilst incorrectly predicting the geology. Therefore a low misfit does not necessarily indicate a good solution for 1D. The 2.5D method is a least-squares best fit of the observations and so the quoted misfit for 2.5D is a very different measure than for 1D.

The study demonstrates that 2.5D yields a much more satisfactory geology section and a better reconciliation with information contained in the survey data.