HOISTEM DATA PROCESSING FOR DISCOVERY OF CONDUCTIVE MANGANESE ORE UNDER COVER

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A time-domain Airborne Electro-Magnetic (AEM) survey was flown with the HoistEM system over the Woodie Woodie manganese mine corridor in the east Pilbara of Western Australia. The Woodie Woodie Manganese Mine is one of the unique high-grade manganese ore deposits in the world. Manganese ore in the Woodie Woodie area is hosted in Archaean dolomite and chert breccia that is 2.5 billion years old. The ore deposits usually sit in fault- and pipe-like structures within the dolomite, and the mineralisation may not always come to the surface. Some ore bodies are also buried by Permian glacial sediments (250 million years old) and also by younger sedimentary deposits.

Conductivity Depth Images (CDIs) were successfully created using EmFlow software by experimenting with different parameters, such as Tau value, to find the best processing solutions. Manganese mineralisation shows up as high conductivity in discrete CDIs calculated for the Woodie Woodie Mine corridor HoistEM survey. EM conductivity mapping using CDIs has shown correlation between isolated responses for about half of the known manganese ore zones. Recent drilling of several new EM targets in areas of regolith and bedrock cover has lead to the discovery of the over 6 large tonnage manganese ore bodies to date, in fact, one—ChrisD—is the largest ore body discovered so far at Woodie Woodie. FracSIS Professional 4.2 3D imaging software was used for integrated interpretation of Mn ore occurrences in relation to conductive response and geochemistry from drillhole samples to help understand the nature of the ore system and to find the best approach to explore for additional resources. There is good 3D correlation between manganese ore from drilling and HoistEM CDI results, which indicates that CDIs worked well (Figure 1).
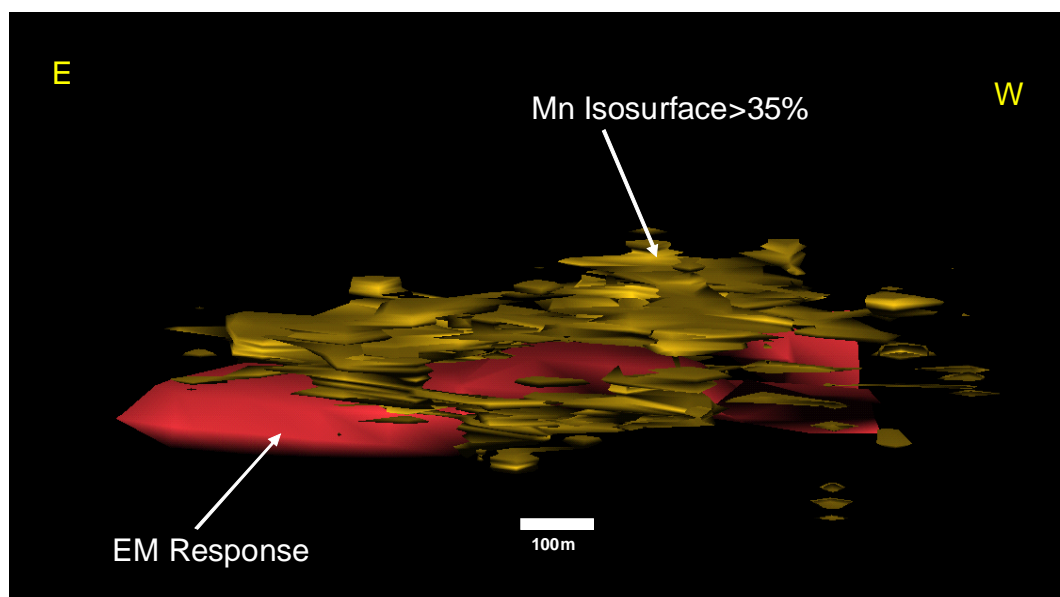

Figure 1: East-west 3D view showing the geometry of the HoistEM conductor isosurface (red) and the Mn ore intercepts from drilling (gold).

Comparison of HoistEM data for repeat flight lines using the transmitter-receiver frame at 40 m and then at 70 m above the ground reveal the amplitude at 40 m is twice the size of the 70 m flight. CDIs can image the main features in the 70 m data, but shallow detail in the regolith becomes lost due to high system distance and weaker EM Coupling. When the system distance increases, high field flux density from the smoke ring of the ground conductors can not be detected.

Evaluation of a test range of flight lines suggested that 80 m line spacing and 40 m terrain clearance, with line orientation orthogonal to elongation of ore pods, was optimal for HoistEM surveys.

Comparison between CDIs calculated using EMFlow, Emax, and Newmont's algorithms were made over Chris D. The conductive features from the Newmont CDI results are too broad for identifying discrete Mn targets and narrow conductors. Emax and EMFlow results are closer, but EMFlow shows ChrisD and adjacent features in more detail. HoistEM CDI conductivity depth data were compared to coincident downhole conductivity measurements, and the CDI results were calibrated using the Pearson correlation coefficient. Calibration produces a radical improvement in conductivity distributions at shallow depths. The regolith and Permian cover responses appear better predicted at depth in comparison to the initial unconstrained CDI. Furthermore, calibration resulted in removal of line busts in the data (Figure 2).
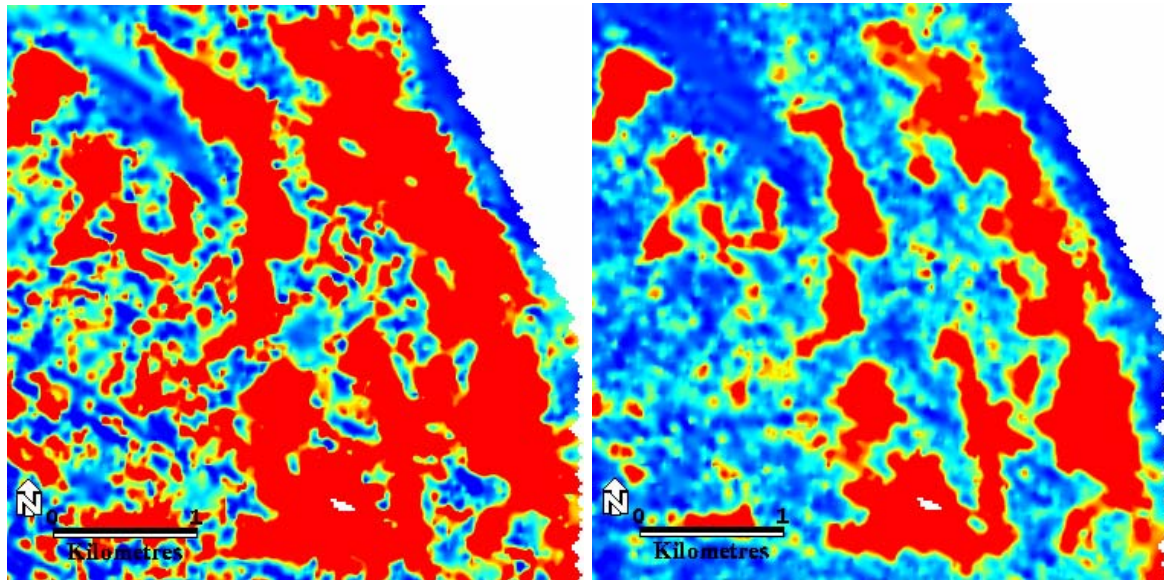

Figure 2: Initial (**left**) and borehole calibrated (**right**) CDI depth slices for 6-8 m over the Chris D area showing the regolith response.

Experimentation with processing to reduce noise and CDI input parameters helped to produce reliable CDI data that helped discover new, blind Mn resources having a present value of AU$500 million. This study demonstrates that time domain HEM is a cost-effective and stable method for the exploration of podiform, high-grade manganese ore bodies, as long as the host rocks are comparatively resistive. HEM processing routines developed from this study are already being applied elsewhere for exploration of other commodities, salinity mapping, and near-shore seabed mapping.