

## Curtin University 3rd year field geophysics students visit Abra mine site



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### Introduction

The Curtin University 3rd year field geophysics students carried out their field work experience at the Abra Mining site and



Fig. 1. Location of the Abra polymetallic base metal deposit in WA.



Fig. 2. Students and staff standing in front of truck carrying seismic equipment to Abra.

camp north of Meekatharra in WA, late August 2011 (Figure 1). The project was sponsored by Abra Mining Limited and supervised by Jayson Meyers, Christian Dupuis and Dominic Howman. There were 27 students from many different countries and six supervisors (Figure 2). The field work was a logistical challenge for getting so many people, so much equipment and a large amount of food and other supplies to and from a remote area in such a short time frame. All the Curtin students and staff returned safely and without any incidents.

### Abra geology and mineralisation

Abra is a sedimentary hosted, polymetallic base metal ore deposit system that was discovered in 1981 by drill testing a coincident, 'bull's eye' magnetic and gravity anomaly with no geochemical or outcrop evidence for mineralisation, and was later shown to have a well defined anomaly in fixed and moving loop time domain EM surveys (Vogt and Stumpf, 1987; Mutton and McInerney, 1987). The host rocks for the deposit are siliciclastic and carbonate deposits of the middle Proterozoic Edmund Group within the Bangemall Basin. The deposit sits within the Jilawarra sub-basin, which formed as part of the long-lived Capricorn Orogen between the Pilbara and Yilgarn cratons.

Drilling has confirmed that the top of the deposit sits below 250 m depth, where barite and iron oxide alteration zones of magnetite and hematite occur as stratiform, higher grade mineralised zones underlain by a lower grade stringer zone of feeder sulphide-quartz-carbonate veins that form within a funnel shaped envelope. The lower part of the stringer zone contains higher Cu-Au concentrations than the upper part of the deposit, which is enriched in Ba-Ag-Pb, and both zones also contain Zn. The deposit remains open in all directions, especially where the ore body continues to dip towards the south. Total indicated and inferred resource estimates for the deposit stand at 93 million tons at 4.0% lead and 10 g/t silver, and 14 million tons at 0.6% copper and 0.5 g/t gold. The deposit is currently sub-economic due to ore body depth, low metal grade and current metal prices.

There are many opinions about the style and origin of the deposit which range from deposition by seafloor hydrothermal processes during and shortly after sedimentation, MVT replacement of carbonate layers during formation of the sub-basin, a hybrid form of VHMS deposit, a hybrid end member of the IOGC style of deposits, or just a unique system that does not fall into any widely accepted category. The only major thermal

event that occurred around the time of basin formation and mineralisation was a regionally extensive tholiitic basalt and dolerite sill and dyke swarm complex at ca. 1.4 Ga (Piranjo, 2004). This event is similar in age to the timing of mineralisation at Abra, which suggests that ore formation is likely at least 40 to 290 Ma younger than the host rocks (Rasmussen *et al.*, 2010).

The genesis of the Abra deposit remains a mystery, as well as the geometry of the mineralisation in relation to major structures, crystalline basement, and extensions to mineralisation surrounding the known ore zones. A recent potential field inversion study by Curtin Masters student Daniel Eden showed that the magnetic expression at Abra can be explained by the known mineralised zone, but the gravity expression is a combination of the known mineralised zone and an underlying excess mass, possibly elevated basement rocks or additional mineralisation at depth.

### 3rd year students' field trip

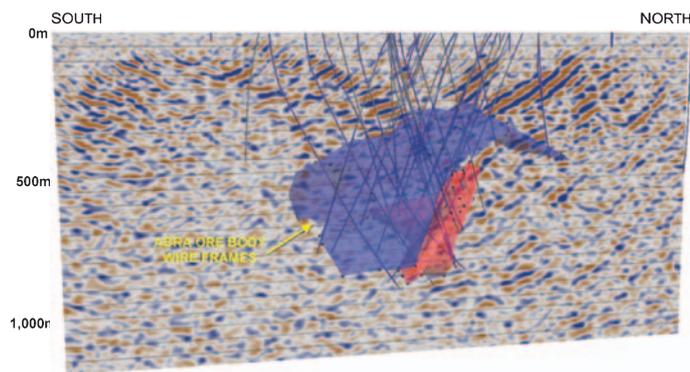
Abra and adjacent prospects provided the perfect location for students to try out magnetic, gravity and EM methods on actual mineralisation still in the ground. As an added bonus, the students, most of whom are heading into the petroleum industry, acquired a line of high resolution multi-channel seismic data



**Fig. 3.** Students examining diamond drill core before carrying out geophysical surveying.



**Fig. 4.** Curtin University's accelerated weight drop seismic source at Abra.



**Fig. 5.** Depth migrated seismic reflection profile across the Abra deposit with drillholes and ore body wire frames. No vertical exaggeration.

directly over the Abra deposit for the first time. The students carried out a literature review on Abra before heading to site, and on the first day at site they reviewed diamond drill core, following the usual safety and site inductions (Figure 3). The students visually saw the host rocks and ore+alteration minerals that were responsible for the geophysical anomalies.

Groups of students were cycled through different survey methods during each day, and were responsible for data download and QC during the evenings – as well as camp duties. Most hands were on the seismic data acquisition, where shots and geophones were spaced at 5 m intervals using a spread of 500 active channels, over a line that was 2.5 km long oriented in a N–S direction over the centre of the Abra deposit. An accelerated weight drop was used as a source (Figure 4), and several shots with low noise were recorded and stacked for each shotpoint. Shot and receiver locations were surveyed using a RTK DGPS system.

### Results

The results of the seismic reflection surveying are presented as a depth migrated profile in Figure 5. This image shows that the stratiform Abra mineralisation is seismically chaotic and transparent, probably due to brecciation and small scale folding within the ore zone, and patchy areas of low velocity lead sulphide. The surrounding unaltered sedimentary host rocks, mostly siltstone and sandstone, show up as bright, continuous reflectors. A series of apparently N-dipping faults are observed to offset the sedimentary reflectors in the northern part of the line. There is also a bright seismic event sitting just below the stringer zone at Abra, which is the red coloured ore zone in Figure 5. This reflection event may be a horst block of crystalline basement or it could be a zone of hydrothermal alteration/mineralisation. The reflective pattern in the middle and southern part of the line appears to show an overall synclinal fold to the south of the known ore body. The axis of this synclinal structure is seismically chaotic, and this seismic character may be related to a NNE-trending fault that crosses the seismic line at a low angle, producing a wide chaotic zone in the section. Due to time constraints, the students were unable to acquire an E–W seismic line across the deposit.

### Discussion

While all the seismic events in the profile are difficult to interpret, the data show encouraging results and promise for this type of surveying to provide useful information at mine scale to

depths in excess of 1 km. The ability to image seismic events and interpret complex layering and structure at Abra would be made much more reliable by carrying out 3D seismic acquisition and processing.

Another direction of geophysical surveying yet to be tried at Abra is passive electrical methods, such as AMT and MT. It is hoped that these methods will show deep zones of low resistivity corresponding to mineralisation that could be overlain on the seismic profile to follow extensions to the known mineralisation, highlight major structural features and identify deep targets.

The Abra deposit remains enigmatic and unmined. However, deep exploration targeting using innovative geophysical methods will reduce drilling risk in this environment. Work is ongoing at Abra to highlight new high grade ore zones and shallower ore bodies, and the Curtin students are fortunate to have gained experience by being part of this process.

### Acknowledgements

The 3rd year student field project would not have been possible without financial and logistical support from Abra Mining, and Dr Mingyan WANG and his staff are acknowledged for their support. Resource Potentials and Atlas Geophysics donated staff helpers and state of the art magnetic and gravity survey equipment to teach the students how to collect industry quality data. HiSeis supplied seismic acquisition equipment. Milovan Urosevic and his team carried out the seismic data processing at Curtin University.

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