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A new interpretation of Cambrian basement geology increases the prospectivity for Cu porphyries in western Victoria

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SUMMARY

Recent Geological Survey of Victoria work has confirmed the presence of the Miga Arc, a buried Andean-type Cambrian arc system in western Victoria.

Geophysical data sets, particularly magnetics and gravity, were interpreted to characterise the regional tectonic setting, and to gain a deeper understanding of poorly exposed bedrock of the southern Miga Arc, within the Geological Survey of Victoria's Willaura Cu Porphyry project area.

Geophysical interpretation and modelling, and field mapping of Cambrian bedrock has identified new regional Late Silurian dextral faults which are important in understanding the distribution of Miga Arc rocks in western Victoria. The updated bedrock interpretation together with new geochemical results has significantly expanded the potential exploration fairway for Cu porphyries in rocks associated with the buried Miga Arc.

Key words: Miga Arc; Mount Stavely Volcanic Complex; Lachlan; Delamerian; geophysical modelling; Cu porphyry; dextral strike-slip faults.

INTRODUCTION

The Delamerian-Lachlan boundary in western Victoria is mostly obscured by Murray Basin, Grampians Group and Newer Volcanics cover rocks. Twenty years of field mapping and university geochemical research (Foden *et al*, 2006) suggested the tectonic setting in western Victoria had been an Andean-type convergent margin during the Cambrian. A 2009 AUSCOPE deep seismic transect over western Victoria imaged crustal geometry consistent with an ancient subduction zone; a distinct, largely intact igneous edifice buried at shallow to deep levels beneath Late Cambrian Nargoon Group metasediments. This has been named the Miga Arc. Connectivity between large buried parts of the Miga Arc and intermediate metavolcanics contained within fault slices exposed at the surface (Mount Stavely Volcanic Complex) has been established. Southeast of the Grampians the Stavely and Dryden Belts are interpreted as fault slices of Miga Arc (Buckland, 1987; Scheibner, 1985; Crawford, 1988; Cayley & Taylor, 2001; Foden *et al*, 2006), as are some fault slices linking the Stavely and Dryden Belts (eg. Mount Elliot; Cayley & Taylor, 2001).

Andean-type subduction zones are prospective for copper porphyry systems. The Stavely Belt of Cambrian volcanics south of the Grampians contains some poorly explored prospects identified in the 1980's and 1990's, but the lack of a regional tectonic setting and sub-economic grade in limited, relatively shallow drilling meant these were not fully tested. The recently proposed Andean tectonic setting for western Victoria has given new incentive to re-evaluate the Stavely Belt region and extend the prospectivity fairway under areas of cover. The Geological Survey of Victoria (GSV) carried out a targeted mapping project centred on the Stavely Belt, the Willaura Cu Porphyry project (Figure 1).

Geophysical data sets over the project area were interpreted to gain a deeper understanding of the structural setting of Cambrian basement rocks in the context of an arc system. Filtering of data and image enhancement techniques brought out subtle features enabling the interpretation of structures not identified in previous mapping. A newly recognised fault slice of arc volcanics was defined to the west of the Stavely Belt beneath Newer Volcanics cover, named the Bunnugal Belt. Modelling of potential field data has provided information on the geometries of Miga Arc volcanics, and associated intrusives.

Together with new geochemical results (GSV/GA, in prep.) the new geophysical basement interpretation has significantly expanded the exploration fairway for mineralised porphyries under areas of cover, and away from the belts of magnetic volcanics.

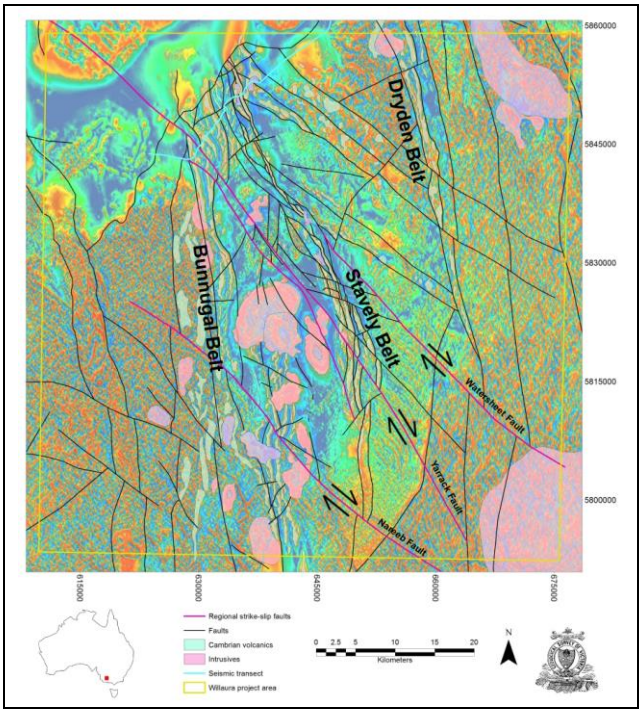

Figure 1. TMI (tilt filter) image of the project area showing the locations of volcanic belts and the distribution of Cambrian volcanics, intrusives and faults.

METHOD AND RESULTS

The limited amount of basement outcrop in the project area, and the often poor quality of exposure where it occurs has meant geological mapping in the area has been challenging, and the geological interpretation was heavily reliant on geophysical data.

Geophysical data

Geophysical data sets that were available for this study included regional government airborne magnetic and radiometric data (100-200m line spacing), gravity data and the 2009 AUSCOPE Delamerian Deep Seismic Transect (Cayley et al, 2011). Other data that were utilized included open file company data (QUESTEM, magnetics), borehole logs and SRTM data. Petrophysical properties were obtained from GSV's database, direct measurements of core from the project area by the Australian Geophysical Observing System (AGOS), and literature.

To gain the maximum information from the potential field data, various filters were applied, and visualisation enhancements were made, allowing a detailed interpretation of Cambrian bedrock. Particularly useful were the Analytic Signal and Tilt filters for TMI data (Figure 1), and high pass filters for gravity data (Figure 2). Potential field data were modelled to gain further understanding of geometries, structures and stratigraphic relationships with depth.

Geological interpretation

An updated Cambrian basement interpretation for the Willaura Cu Porphyry project area has been produced. It identified late regional structures that are important in understanding the distribution of Miga Arc rocks within the whole of the Stavely Zone, and recognised that the obscured belt of volcanics west of the Stavely Belt is probably another fault slice of Miga Arc rocks, here named the Bunnugal Belt. Results of recent field mapping during the current project identified regions of strike rotation of up to 90° in Nargoon Group metasediments north of the Bushy Creek granodiorite. This region of metasediment deformation lies between the Stavely and Bunnugal Belts, along a NW trend linking areas where the belts of magnetic volcanics have been offset dextrally, and along which magnetic intrusives have been truncated and displaced. The rotation in strike was interpreted as fault drag related to a regional strike-slip fault network identified in potential field data, the Yarrack Fault (Figures 1 and 2). Another regional NW trending dextral fault, the Nareeb Fault, was identified in potential field data in the southern half of the project area. A large 300m long dextral strike-slip fault melange was also recognised in field mapping east of the Stavely Belt within Cambrian metasediments of the Glenthompson Sandstone (Nargoon Group), the Watersheet Fault. These types of structures have previously been mapped in Late Ordovician to Early Devonian Grampians Group cover rocks (Cayley & Taylor, 1997; Morand *et al*, 2003), but equivalents were not recognised in underlying Cambrian basement until now.

Other results included:

- The extension of the Stavely Belt to the south beneath cover (confirmed by recent GSV/GA drilling, in prep.)
- New linking thrust faults interpreted between the Stavely and Dryden Belts.
- New intrusives interpreted under cover.

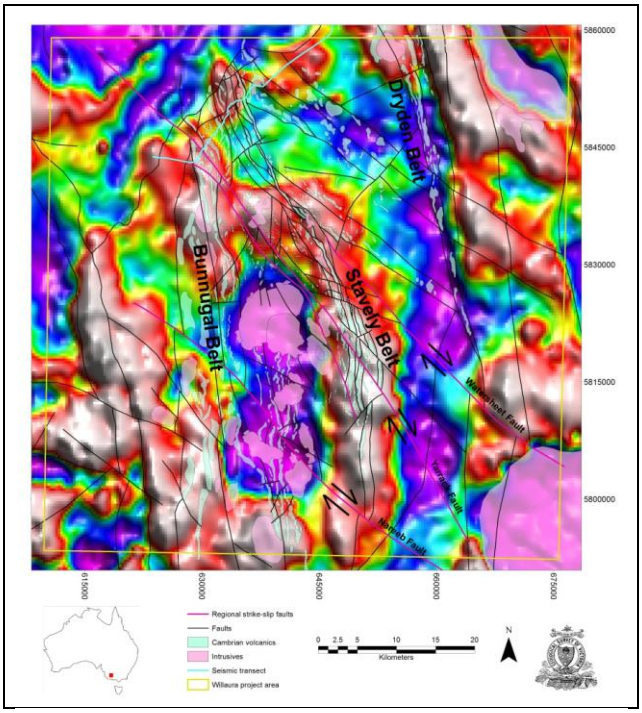

Figure 2. Bouguer gravity (30km high pass filter) image of the project area showing the distribution of Cambrian volcanics, intrusives and faults.

Recent geochemical analysis by GSV/GA combined with previous university work has shown the later intruding Cambrian porphyries are not just restricted to the belts of Mount Stavely Volcanics but also occur throughout the Stavely Zone, and were emplaced into the already faulted and tilted

volcanic fault slices and metasediments. These intrusives are interpreted as the last "gasp" of magmatism associated with the arc, and in places have been dissected by the later strike-slip faults (eg. Buckeran Diorite).

CONCLUSIONS

The exploration fairway for Cu porphyries in western Victoria's Stavely Zone has been significantly expanded by the results of GSV's Willaura Cu Porphyry mapping project. Regional dextral shear zones identified in Cambrian bedrock for the first time in Willaura have enabled the interpretation of similar structures evident in magnetic data northwest of the Grampians, where they have segmented continuous packages of volcanic rocks into off-set slivers (Tyar, Black Range and Glenisla belts). All these belts are now considered prospective. These structures also provide a potential linking mechanism between belts of the Mount Stavely Volcanic Complex south of the Grampians with those to the northwest. The Bunnugal Belt, a belt of previously interpreted mafic/ultramafic volcanics beneath Newer Volcanics cover west of the Stavely Belt is now interpreted as another fault slice of Miga Arc rocks and is considered prospective for Cu porphyries.

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