The NSW Thomson Orogen Project: New Frontiers in Exploration

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Introduction

The Early Palaeozoic NSW Thomson Orogen is covered by a shallow blanket of Cretaceous Eromanga Basin. The orogen has untested potential for orogenic gold, arc-related polymetallic, and MVT base metal deposits. CRC LEME, in conjunction Geological Survey of NSW and Geoscience Australia, is conducting a multi-disciplinary study including regolith mapping and baseline geochemistry to help reduce risk for mineral exploration in this greenfields province.

Background and aims of the project

There has long been an awareness of the potential of the Thomson Orogen as a new metallogenic province. With the focus of the Geological Survey of NSW (GSNSW) now shifting to new frontiers and new provinces for mineral exploration, the opportunity has arisen to consolidate existing knowledge and collect new data to help better understand the Thomson Orogen, with the aim of opening up new opportunities for mineral explorers.

In conjunction with the GSNSW and Geoscience Australia, the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRCLEME) has undertaken a three year project (2005-2008) to provide regolith and baseline geochemistry coverage across the Thomson Orogen in NSW.

What and where is the Thomson Orogen?

The Thomson Orogen is one of the most poorly understood orogenic belts in Australia. It covers a vast area, mostly throughout south-central Queensland, but extends into northwestern NSW (Fig. 1). Named by Kirkegaard (1974) after the Thomson River in central Queensland, it is part of the greater Tasmanides of eastern Australia. New geochronology data suggest the Thomson Orogen has undergone a history distinct to the Lachlan Orogen (Draper, 2005). Neoproterozoic to Middle Cambrian sedimentation and ~ 500 Ma deformation recognized in the Thomson Orogen is more akin to the Kanmantoo and Adelaide fold belts. A felsic magmatic/volcanic event at ~470 Ma that is not recognized in the Lachlan Orogen, as well as an abrupt change in structural grain at the contact between the orogens suggests some differences in their early Palaeozoic histories (Draper, 2005). The orogens share a similar post-Middle Devonian history, with deformed orogenic rocks unconformably overlain by epicratonic Late Devonian infrabasins. The Thomson

Orogen is in turn overlain by the Permian Cooper Basin and Mesozoic Great Australian Basin (which incorporates the Eromanga Basin).

The NSW Thomson Orogen Project area

The NSW portion of the orogen incorporates the entire southern margin with boundaries against the Delamerian and Lachlan orogens (Fig. 1). The exact boundary of the orogen is unclear and is interpreted from gravity and magnetic signatures, and thus the project area incorporates a buffer zone that takes in the Thomson Orogen margin and parts of the Lachlan and Delamerian orogens (Fig. 1). The area of interest for this project covers eleven 1:250 000 sheets: the entire Urisino, Yantabulla, Enngonia, Bourke, Louth, and White Cliffs sheets; and parts of the Milparinka, Cobham Lake, Walgett and Angeldool sheets.

Based on drilling and seismic data, the depth to pre-Mesozoic basement below sea level in the project area shallows irregularly from approximately 1050m in the northwestern corner to zero at basement exposures along the southern margin. For the majority of the project area, the interpreted depth to basement is a maximum of 250m (Packham and Jovenski, 2001).

Metallogenic Potential of the project area

In terms of the metallogeny of the project area, gold endowed Late Cambrian inliers exposed in the west of the project area (Tibooburra area) suggest that there is potential for orogenic gold mineralization. Limited drilling has revealed quartz veining in altered metasediments throughout the NSW Thomson Orogen, including sulfide mineralization associated with quartz veining in deformed phyllites on the Urisino 1:250 000 sheet.

The presence of basalts (with ocean island chemistry) and serpentinites in the project area (Louth Volcanics) suggest that the orogen has the potential to host arc and ocean-crust related gold and base metal deposits. Gold-base metal deposits around Mt Dijou, south of Bourke, and tin deposits associated with the Triassic Doradilla Granite are also within the interpreted Thomson Orogen boundary.

Project Methods

A prime objective of the project is to provide baseline geochemical coverage across the region. However, since the orogen is predominately covered by Mesozoic and younger sediments, it is essential to understand how basement mineralization may be geochemically expressed through this cover. To this end, the project is divided into three related modules:

a) Regolith landscape evolution

This research aspect, led by the CRCLEME team at the University of Adelaide, in conjunction with CRCLEME, attempts to shed light on the 3D landscape and morphotectonic evolution of the Mesozoic to Cainozoic cover rocks and regolith. To date, research has concentrated on the Tibooburra area because of the quality of basement and Mesozoic outcrops and the availability of known orogenic gold

occurrences. This work provides a test bed for our knowledge of the regolith and geochemical responses throughout the Thomson Orogen.

b) Regolith mapping

Drawing on the more detailed mapping and research from the University of Adelaide and in-house expertise, GSNSW has developed a rapid, desktop-based regolith mapping technique that is being applied to the Thomson Orogen. The maps not only provide concise transport and compositional information, but also infer the provenance of the regolith materials, and therefore indicate a weighted likelihood of basement signature at the surface.

c) Baseline geochemistry

The low-density geochemical survey team is based out of Geoscience Australia in Canberra, working in conjunction with CRCLEME, and applies the methodology recently developed and tested in the Riverina region (Caritat *et al*., 2005) and elsewhere. Sampling locations for the Thomson survey are guided by defining and prioritizing catchments across the project area. The main medium used for the survey is overbank sediments, taking a near-surface (0-10cm depth) and B-C horizon samples (10cm interval at ~60-90cm depth) from near the outlets or spill points in each catchment. This provides a well-sorted, fine-grained material broadly representative of major rock types outcropping or subcropping in the catchment, from a consistent sample medium.

Biogeochemical samples have also been collected at or near the overbank sample localities from a variety of plant communities including Black Box, Coolibah, Bimble Box and River Red Gum.

MMI Technologies, based out of Perth, have also kindly provided to prepare and analyse (through ALS Chemex) 100 free samples using their partial leaching technique. Using this technique, loosely-bound mobile metal ions (MMI) are separated and analysed from a near-surface soil sample (10-25cm depth), providing a window into possible metal sources at depth. It is thought that a combination of convection, capillary rise and evaporation (plus other possible mechanisms) causes upward migration of mobile metal ions from a metal-rich source such as an orebody, which result in a near-surface soil anomaly of loosely bound metal ions directly above the metal source (Mann *et al.*, 2005). This is the first time the MMI technique has been used in conjunction with a regional baseline geochemical survey, and the results should provide not just a test of comparability between the concentrations and distribution patterns obtained from the analysis of overbank sediments, plants and loosely bound metals, but also a better understanding of element sources, sinks and mobility in the project area and a regional context for more detailed future geochemical surveys.

Results and projected outputs

To date, the project has produced:

- Four research papers on the Tibooburra area (Davey and Hill, 2005; Gibbons and Hill, 2005; Hill *et al.*, 2005; Hill, 2005)
- One 1:25 000 regolith landform map (Mt Browne and Mt Poole inliers, in Davey, 2005)

- Two honours theses (Davey, 2005; Gibbons, 2005)
- Four 1:100 000 regolith provenance sheets (Tibooburra, Olive Downs, Milparinka, Yantara). These sheets have been submitted to cartography, and preliminary versions will soon be publicly available
- Collection and field portable XRF analysis of overbank samples from 76 catchment sites across the Thomson Orogen, plus about 80 gold and 40 fluorine analyses (standard XRF and ICPMS analyses are in progress at Geoscience Australia and ALS Chemex). Further sampling will be conducted in October 2006.

In the next two years, the outputs of the project will include:

- Two 1:25 000 regolith maps (New Bendigo Inlier, Warratta Inlier)
- At least two more honours theses
- GIS digital database release as DVD- including all geological, geochemical, geophysical and cadastral data available from the NSW Thomson Orogen, including all relevant reports and papers
- Explorers Guide- a practical guide to exploration techniques in the Thomson Orogen and far-western NSW.

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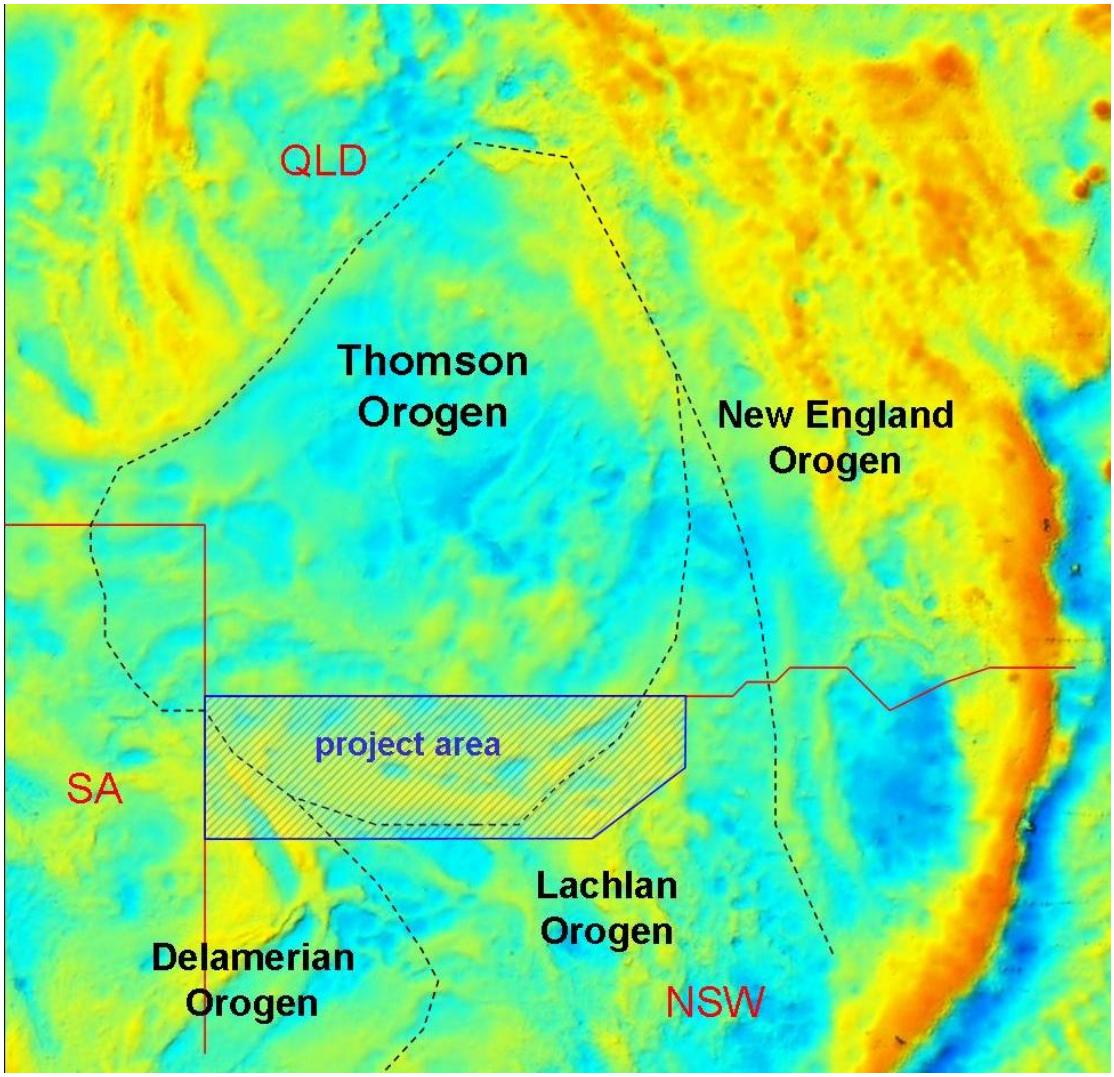

Figure 1. Locality diagram (superimposed on gravity image), showing the project area (shaded box) within the context of major orogen boundaries of eastern Australia (dashed lines), and state borders (lines). Note that state borders and orogen boundaries are approximate only.