THE THOMSON OROGEN PROJECT – A WORK IN PROGRESS

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SUMMARY
The Thomson Orogen, which underlies sediments of the Great Australian Basin in northwest New South Wales, is the last major greenfields terrain in NSW. The Orogen has potential for magmatic arc and ocean-crust related gold and base metal deposits. However, the basin cover presents a significant impediment to exploration. The Thomson Orogen Project aims to develop an effective means of exploring through this cover.

A multi-disciplinary approach to achieving this objective has resulted in new geological, geophysical and geochemical datasets being acquired. These datasets include high resolution magnetics and radiometrics and the results of overbank sediment, lag and plant sampling. A number of interpretative products including regolith maps and a depth-to-basement map have also been generated.

BACKGROUND AND AIMS OF THE PROJECT
In July 2005, CRC LEME, in collaboration with the New South Wales Department of Primary Industries (NSW DPI) and Geoscience Australia (GA), established the Thomson Orogen project. This three year (2005–2008) project has the primary objective of improving prospectivity in the Thomson Orogen, a poorly known and poorly explored terrain, by developing an effective means of exploring through the cover. This project forms part of the 'New Frontiers' initiative by NSW DPI and includes regional mapping, seismic, drilling, gas geochemistry and airborne geophysics.

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 (Figure 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 recognised 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 recognised 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 (Figure 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 (Figure 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 Angledool sheets.

The depth to pre-Mesozoic basement in the project area, based on drilling and seismic data, varies from approximately 1050 m in the northwestern corner to 0 m at basement exposures along the southern margin. Over most of the project area, the interpreted depth to basement is less than 250 m (Packham & Jovenski 2001). However, recent interpolation of drillhole data indicates approximately 60% of the orogen is covered by less than 300 m of cover.

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 mineralisation. Limited drilling has revealed quartz veining in altered metasedimentary rocks throughout the NSW Thomson Orogen, including sulfide mineralisation 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 also 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

The CRC LEME project has three main components.

1. Low-density geochemical surveys employing overbank sediment, lag and vegetation samples. Samples are being analysed using a number of techniques, e.g. Mobile Metal Ion (MMI) partial leach, X-Ray Fluorescence (XRF), Inductively-Coupled Plasma-Mass Spectrometry (ICP-MS) and NITON portable XRF).
2. Regional regolith mapping providing a basis for interpretation of surface and near-surface material influencing geochemical results.
3. Detailed regolith mapping and geochemical studies aiming at providing more accurate regional regolith maps by generating a better understanding of post-Palaeozoic landscape evolution and its influence on geochemistry.

Low-density geochemical surveys

The low-density geochemical survey team led by the CRC LEME team at Geoscience Australia is applying the methodology recently developed and tested in the Riverina region (Caritat *et al.* 2005) and elsewhere. Sampling locations for the Thomson survey were established by defining and prioritising catchments across the project area. The main medium used for the survey is overbank sediments, with samples being taken from the near-surface (0–10 cm depth) and B–C horizon (10 cm interval at ~60–90 cm depth) at or near the outlets or spill points in each catchment. This methodology generates consistent samples of well-sorted, fine-grained sediment broadly representative of major rock types outcropping or sub-cropping in the catchment. These samples have been sieved and the <80 micron fraction is being analysed for major and trace elements (60+ elements) using XRF, ISE (ion specific electrode) and ICP-MS. Whilst in the field the samples of over bank sediment were also subjected to XRF analysis using a NITON.

In addition, MMI Technologies, based out of Perth, has analysed (through ALS Chemex) the overbank sediment samples using their partial leaching technique. Using this technique, loosely-bound mobile metal ions are separated and analysed from a near-surface soil sample (10-25 cm depth), providing an insight 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 results 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.

Biogeochemical samples were collected at or near the overbank sample localities from a variety of plants including black box, coolibah, bimble box and river red gum. Those samples are being analysed for 37 Major and minor elements.

Regional regolith mapping

A rapid, desktop-based regolith mapping technique has been developed by NSW DPI staff in the Project and is being applied to the entire Project area. Principal datasets include ASTER, Landsat TM, SPOT5, DEM, radiometrics, magnetics and inferred depth-to-basement. The resultant maps not only provide information about the composition of regolith materials but also support inference about the provenance of those materials and depth to basement, facilitating calculations about the likelihood of basement signatures being expressed at the surface.

Regolith landscape evolution
This aspect of the research, led by the CRC LEME team at The University of Adelaide, attempts to shed light the post Palaeozoic evolution of the landscape and the regolith in the Thomson Orogen region. Research to date has concentrated on the Tibooburra area because orogenic gold is known to occur in the area and neotectonic activity and the subsequent dissection of the landscape has resulted in good exposures of Mesozoic and younger sediments. This work provides a test bed for ideas about geochemical dispersion throughout the Thomson Orogen.

PROJECT OUTPUTS TO DATE

To date, the project has produced:

- Two honours theses (Davey 2005, Gibbons 2005);
- Five research papers on the Tibooburra area (Davey & Hill 2005, Gibbons & Hill 2005, Hill *et al.* 2005, Hill 2005, Greenfield & Reid 2006);
- One 1:25 000 regolith landform map (Mt Browne and Mt Poole inliers, in Davey 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); and,
- Abundant analyses and samples, including overbank samples and field portable XRF analyses from 76 catchment sites across the Thomson Orogen and about 80 gold and 40 fluorine analyses. Standard XRF and ICP-MS 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;
- A 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; and
- The Explorers' Guide – a practical guide to exploration techniques in the Thomson Orogen and far-western NSW.

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