Regolith Science in Mineral Exploration

December 2006 Edition No 12





The future of Australian regolith science

Regolith science is a relatively emerging science that LEME has been engaged in through its research and training programs – much to the benefit of the mineral exploration industry.

However, the Centre and its fully focused regolith science programs will cease to exist after 30 June 2008. The demise of LEME has raised concerns about what organisation(s) will continue the development of regolith science research in Australia.

To address this issue, the Centre has appointed a special taskforce chaired by CEO, Dr Steve Rogers. This taskforce will soon be seeking input from its existing and potential end users and will shortly send out a letter for comment. For more information,

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LEME lecture examines gold nugget origin



One of the bigger specimens on display at the LEME gold nugget lecture.

Controversies have long raged over the origin of gold nuggets. However, new research by Dr Rob Hough and Dr Charles Butt (CSIRO Exploration and Mining) has revealed that gold nuggets are mineralisation relics left in the weathering profile through prolonged erosion and weathering of the surrounding rocks.

Dr Hough, who presented a lecture in early October to celebrate Earth Science Week, showed through a series of photos, how his research has uncovered tantalising hints about the gold nugget formation process. "When a gold nugget is sliced and put under the microscope, you can see random interlocking gold crystals, – this observation was unexpected," Dr Hough said.

"Elemental analysis of many nuggets has also shown they have impure interiors containing significant silver."

These observations suggest gold nuggets are primary in origin, having formed in environments below the earth at elevated temperatures – conditions very different to those found near the surface.

As geological time progresses, the nuggets are released from their host rocks through weathering, where they become subjected to processes active in the regolith. In this setting, silver is preferentially leached out from the nugget's surface and along gold grain boundaries. These gain boundaries often develop into the cracks commonly seen in nuggets.

"Once in the regolith, precipitation of purer gold occurs on the surface of the nuggets. Recent work has shown that bacterial activity may also play a role here," Dr Hough said.

"We know what types of processes are most likely involved but more research needs to be done on these precious objects if we want to determine the conditions of their formation and how they relate to larger gold deposits."

At the end of the lecture, and much to the audiences' delight, Dr Hough passed around a huge nugget while answering questions about his research. After question time, a group of avid prospectors came forward and sought his opinion on their prized nugget specimens.

2006 LEME Regolith Symposium

Departing from the previous tradition of holding separate symposia at LEME's three nodes in Perth, Adelaide and Canberra, a combined Regolith Symposium was held at the Hahndorf Resort, South Australia, during November 2006.

For four days, staff and students delivered more than 90 presentations that showcased the Centre's latest regolith research covering a wide range of topics from biogeochemistry to hyperspectral analysis.

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Some mineral exploration research highlights from the 2006 Regolith Symposium included:

Seismic survey trial shows promise at the Beverley Uranium Mine



Trial seismic data identifies a target paleochannel at the Beverley mine.

Led by Dr Jayson Meyers, students from the Department of Exploration Geophysics at Curtin University are one step closer in realising the potential of seismic reflection surveys as a uranium exploration tool following a trial survey at the Beverley Mine, South Australia.

Extensive processing of data acquired from three, high-resolution lines shot over areas near the mine where paleosurface geometry and mineralisation are accurately known, resulted in geologically interpretable stacked seismic sections.

Survey results have shown that seismic reflection has the potential to become a new exploration tool in the region. However, work still needs to be done to generate higher enough signal strengths and frequencies to penetrate and resolve layering at and below target depth.

Contact: jayson.meyers@geophy.curtin.edu.au

Nickel accumulator plants identified at Bulong

A recent biochemistry sampling program near the Bulong Nickel Mine by Curtin University's Department of Applied Geology PhD student Siriporn Soongpankhao has identified native plant species containing relatively high accumulations of nickel and cobalt in twigs and leaves.

A vegetation sampling program over known mineralisation adjacent to the Bulong Mine, located 35km east of Kalgoorlie, Western Australia, revealed that plant species, Hybanthus floribundus, Casuarina pauper and the more common eucalyptus family contained anomalously high levels of nickel and cobalt - some samples returned concentrations around 900ppm nickel and 141ppm cobalt. Siriporn's study has shown that Hybanthus floribundus, a known nickel accumulator, had an extremely high uptake of nickel, in the order of 40 times that of the surrounding soil concentrations. Her preliminary research has also found no correlation between nickel and cobalt values in the plants sampled and adjacent soil. Contact: siriporn.soongpankhao@ postgrad.curtin.edu.au



Hybanthus floribundus, a known nickel accumulator, shows positive results over the Bulong nickel mineralisation.

Uranium mineralisation expressed in South Australian plant biogeochemistry

A range of plant species sampled by LEME PhD student Michael Neimanis (The University of Adelaide) has successfully expressed uranium mineralisation over known deposits in the South Australian Curnamona Province.

In early 2006, a selection of native plant species were sampled over the known Gould's Dam, Armchair, Radium Ridge, Streitberg, Gunsight, No. 6 Mine and Four Mile Creek uranium prospects. These sites were chosen because they represented a range of uranium mineralisation styles found in the region.

Uranium concentrations, and associated pathfinders, varied from site to site and species to species, with the highest level of uranium recorded (6.59 ppm) occurring in Eucalyptus gillii (Curly Mallee), at Radium Ridge. These preliminary findings show there is significant justification to further investigate uranium mineralisation-biogeochemical associations with other mineralisation styles not covered by this study.

Michael plans to focus his work on sampling River Red Gums and the Inland Tea-Tree, with a particular interest in determining which plant organs store the most uranium.

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Experiments suggest gold was more mobile in the geological past

Solubility and microcosm experiments carried out by LEME at Australian National University's Department of Earth and Marine Science and CSIRO Land and Water suggest gold may have been more mobile in the ground and pore water in the geological past.

Native gold solubility experiments suggest that groundwater, especially brines, can contain up to 10 ppb dissolved gold, much higher than currently observed in groundwater. Bacterial microcosm experiments show that up to 100 ppb gold can be mobilised from gold-bearing soils, indicating that gold is very reactive at local scales in pore water of regolith, especially soil. However, given the low levels of gold detected in groundwater so far, it appears that gold is not transported far from its source. It is possible that gold was mobilised and transported further in the geological past, for example, during deep weathering episodes reflected in regolith in some parts of Australia.

LEME senior ANU researcher Dr D.C. 'Bear' McPhail said his collaborative research in this area with Alistair Usher (ANU) and Dr Frank Reith (CSIRO/ANU) suggest that other processes such as adsorption on mineral surfaces and/or organic material could limit gold's mobility.

"Due to the low levels of aqueous and colloidal gold concentrations observed in natural environments, the exact reasons why its mobility appears to be restricted by current environmental conditions need to be determined by further research," Dr McPhail said.

"These findings have implications for mineral explorers, as knowing the solubility of native gold helps to interpret measured gold concentrations in groundwater for hydrogeochemical exploration."

Knowing the thermodynamic properties of goldbearing reactions under regolith conditions can allow for more reliable modelling of gold transport during weathering.

"If gold was more mobile in the geological past, such as during deep weathering episodes, then this work could help focus exploration in weathered terrains, covered or otherwise," Dr MacPhail said.

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Copies of Regolith 2006, Consolidation and Dispersion of Ideas - Proceedings of the CRC LEME Regolith Symposium can be purchased from LEME head office for \$55 including GST.

LEME Murrin Murrin nickel laterite study now available

A comprehensive study carried out by LEME researchers on the Western Australian Murrin Murrin Nickel Laterite Deposit is now available.

The study, entitled Geology, Geochemistry and Mineralogy of the Murrin Murrin Nickel Laterite Deposit (Open File Report 207), is a regional and deposit-scale examination of the regolith characteristics and factors that controlled nickel and cobalt enrichment within the deposit.

The report includes a 1:50,000-scale regolith map created by the integration of aerial photography and magnetic, radiometric and Landsat TM imagery.

Regolith characteristics of the nickel-laterite studies at two deposits were modelled using Mining Visualisation Software. Mass balance studies and CIPW-Norm mineral abundances were also undertaken.

The report's deposit-scale studies have shown that mineralisation is strongly controlled by lithology at one site, whereas strong structural overprinting of underlying ortho and mesocumulates has influenced mineralisation at the other site.

The report is a valuable description of a poorly documented style of nickel laterite deposit.

The 93-page report and data CD-ROM can be purchased in hard copy form for \$42.00 plus postage and packaging, or downloaded as a PDF from: http://www.crcleme.org.au



The Murrin Murrin Nickel Mine, Western Australia.

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LEME Technology Transfer Upcoming presentations/courses 2006-07:

- 13-15 December 2006. 9th Australasian Environmental Isotope Conference and 2nd Australasian Hydrogeology Research Conference, Adelaide, SA
- 12-13 February 2007. Austmine 2007, Burswood Entertainment Complex, Perth, WA
- 19-23 February 2007. Regolith Geology and Geochemistry (Honours/MSc course), Wilsons Promontory, Vic
- 12-23 March 2007. Regolith Geology and Mineral Exploration (MSc course)
- 19-23 March 2007. Regolith Mapping and Field Techniques (honours/MSc course), Fowlers Gap via Broken Hill, NSW
- 26-30 March 2007. Introduction to Hydrogeochemistry (honours/MSc course), University of Melbourne, Vic
- 26-29 March 2007. 7th AMIRA Biennial Exploration Managers Conference, Barossa Valley, SA
- 16-18 May 2007. CRC Association 12th Annual Conference 2007, Perth Convention Centre, Perth, WA
- 14-19 June 2007. 23rd International Applied Geochemistry Symposium, Oviedo, Spain
- 28 July-3 August 2007. XVII Inqua Congress 2007, Cairns Convention Centre, Qld
- 19-24 August 2007. Goldschmidt 2007, Cologne, Germany Sept 2007. KALGOORLIE '07, Kalgoorlie, WA

Further information about CRC LEME regolith courses can be found here: http://crcleme.org.au/Educ/MTECcourses.html

Recent Publications

(Available via our website http://crcleme.org.au)

- Open File Report 203 Regolith studies at the Boomerang Gold Prospect, Central Gawler Craton, South Australia
- Open File Report 207 Geology, geochemistry and mineralogy of the Murrin Murrin Nickel Laterite Deposit
- CRC LEME 2005-06 Annual Report (Downloadable from http://crcleme.org.au/Pubs/annualreports.html)
- Regolith 2006, Consolidation and Dispersion of Ideas. Proceedings of the CRC LEME Regolith Symposium, November 2006

Past issues of the Minerals Brief can be downloaded from:

http://crcleme.org.au/Pubs/index.html

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CRC LEME is the cooperative research centre for regolith geoscience with some 130 contributing researchers from eight Core Parties around Australia. We generate and apply regolith knowledge for mineral exploration and environmental



Cooperative Research Centre for Landscape Environments & Mineral Exploration