Cooperative Research Centre for Landscape Environments and Mineral Exploration

CRC LEME Minerals Brief

Regolith Science in Mineral Exploration

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FROM THE CEO

Dear Mineral Explorer

This edition of *Minerals Brief* draws upon the presentations given at the recent LEME-GSWA sponsored Kalgoorlie MINEX seminar. It reports some new work, as well updating previously reported projects. Abstracts of the 26 presentations are now on the website - http://crcleme.org.au/NewsEvents/Events/seminars.html

One of the many highlights of that seminar was the announcement of some preliminary results of a new geochemical prospecting technique. For the first time we have a glimmer of a technique that reads surface geochemical signatures of mineralisation concealed under 20 metres of transported regolith (eg hardpan), where no other technique works. Further details of the significant discovery will be released over the ensuing months. Another highlight was the address entitled *Fifty Years of Geochemical Exploration* by Butt-Smith Medallist Dr Richard Mazzucchelli. He will be repeating that commemorative address at a forthcoming SMEDG meeting, and IGES in Perth.

R Dennis Gee ***Chief Executive Officer*** ***dennis.gee@csiro.au***

REGIONAL STUDIES

Curnamona Province

At the White Dam Cu-Au deposit, 30 km N of Olary, Aaron Brown (Adelaide University) is using detailed regolith landform mapping (1:25 000 scale) to provide a framework for improved ranking of calcrete anomalies. Although low outcrop occurs south of the deposit,

the deposit itself occurs under sheetflow deposits and alluvial channels in which calcrete is irregularly developed. By integrating landscape knowledge and calcrete geochemistry, calcrete anomalism in depositional areas can be regarded as less significant than those in erosional landforms. aaron.brown@adelaide.edu.au

Patrice de Caritat (GA) and Dirk Kirste (ANU) used analysis from 350 groundwater samples from the Curnamona Province to evaluate groundwater sampling as an for exploration tool in areas of deep cover. A number of samples with sulfate contents in excess of the amount expected from simple rainwater evaporation or mixing, together with low $\delta^{34}S$ compositions, could have been derived by oxidation of sulfides. Elevated Cu, Pb and Zn in some of the waters are also present. Because some of these waters are from deep sedimentary cover, hydrogeochemistry is a useful tool in regional exploration in areas of cover. patrice.decaritat@ga.gov.au

Gawler Craton

Sampling of 94 groundwaters from Tunkillia region of the Gawler Craton by David Gray and Mark Pirlo (CSIRO EM) reveal salinities close to or slightly below that of sea water. Although Na, Cl, Br and SO_4^{2-} contents are as expected for their salinities, Ca and Sr contents are enriched and K contents depleted, especially at higher pH. These features indicate breakdown of feldspar to form secondary clay minerals. Tunkillia salinities are more uniform than those of the Yilgarn Craton and may reflect very old waters with little flow and density-driven movement. The Eh of samples may be high, especially in the mineralised Area 223 where pH values are neutral, implying high O_2 fugacity. Gold contents are low, whereas in Area 191, with moderate Eh, Au contents are high. Thus Eh affects Au dissolution processes at Tunkillia in a different way to those in the Yilgarn Craton. david.gray@csiro.au

HEAVY MINERALS

Baohong Hou (PIRSA), in association with colleagues from PIRSA and Adelaide University, unravelled the complex dune stratigraphy, and studied sediments from the Ooldea Range (a massive Eocene barrier dune complex in the Maralinga Embayment of the Eucla Basin, South Australia). Several cycles of marine transgression define where heavy mineral sands would expect to accumulate. These predictions have been verified by the recent discovery of the Jacinth Deposit by Iluka Resources Limited. hou.baohong@saugov.sa.gov.au

Mark Paine (CUT) has completed his PhD study of the Bondi Main heavy mineral sand deposit in the Murray Basin of western Victoria. His palaeogeographic and stratigraphic models are important in recognising where heavy minerals are likely to be trapped so that the number of potential heavy mineral-bearing units in an area can be established. The use of an Automatic Geological Scanning Electron Microscope (AutoGeoSEM) enabled rapid and objective determination of the component heavy minerals in profiles. Specifically, weathering overprints pisoliths, nodules and hardened mottles contributed significantly to the heavy mineral suite and swash zone sediments contain the greater proportions of the more valuable minerals as well as the higher quantities of heavy minerals.
m.paine@exchange.curtin.edu.au

HYPERSPECTRAL STUDIES

Tom Cudahy (CSIRO EM) and a team from LEME, Geological Survey of WA, Placer Dome and HyVista Corporation have mapped the distribution of alteration and regolith minerals recorded in 26 HyVista flight lines on the Kalgoorlie-Kanowna 1:100 000 mapsheet. They produced maps of features like kaolinite abundance and crystallinity, iron oxide types and abundances, and mica compositions and abundances. Kaolinite crystallinity effectively separates erosional from depositional areas, whereas mica compositions readily define areas of K-rich alteration within weathered mafic rocks. thomas.cudahy@csiro.au

Alan Mauger and John Keeling (PIRSA) are using data generated by the CSIRO HyLogger spectral core scanner to investigate the relationship between Au distribution, hydrothermal alteration and weathering at the Perseverance Gold Deposit, Tarcoola, Central Gawler Gold Province (see LEME Minerals Brief 1). The dominance of kaolinite and goethite in the top 70m of the profiles readily define the weathered zone. Alunite-jarosite minerals (derived from weathering of sulfides) are also identified in this zone. At the base of the weathered zone, smectites and abundant Fe oxides are associated with Au (up to 64 g/t). However, below the base of oxidation there is no consistent association between mineralogy and mineralisation. These features suggest that supergene processes are important in generating potentially economic mineralisation in the Tarcoola Goldfield. mauger.alan@saugov.sa.gov.au

MINERAL HOST STUDIES

Rob Hough (CSIRO EM) and a team from LEME and ANU are studying regolith materials from the Mount Gibson Gold Deposit (300 km NNE of Perth), see also LEME Minerals Brief No 1. Ferricrete in Tertiary sediments above the mineralization contains late-stage alunite which hosts 290 ppm Cu, 500 ppm Pb and 360 ppm As, as well as 1-2 g/t Au. The latter occurs either as evenly distributed, very fine grains or is incorporated into the alunite structure. Hematite veins and kaolinite within the ferricrete are devoid of Au and have very much lower base metal contents. Similar concentrations of Au with alunite are present in other Au deposits, so that alunite may represent a sampling medium to search for hydromorphic dispersion from deeply buried mineralisation. robert.hough@csiro.au

BIOGEOCHEMICAL STUDIES

Steve Hill (AU) is using plant biogeochemistry in the Curnamona Province to detect mineralisation within and through cover. In plants, the lateral roots amalgamate chemical signatures from otherwise heterogeneous sampling media, whereas tap roots penetrate the cover and extract a chemical signature from bedrock or aquifers. Studies at the Flying Doctor Zn-Pb-Ag Prospect, 8 km along strike from Broken Hill mineralisation, show that leaves from black bluebush (*Maireana pyramidata*) are *amalgamators* and have elevated Pb above the mineralisation. However, prickly wattle (*Acacia victoriae*) phyllodes act as *penetrators* of shallow cover, and have elevated Cd, Cu, Pb and Zn specifically identifying the

mineralisation without the spurious anomalism found in the <80 µm soil fraction. steven.hill@adelaide.edu.au

EXPERIMENTAL STUDIES

PhD student, Chris Gunton (ANU) is studying how groundwater composition controls sorption of metals onto goethite. Experiments show adsorbed Cu increases with pH, and sorption increases 20-fold with NaCl concentration as Cu chloride complexes on goethite surface. However, Zn is adsorbed at higher pH than Cu but is not so strongly affected by NaCl in solution. Sulfates also appear to have little effect on sorption of Zn by goethite. Thus, Zn is expected to disperse further and be less affected by salinity than Cu during weathering. chrisg@ems.anu.edu.au

PhD student, Alistair Usher (ANU) is conducting experiments on the geochemistry of dissolved Au. He is using UV-Visible Spectrophotometry to identify oxidised Au (III) chloride and iodide complexes which may be important in the transportation of Au in acidic, very oxidised (atmospheric) conditions. Gold iodide complexes are quite stable and could be important in transporting Au in saline solutions. The more complicated Au (I) complexes are actually more likely to be the transporting agent in many groundwater conditions. An important side benefit of this study has been the development of improved methods of measuring low levels of dissolved Au in water. alistair.usher@anu.edu.au

GEOPHYSICAL STUDIES

Jayson Meyers and Anousha Hashemi (CUT) are working with Pilbara Manganese to refine the Hoist EM system and develop innovative data processing strategies to find manganese ore below regolith at Woodie Woodie in the east Pilbara. Conductivity depth inversions (CDIs) that show manganese ore and other conductive geological features have helped define a number of high priority targets and improved the success rate of the target drilling of blind deposits. In particular one of the Hoist EM discoveries, containing excess of 1.5 Mt of manganese, occurs below 30m of Permian cover and would not have been identified using conventional EM techniques. meyersj@geophy.curtin.edu.au

PhD student, Margarita Norvill (CUT) has developed novel signal processing algorithms to improve EM and electrical geophysical surveys in electrically noisy areas (commonly within 100 km of a city). The research was originally undertaken to improve data quality from the MIMDAS system (developed by MIM Exploration Ltd, now Xstrata Pty Ltd) but the algorithms can be readily applied to other systems to reduce the signal-to-noise ratio. Testing in both near-urban and remote areas improves systems substantially with results from the latter improving resolution at greater depth. mnorvill@geophy.curtin.edu.au

LEME KNOWLEDGE TRANSFER

Upcoming LEME Minex presentations:

14 March 05	AIG Seminar: Spurious or anomalous geochemical innovations in the exploration for blind ore bodies, Perth
22-23 March 05	Annual Geoscience Exploration Seminar - AGES 3005, Alice Springs, NT.
3-7 April 05	8th Int Conference on Biogeochemistry of Trace Elements (ICOBTE), Adelaide. Enquiries to: steve.rogers@csiro.au
5-7 April 05	AMIRA 6th Biennial Exploration Managers Conference, Hunter Valley NSW
25 May 05	LEME Minerals Exploration Seminar, Perth.
November 05	Regolith 2005 Symposia, Canberra, Adelaide and Perth.
19-23 Sept 05	22nd International Geochemical Exploration Symposium, Perth.

Recent Minex Publications

OPEN FILE REPORTS http://crcleme.org.au/Pubs/OFRSindex.html

- **OFR No 155 -** Regolith characterisation and geochemistry as an aid to mineral exploration in the Harris Greenstone Belt, Central Gawler Craton, South Australia. Vol 1 and 2. MJ Sheard and IDM Robertson
- **OFR No 156** - The South Australian Regolith Project Final Report - Summary and Synthesis. MJ Lintern.

- LEME-GSWA Minerals Exploration Seminar, Kalgoorlie WA, Feb 05. **Abstract Volume** http://crcleme.org.au/NewsEvents/Events/seminars.html

- Eight new Case Histories for the LEME Monograph **Regolith Expression of Ore Systems in the Australian Regolith** http://crcleme.org.au/Pubs/Monographs/RegExpOre.html
  - Boddington Gold Deposit WA
  - Bronzewing Gold Deposit, WA
  - Calista Gold Deposit, Mt McClure Mining District, WA
  - Kanowna Belle Gold Deposit, WA
  - LP3 Pb-Zn Mineralization, Cobar District, NSW
  - New Cobar Cu-Au Deposit, Cobar Goldfield, NSW
  - Osborne Cu-Au Deposit, Cloncurry, NW Qld
  - P4 Au-As-Sb-Pyrite Mineralization, Cobar District, NSW

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