PROGRAM ONE: REGOLITH GEOSCIENCE

QUARTERLY REPORT JANUARY – MARCH 2004

PROJECT 1.0: PROGRAM MANAGEMENT AND PROJECT GENERATION

PROJECT AIMS:

WORK PLAN FOR QUARTER:

- Review Projects in Program One and Two

PROGRESS:

- Reviewed Perth based Projects 18-19/03/04

ISSUES AND COMMENTS:

- Lisa Worrall (Geoscience Australia) was appointed leader of Program One effective 08/03/04.
- Mary Walsh (Geoscience Australia) is now working half time as the Administrative Assistant for Program One.

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS

- Lisa Worrall: Presentation to the LEME Board Meeting in Adelaide 05/03/05 "Testing the Potential of a New Gold Province in the Central Gawler Craton"

OUTLOOK AND WORKPLAN FOR NEXT QUARTER:

- Complete review of projects in Programs One and Two
- Prepare 04/05 project portfolio for Program One

STAFF MOVEMENTS IN NEXT QUARTER

Lisa Worrall to Adelaide to complete P1 and P2 Project reviews 20/04/04
to Sydney for discussions with NSW DMR18/05/04
to Cobar for the Exploration Field Workshop, Cobar Region 2004 23/05/04 – 27/05/04
to Perth for the LEME Minerals Exploration Seminar and Minerals Advisory Council Meeting 31/05/04 – 04/06/04

Lisa Worrall on leave 28/06/04 – 02/07/04

Mary Walsh on leave 10/05/04 – 19/05/04

PROJECT 1.1: GEOCHRONOLOGY AND QUANTITATIVE MODELS

PROJECT AIMS: To provide reliable numerical ages for regolith materials, and to develop quantitative models of landscape evolution in regions which are important for mineral exploration and land management.

WORK PLAN FOR QUARTER:

- Attend ANZGG Conference, Mt Buffalo, Victoria (Pillans, Chappell)
- Continue with pilot samples for (U-Th)/He dating (iron-oxides) and U/Pb dating (anatase) (Smith, Dunlap, Eggins)
- Complete compilation of Geochronology Workshop papers (all)
- Laboratory analysis of paleomagnetic samples from WA, SA, NT, Qld (Pillans)

PROGRESS:

- Pillans and Chappell attended ANZGG Conference, Mt Buffalo
- Measurement of paleomagnetic samples from Tanami area completed
- Almost all revised manuscripts for Geochronology Workshop report have been received
- U and Pb isotope data measured on anatase samples by TIMS (Smith, Eggins).
- Refined pre-treatment methods for He measurements on iron oxides (Smith, Dunlap)

ISSUES AND COMMENTS:

- None

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS

OUTLOOK AND WORKPLAN FOR NEXT QUARTER:

- Complete LEME report from Geochronology workshop (all)
- Attend Minerals Exploration Seminar, Perth (Pillans)
- Laboratory measurement and analysis of samples (all)
- Fieldwork in central Australia (Chappell)
- Preparation of project budget for 2004-2005 (Pillans)

STAFF MOVEMENTS

- Brad Pillans in Perth 01/06/04 – 03/06/04

PROJECT 1.18: NORTHERN TERRITORY REGOLITH

PROJECT AIMS:

To provide a regional regolith-landform framework of the Territory as a basis for guiding mineral exploration and other land-use issues.

WORK PLAN FOR THE QUARTER:

- Assessment and consolidation into databases all field observations (all staff) from NT regolith Traverse.
- Select detailed study sites for further fieldwork in 2004.
- Prepare currently available data for use in the construction of the 2.5 Million scale NT Regolith map.

PROGRESS:

- Fieldwork
  - NT Regolith Traverse is now completed on time and data collected that assisted with detailed study area choices
  - All preparation work was completed in advance of the Traverse and meet target deadlines.
  - Preparation of arrangements for approaching field activities from NTGS HQ Alice Springs
- Workshop:
  - Present regolith materials and mapping workshop in Darwin to NTGS Gabfest audience. (Craig, Anand and Gray- January 18-21st 2004.) The planned workshop was presented on time and was well received by attendees. Feedback from NTGS indicates that the outcome of introducing NTGS geologists to a better and wider understanding of regolith materials regolith and exploration, and regolith mapping approaches was well met.
- Data Consolidation
  - Data consolidation and survey is ongoing and is proceeding according to plan.
- Palaeomagnetic age trial samples:
  - Two trial samples were collected and presented for age determination. One sample proved to be successful and an age greater than 780k is expected when final calculations are completed. Further samples will be collected during the next fieldwork phase of the project.
- Regolith materials analysis:
  - X-ray diffraction mineralogical analysis and X-ray fluorescence analysis of 58 regolith specimens taken during the 2003 field trip were completed. The XRF analysis was for 21 major and minor elements and LOI. Thin and polished sections have been prepared.
- Presentations/Publications
  - Radiometric stitches, 2004 (RC); abstract written for ASEG Conference: "Radiometric Stitching" (RC); AGIS & Gabfest Project Outline (CE); Project Outlines -GA; CRC; NTGS (MC); Mining News Interview (MC). Project Outline -Perth (IDMR); Workshop Notes and Presentation - Darwin (MC, RRA).

ISSUES AND COMMENTS:

Some difficulty has been encountered with the preparation of Satellite imagery and Aster imagery at NTGS due to workloads and software availability. Alternative arrangements were successfully negotiated at GA to meet immediate needs prior to the commencement of May 2004 field operations.

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS

OUTLOOK AND WORK PLAN FOR THE NEXT QUARTER. (APRIL-JUNE, 2004)

- Petrology and description of the same specimen suite (first pass) was completed in April and interpretation of the XRD data are underway in May. The specimens have been doccumented with an extensive suite of close-up photographs and photomicrographs, ready for compilation into an atlas. Plans to merge the XRF and XRD data with the petrology (second pass) provided there is time.
- Undertake fieldwork in four selected NT study areas over next four months.
- Assessment and consolidation of observations into RTMAP databases (all staff) from NT field program.
- Further sample processing and analysis to begin following fieldwork sampling program.
- Prepare currently available data and commence interpretation of field data and imagery for the construction of 2.5 Million scale NT Regolith map.
- Prepare/trial geophysics data for the following analyses; magnetic depth forward modelling; magnetic depth profiles; Prepare further images for fieldwork as negotiated.

STAFF MOVEMENTS:

Field Operations Stage 1

Mike Craig, Ian Robertson, Jody Smith (GA-Graduate) and Christine Edgoose in field NT from 31 May to June 3oth - Barrow Creek -Tennant Creek`.
Mike Craig 30-June -10th July return to Canberra.

Field Operations Stage 2:

Mike Craig, Ian Robertson, and Christine Edgoose in field NT from 12th July -28th August -Darwin-Gorgina Basin

Non Field Operations

Roger Clifton -HQ Darwin
Ravi Anand -HQ Perth
Amanda Cornelius -HQ Perth

Leave arrangements

Ian Robertson on leave 22/06/04-12/07/04

PROJECT 2.1: WESTERN NSW REGOLITH

PROJECT AIMS:

WORK PLAN FOR QUARTER:

PROGRESS:

- Appointment of Luisa Ruperto (from 18 Feb 2004) as GIS specialist for the WNSWR project
- Development of a basement depth & regolith thickness model for Teilta 1:100,000 mapsheet based on drillhole data and outcrop observation
- Database population for geochemical GIS of the Broken Hill region, and initial concept development for geochemical GIS of all the project-generated geochemical data in the area (since 1998)
- 2D reactive-transport modelling of the formation and dispersion of hydrogeochemical anomalies around sulfide mineralisation

STUDENT ACTIVITY WITHIN PROJECTS:

- Karen Hulme carried out fieldwork sampling River red gum material and performing analyses
- Other students started (details: cfr Steve Hill)

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS

- Shortcourse on "Geochemical Modelling" at ANU (27-30 Jan 2004)
- Presentation at the Australian Geological Convention (Hobart, 8-13 Feb 2004)
- LEME-MTEC Shortcourse on "Regolith Geology & Geochemistry", Wilsons Promontory, Victoria (23-27 Feb 2004)
- LEME-MTEC Shortcourse on "Regolith Mapping & Field Techniques", Fowlers Gap via Broken Hill, NSW (15-19 March)
- LEME-MTEC Shortcourse on "Introduction to Hydrogeochemistry", Melbourne, Victoria (29 Mar-2 Apr 2004)

CURNAMONA PILOT AND WHITE DAM

PROJECT ACTIVITY (INCLUDING ANY STUDENT ACTIVITY)

- One week fieldtrip in January for regional and known mineralisation regolith and biogeochemical sampling. Attended by staff Karin Barovich and Steve Hill, PhD students Karen Hulme, Aaron Brown, Ian Lau and summer scholar Nathan Reid.
- Laboratory preparation of fieldtrip samples and submission to analytical laboratories
- Paul Wittwer (Adelaide University, Honours Student) commenced Honours project on calcretes in the Olary region

PROGRESS TOWARDS ACHIEVING PROJECT OUTPUTS AND OUTCOMES

- Regolith and biogeochemical sampling completed across study area and over 4 sites of known mineralisation (White Dam, Wilkins, Green & Gold, Luxemberg)

- Soils, calcretes, and bluebush samples submitted to laboratories (soil and calcrete assays have just been returned)
- Template for presentation of elemental assays within a regolith and biogeochemical atlas of White Dam completed

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS.

- Lisa Worrall visited and briefly met with Aaron Brown and Steve Hill to discuss preliminary White Dam results
- Paul Wittwer presented his research proposal and literature review at Adelaide University

“STAFF MOVEMENTS” AND PLAN FOR NEXT QUARTER

- Fieldtrip for Paul Wittwer with Karin Barovich and Steve Hill planned for May 25-29, 2004
- Steve Hill travelling during May and June with Program 5 commitments
- Ian Lau will be close to completing PhD thesis by end of June, 2004

PROJECT 2.31: PREDICTIVE REGOLITH PETROPHYSICS

PROJECT AIMS:

WORK PLAN FOR QUARTER:

PROGRESS:

- Petrophysical sampling of selected Tunkillia core samples
- inversion modelling of Tunkillia RAB controlled sections. Results indicate inferred "mafic dykes" may in fact be sills, and indicate "depth to fresh rock" contact
- Discussions with PIRSA (Mauger/Keeling) re petrophysical / spectral core logger results from Tunkillia
- Determined minimum spec for effective aeromag for regolith exploration at Tunkillia
- Built 3D forward /inverse model of Yarlbrinda SZ
- Visited GA (Worrall) and ANU (McPhail) to discuss future plans
- Attended 1st European Geoscience Union Assembly, Nice
- Attended SA Resources & Energy Investment conference, Adelaide
- Hons Student (K Pfeiffer) delivered literature review & project plan (Apr) - Tanami; significant time spent planning / scoping Pfeiffer's project
- Hons Student (N Anderson) delivered literature review & project plan (Apr) - Tibooburra; significant time spent planning / scoping Andersons project

ISSUES AND COMMENTS:

AWARDS, PRESENTATIONS, PUBLICATIONS AND SIGNIFICANT VISITORS

- Presented at CGGP meeting, Adelaide 03/05

- Visit from A Larking (LEME board member)
- Visit from L Worrall (P1 leader)
- Awarded Stillwell Medal for paper, Direen & Crawford, The Tasman Line..., AJES, Oct 2003

OUTLOOK AND WORKPLAN FOR NEXT QUARTER:

- Co-ordinate, teach and assess Mineral & Environmental geophysics III
- Investigate purchase of small-scale Res/IP set from ABEM (Sweden) vs building purpose built equipment
- Negotiate with CUT geophysicists re future of geophysical projects
- Supervise P Heath -edit papers submitted to ASEG, seminar delivered to G&G, AU
- Project planning & discussions with other LEMErs for new FY
- Negotiating agreement with CSIRO DEM (N Ryde) for access to molspin magnetometer (Tanami sub-project)
- Negotiating purchase of GWB software
- Planning fieldwork in Tanami

QUARTERLY REPORTS – JANUARY TO MARCH 2004 – PROGRAM 2 (Ravi Anand)

AMIRA P618 – ISOTOPIC DISCRIMINATION OF PARTIAL LEACH GEOCHEMICAL ANOMALIES IN COVERED TERRAINS

Project Leader: G. Carr

During the period October 2003 to March 2004 the AMIRA P618 project has been focussed on the following endeavours.

Detailed sampling programs were undertaken over two case history sites. At Kutarta, at MVT prospect on the Lennard Shelf, 184 samples were collected along three traverses over the surface projection of the blind mineralisation and in a "background" situation. At the Wheatley Archaean VMS prospect 140 samples were taken over blind mineralisation and along background traverses. All analytical work for the Kutarta project was completed and about 50% of the work for Wheatley.

- We have continued to develop the single pass ion exchange column technique using acetate solutions for Pb isotopic analysis.
- We have been working on a method of sequential stripping of Pb from soil samples to get signatures of the labile as well as the "background" components in each sample.
- We have finally solved problems in technique development for continuos flow mass spectrometry for S isotope analysis and have commenced analysis of several hundred samples.

Two case history reports have been written and are being circulated internally for review.

DEVELOPMENT OF GEOCHEMICAL MODELLING

Project Leader: D.C. McPhail

This project is a strategic one because it is a direct link with pmd*CRC. Progress in last quarter consists of compiling references related to the thermodynamic properties of gold and iron minerals and aqueous species, and the continued development of the web-based database of thermodynamic properties and ancillary software to provide database files useable in current state-of-the-art geochemical software packages (e.g., Geochemist's Workbench and HCh).

Laura Richardson (undergraduate; ANU) was hired to assist with the compilation of gold and iron references.

Ge/Si and Ga/Al INDICATORS

Project Leader: S. Welch

The purpose of this project was to investigate mobility of trace elements with respect to major elements during weathering, specifically focusing on Ge/Si and Ga/Al ratios. It is suggested that the element mobility could be significantly different under predominately inorganic versus biotic-organic dominated weathering reactions. The scope of the project has broadened to focus on the effects of biotic verses abiotic processes on mineral weathering in the regolith.

I have made considerable progress for this project in the last few months primarily due to the fact that (i) we now have a small but functioning lab for use by several LEME researchers in the Department of Earth and Marine Sciences and (ii) that the ICP-MS in our department is currently working for solution analysis.

In the last few months, I have started several sets of mineral dissolution experiments with mineral separates in solution of organic and inorganic acids over a range of pH to determine a baseline behaviour. Results show that major ion release to solution is ~ 2 to 10 fold greater in organic solutions compared to inorganic controls depending on experimental conditions. Major ions such as Al and Fe are preferentially released to solution compared to inorganic controls, presumably due to the formation of metal-organic complexes. Analysis of trace elements such as Ga, Ti, V, Li, REE, show they are preferentially mobilised by organic acids as well.

Based on results of the initial analysis, additional samples of the Bemboka granodiorite have been prepared for laser ablation analysis. Many of the samples have been characterized by electron microscopy to target areas for analysis by laser ablation ICP-MS, though samples have not yet been analysed.

In April 2004 I collected additional samples from Bemboka for organic extraction and mineral leaching experiments. Samples have been crushed and sieved and are being prepared for bulk rock geochemistry and clay analysis.

GOLD, LEAD AND ARSENIC MOBILITY

Project Leaders: D.C. McPhail and D.J. Gray

The main aims of this project are to understand better the geochemistry and mobility of gold, and the properties and solubilities of lead- and arsenic-bearing apatite-group minerals.

This is an integrated project that consists of multiple experimental, numerical modelling and field studies. The individual components include: the geochemistry of gold in hypersaline brines; the relationship between biota and gold mobility; the reactive transport of gold; sorption of gold on mineral surfaces; the synthesis, solid solution properties and solubility of lead- and arsenic-bearing apatite-group minerals.

- Experiments have started on the geochemistry of gold in hypersaline brines (Ph.D. student Alistair Usher).
    - UV-Vis spectra have been measured for Au(III, I) in chloride, iodide and thiosulphate solutions. Preliminary results show promise in identifying Au(I) thiosulphate complexes and possibly Au(I) iodide complexes; however, Au(I) chloride complexes are probably invisible in the observable range of UV-Vis wavelengths.
    - A preliminary experiment to measure the solubility of native gold under halite-saturated conditions has commenced. We need to establish our methodology of measuring very low (e.g., ppt) concentrations of dissolved gold in concentrated salt solutions. We are also exploring the possibility of using Au(I) solids in order to avoid the need for precise control of redox in these experiments.
    - There is a link with LEME project 2.20 Development of Geochemical Modelling. The initial stage of that project is to develop a database of reliable thermodynamic properties for gold minerals and aqueous species, over wide ranges in temperature, pressure and solution composition. This will provide a basis with which we can predict gold geochemistry and mobility in regolith and other environments.

- Ongoing progress in the studies of microbiology and gold (Ph.D. student Frank Reith). The most important aspects in this quarter have been:
    - Continued experimental studies of microbiological growth and the mobilisation of gold in regolith samples (>70 day experiments to determine correlations between changes in bacterial population and concentrations of gold and other elements) – results are pending chemical analysis of sampled solutions.
    - DAPI staining (for DNA and RNA associated with gold grains from regolith samples) and confocal microscopy. Biofilms have been identified on gold grains from the Palmer River region of Queensland. This may be the first evidence in the world of biofilms on gold grains that have a morphology attributed to bacterial activity.
    - Preparation of first manuscript from Frank Reith's research. Present title is "*Bacillus cereus, gold and associated elements in soil and regolith samples from Tomakin park gold*

mine in south-eastern New South Wales", the manuscript draft is complete and is in final revisions here and will be submitted to Journal of Geochemical Exploration (plan is during October 2003).

- Reactive transport experiments and gold mobility
    - Dirk Kirste, Sue Welch and Frank Reith will begin to set up column experiments, building on the experience of David Gray's work a few years ago in Perth.

- Sorption experiments
    - We are unlikely to study sorption in the short term; however, we have made contact with David Cohen of UNSW, who did an experimental study on Au(III) on goethite, kaolinite and smectite as part of his Ph.D. several years ago. David Cohen has recently submitted a manuscript on that work to GEEA, and is now revising it after receiving reviewers' comments. There is a good possibility of collaboration with his group.

- Lead- and arsenic-bearing apatite-group minerals
    - Natural apatite-group minerals have been obtained (from Sweden) and their chemical compositions measured. The results clearly show a solvus gap in the solution between hedyphane (Pb-Ca-Cl arsenate) and johnbaumite-turnearite (richer in Pb and poorer in Ca than hedyphane). Materials are being obtained to start synthesising end-members of the apatite group, in preparation for studying solvus gaps in the solid solutions and solubilities of the minerals in aqueous solutions.

GEOCHEMICAL DISPERSION MECHANISMS THROUGH TRANSPORTED COVER
Project Leader: Mehrooz Aspandiar

There are two aims of the project. The first is to conduct a literature search on the potential geochemical dispersion mechanisms operating through transported regolith cover, and this phase has been initiated and is in progress. The type, nature and extent of the different mechanisms is being researched, documented and placed in a framework for the nature of the Australian transported regolith. The second aim is to find field sites having characteristics where the effectiveness of the potential mechanisms will be tested, and planning is in progress to visit some of the prospective sites. The sites will be tested with surface sampling and geochemical analysis to validate whether anomalies can be seen through cover and subsequently test the mechanisms.

MINERAL HOSTS

Project Leader: R. Hough

To better understand the formation of geochemical anomalies in the regolith. The project involves constraining mineralogical associations with significant trace elements, especially Au in regolith from different deposits. It provides an insight into the dispersion processes for trace elements into mineral hosts, also their environmental implications. Ultimately we aim to determine how geochemical anomalies form that in turn will assist in the understanding of when, how and where particular regolith material is applicable for the exploration industry.

- New electron microprobe data has been acquired for Mount Gibson Enterprise pit samples including work on the hardpan, ferricete and saprolite. Appreciable anomalism was detected and these results further confirm, and add to the previous Laser Ablation ICPMS results.

- Lancefield South: Samples from various sedimentary units ranging from Quaternary to Permian sediments and *in situ* regolith were collected from pit walls to investigate whether there is any dispersion in secondary minerals developed in the overlying sediments from the underlying mineralisation. A variety of techniques including petrography, SEM, electron microprobe, Laser Ablation ICPMS and XRD are being used to characterise the regolith materials. Results from geochemical analyses of different constituents of regolith materials have been received for a suite of 25 samples. Initial electron microprobe data show there is dispersion of As and Cu in goethite in Permian sediments, and only Cu in goethite of Tertiary sediments, and possibly goethite and smectite in red-brown hardpan. Laser Ablation ICPMS analysis is underway.

- Results from Mount Gibson and Lancefield South indicate we are able to detect late stage Au and pathfinder element dispersion within weathering products in transported overburden.

- We have collected samples from the Whirling Dervish gold prospect in cooperation with the Northern Yilgarn team. Bulk geochemical analyses have been performed, and we have prepared polished thin sections that are now ready for detailed petrography, SEM and Probe analyses.

- We have made extensive headway in analysis of the internal crystallography of gold nuggets and are in the process of acquiring some further samples. Our current results show how silver depletion lies along crystal boundaries within the gold and that the depleted areas are in the same crystallographic orientation as their host grains.

- Ray Smith (CSIRO EM), on retiring in February after 31 years' employment with CSIRO, has been appointed a CSIRO Emeritus Research Fellow. In this role, he continues his research into geochemical dispersion from concealed mineral deposits. His investigation of the basal lateritic conglomerate, which forms the cover about the Golden Grove Gossan Hill Cu-Zn-Au VHMS

deposit, has established criteria for identification, in the cover, of detritus derived from the ore deposit or its immediate proximity. The study sites are located within the kilometre-wide multi-element geochemical dispersion anomaly described by Ray Smith and John Perdrix in 1983. Such broad and strongly-zoned anomalies are important in mineral exploration for concealed ore deposits. The current study focuses on: (a) improved methods for ranking of geochemical anomalies; and (b) translating findings for a proposed model for exploration involving drilling through thick cover applicable elsewhere. A poster paper on this research has been accepted for presentation at the international SEG 2004 Conference "Predictive Mineral Discovery Under Cover" in Perth in September.

Ryan Noble (PhD study)

The research project on arsenic and antimony distribution in regolith continues to develop. Over the past months the following work has been conducted towards establishing and completing this project:

- I have sieved recently collected soil samples to various size fractions for future analysis. The samples were from the past sampling trip in November covering the Stawell region and Wildwood prospect.
- I have conducted some cluster and principle component statistical analysis on the Wartook soils, confirming that the various techniques give different results and are significantly different, however like initially thought the Bacterial Leach is similar to the hydroxylamine hydrochloride technique and the water and weak hydrogen peroxide technique are also very similar to each other, but very different from the previously mentioned techniques. Total dissolution technique was in between these two groups. Similarities between element responses for all techniques are not clearly explainable yet. Some groupings of Ni with Zn were expected, but further investigation and understanding of the results is required.
- I have written a report on the Wartook soils to be included in the SGM Wartook annual report appendices.
- Although, not directly related to the project, I have submitted a paper to be published in the American Society of Mine Reclamation (ASMR) Proceedings in April based on the Stawell Gold Mine Mt. Micke geochemical characterisation.
- The Wildwood samples have been analysed using the Bacterial Leach and ICPMS, however I have not received the results back.
- I have done some analysis of the calcrete data and also contacted Stan Harrison, who has provided some helpful information. The calcrete data was examined spatial variation of elements. The sampled area is approximately 600 km2 and encompasses the Kewell and Wallup prospects. Initial findings indicate there is minor variation in element concentrations and the carbonate materials are fairly uniform. Initially, the results indicate calcrete sampling is not beneficial in sampling for signatures of underlying mineralisation in the Murray Basin alluvial sediments. The regional calcrete is subject to too high rainfall and too deep transported cover to be an effective sampling medium. I

do plan to follow this up with a comparison of chemistry and underlying geology types, as well as trying to incorporate drilling data.

- I have investigated the use of sequential leaches and have Wildwood samples ready to be analysed. .
- Mineralogical analysis is being planned using the PIMA/ASD instrument at CSIRO. The analysis should provide information on some clay types, iron oxides and carbonates present in the soils. The information will be beneficial in determining if mineralogy is influential in anomaly expression.
- Several presentations made to the LEME review panel including members of the Minerals Advisory Council.

BIOLOGICAL AND NON-BIOLOGICAL FACTORS INVOLVED IN THE FORMATION OF GOLD IN CALCRETE ANOMALIES

Student: M.J. Lintern (Curtin University)

Studies of calcrete and their associated materials in the soil profile continued on two fronts this quarter. Zonation of gold in calcrete was studied using laser ablation which re-commenced after a number of setbacks last year. The first results are being processed and the rate of sample submission will gather pace in the coming weeks if confidence in the instrumentation, the technique and the data increases. The geobiological factors involved in gold in calcrete formation has commenced. *Bacillus cereus* and other spore-forming soil bacteria have been isolated from gold prospects in South Australia and Western Australia.

MINERAL MAPPING SOUTH AUSTRALIA

Project Leader: Alan Mauger

HyLogger:

- Completed scanning 35,000 metres of drill core by 20 January 2004.
- Ongoing processing of data into TSG (The Spectral Geologist program) format through to mid-March.
- Visit to CSIRO North Ryde - TSG training and discussions on Web Delivery of HyLogger data.

Central Gawler Gold:

- Made presentation on HyLogger project.
- Established some priorities for processing HyLogger data.
- Consulted on ASTER data processing for project.

John Keeling:

- Examining HyLogger data for Tunkillia, Barns and Pine Creek.
- Barns results indicate correlation between mineralogy and gold mineralisation.
- Barns study allows comparison of chips vs core and HyLogger vs PIMA.

Ian Lau (PhD student):

- Processed White Dam HyMap data - using SWIR spectral indices has produced FeOx/Veg maps. Next phase is to produce SWIR mineral maps and compare to other processing techniques.
- Regolith Mapping: using HyMap, Radiometrics, Landsat, & DEM produced 1:30,000 map covering same area as HyMap.Completed line tracing and sent to GA for scanning.
- 3 day field trip to White Dam for sampling.

OBJECTIVE REGOLITH LOGGING

Project Leaders: R. Anand / T. Munday

To develop a practical automatic interpretation tool/s and procedures for logging regolith materials returned as core, drill chips, or pulps.

- Defined strategy to test mixed (compositionally) samples as part of a spectral library in TSG/TSA software.
- Case Study:

  Moolart Well:
  - Cross-section generation of drill logs and recorrecting major anomalies in regolith logging (based on log codes).
  - MVS file preparation (create geology file based on Newmont logging; create assay files for Ag, As, Au, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Zn, HmGt, FeOx, Kindex, Brightness, Colour Index, HK, MgChlorite, Montmorillonite, Opal).
  - Gridding of above files and investigation of appropriate limits/settings for each.
  - Image generation – slices and 3d fence diagrams of above.
  - Despatch of 190 samples from a transect across different lithologies at Moolart Well for geochemical and XRD analyses.

  Gidgee:
  - Investigate the mineralogical composition of three drill intersections at Gidgee transect using X-ray diffractograms, supplemented by geochemical data as a control for interpretation of VNIR spectral indices-still ongoing.

- Evaluation of portable XRFs:
  - The Niton Xli700 Environmental Analyser (uses radioactive isotope ^{55}Fe and ^{109}Cd as source) vs Innov-X XT-440 Soil Analyzer (uses miniature X-ray tube).
  - A sample set of about 65-70 powdered regolith samples of different regolith types from felsic and mafic lithologies including known standards were tested for both instruments. Niton instrument was tested by CRCLEME personnel while Innov-X did the testing in USA. Elements of interest include Fe, Mn, Ca, Ti, Cr, Zr, K, Rb, Ni, Co, Cu, V, Pb, Ba, Zn. Data acquired from the instruments were compared with our known XRF data.
  - The highlight of the results indicates in general that Niton Portable XRF is promising, with a lower detection limits than Innov-X Portable XRF in a range of elements, the latter detecting only elements Cr,Fe,Sr,Ti and Zr. Both instruments show consistent performance over a wide concentration range for Sr, Zr, and Fe, the latter element showing a non-linear response. In addition, Niton also gives a better linear response for Ti and Rb over a wide concentration range. Both instruments however give very poor Co results, due to interference by Fe. Although both instruments report fairly poor accuracy in Cr especially below 1500-2000 ppm, Niton still gives a better result. In terms of precision, Fe gives the best precision for both Niton

(5.3% on 12 replicate analyses at 22% Fe, exposure time of 30s) and Innov-X (2.5% on 10 replicate analyses at 32% Fe, exposure time of 40-45s) instruments.

- Presentation of project results and progress at internal CRCLEME project review in March 2004.

- Need to develop strategy for investigating the broader commercialisation options for the Objective logging project. This should be integrated with broader CSIRO EM commercialisation strategy for spectral logging systems.

REGOLITH EXPRESSION OF AUSTRALIAN ORE SYSTEMS

Project Leader: C.R.M. Butt

To assemble and publish a monograph summarizing the characteristic expression of bedrock ore systems in the Australian regolith, as a series of conceptual dispersion, process and exploration models, illustrated by relevant case histories.

About 15 case histories were added to the LEME web page during the quarter, making a total of 50. A further 50 are under review. Six supporting articles have also been drafted and are under review.

We anticipate there will be a final total of 100 case histories. Good progress was made in the this quarter, but will slow in the next quarter with the demands of field work in other projects. The departure of Keith Scott in July will be a considerable loss.

Project staff and 'outside authors' will continue to revise case histories and edit the contributions, and completed case histories will continue to be released on the web when completed. Further introductory articles will be written/reviewed.

WESTERN NSW REGOLITH

Project Leader: P. de Caritat

- Appointment of Luisa Ruperto (from 18 February, 2004) as GIS specialist for the WNSWR project.
- Development of a basement depth and regolith thickness model for Teilta 1:100,000 map-sheet based on drill-hole data and outcrop observation.
- Database population for geochemical GIS of the Broken Hill region, and initial concept development for geochemical GIS of all the project-generated geochemical data in the area (since 1998).
- 2D reactive-transport modelling of the formation and dispersion of hydrogeochemical anomalies around sulfide mineralisation.
- Karen Hulme carried out field work sampling River red gum material and performing analyses.
- Other students started (details: cfr Steve Hill).
- Shortcourse on "Geochemical Modelling" at ANU (27-30 Jan 2004).
- Presentation at the Australian Geological Convention (Hobart, 8-13 Feb 2004).
- LEME-MTEC Shortcourse on "Regolith Geology & Geochemistry", Wilsons Promontory, Victoria (23-27 Feb 2004).
- LEME-MTEC Shortcourse on "Regolith Mapping & Field Techniques", Fowlers Gap via Broken Hill, NSW (15-19 March).
- LEME-MTEC Shortcourse on "Introduction to Hydrogeochemistry", Melbourne, Victoria (29 Mar-2 Apr 2004).

YILGARN LATERITE ATLAS

Project Leader: M. Cornelius

In early March, we completed a reconnaissance field trip to the southern wheat belt and introduced two sampling teams to laterite sampling protocols and landform appraisal in order to identify suitable sample sites. One sampling team led by Don Hunter remained in the field and took 163 samples on the Dumbleyung and Newdegate 1:250 000 geological sheets. Approval was given by CALM to enter all nature reserves and national parks for sampling.

All samples are stored with the Geological Survey at their Carlisle facility. Sampling will continue in April and May.

YILGARN REGOLITH PROJECT (CONFIDENTIAL)

NORTHERN YILGARN

Project Leader: M. Cornelius

Due to OHS concerns, work planned at the Karari pit, Carosue Dam, had to be cancelled. Instead, work commenced at the Whirling Dervish prospect, 1.5 km north of Karari pit, in a geological setting very similar to that at Karari.

Thirteen aircore holes (719 m) were drilled to obtain samples of various regolith materials for mineralogical and geochemical studies. Au analyses show that weak enrichment is widespread in the top 3-5 m, dominantly a carbonate-cemented gravely colluvium.

Diamond drill core from the Whirling Dervish pit was logged (regolith only) and photographed. In addition, approximately 200 specimens were taken for geochemical and/or mineralogical investigations.

Results of geochemical analyses (53 elements) have been received for a suite of 55 regolith and seven fresh rock samples from diamond drill cores. The results will be statistically evaluated together with the results of Sons of Gwalia fresh rock analyses from the Karari pit. A preliminary evaluation shows that significant pathfinder elements are Au and Bi.

Thin sections of 11 samples from diamond core are being prepared and will be examined to determine critical fabrics which may aid core and drill spoil logging.

Spectroscopic analysis of the chip tray materials was completed for all 719 aircore samples using an ASD instrument. The dominant minerals in the regolith are kaolinite/halloysite and montmorillonite. In the saprock, muscovite, phengite, ankerite and Mg-chlorite are present.

The colour and crystallinity index of sediments in the south western part of Whirling Dervish are very different from those of in situ material. A distinct change in kaolinite crystallinity and colour index indicate a thickness of the transported cover of approximately 15 m.

In the north eastern part of the area, the depth of the unconformity appears to be about 24 m (Figure 4). The spectral difference between sediments and saprolite is less obvious and it appears the sediments below about 15 m depth are bleached and kaolinite crystallinity has increased during this process. The material with a crystallinity index <1, a generally accepted range for transported kaolinite, is tentatively classified as sediment.

Work in the northern Leonora area has been delayed and will commence in April. The work will be in conjunction with studies at the Jaguar base metal deposit south of Teutonic Bore.

SOUTHERN YILGARN – ST IVES

Project Leaders: B. Singh and D.J. Gray

Final project outcomes were presented to Gold Fields at their St Ives site in December 2003. In this quarter posters describing the results have been prepared. A preliminary proposal to extend the project at St Ives was also developed in collaboration with Jon Huntington.

REGOLITH EXPRESSION OF AUSTRALIAN ORE SYSTEMS

Project Leader: C.R.M. Butt

To assemble and publish a monograph summarizing the characteristic expression of bedrock ore systems in the Australian regolith, as a series of conceptual dispersion, process and exploration models, illustrated by relevant case histories.

About 15 case histories were added to the LEME web page during the quarter, making a total of 50. A further 50 are under review. Six supporting articles have also been drafted and are under review.

We anticipate there will be a final total of 100 case histories. Good progress was made in the this quarter, but will slow in the next quarter with the demands of field work in other projects. The departure of Keith Scott in July will be a considerable loss.

Project staff and 'outside authors' will continue to revise case histories and edit the contributions, and completed case histories will continue to be released on the web when completed. Further introductory articles will be written/reviewed.

WESTERN NSW REGOLITH

Project Leader: P. de Caritat

- Appointment of Luisa Ruperto (from 18 February, 2004) as GIS specialist for the WNSWR project.
- Development of a basement depth and regolith thickness model for Teilta 1:100,000 map-sheet based on drill-hole data and outcrop observation.
- Database population for geochemical GIS of the Broken Hill region, and initial concept development for geochemical GIS of all the project-generated geochemical data in the area (since 1998).
- 2D reactive-transport modelling of the formation and dispersion of hydrogeochemical anomalies around sulfide mineralisation.
- Karen Hulme carried out field work sampling River red gum material and performing analyses.
- Other students started (details: cfr Steve Hill).
- Shortcourse on "Geochemical Modelling" at ANU (27-30 Jan 2004).
- Presentation at the Australian Geological Convention (Hobart, 8-13 Feb 2004).
- LEME-MTEC Shortcourse on "Regolith Geology & Geochemistry", Wilsons Promontory, Victoria (23-27 Feb 2004).
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CRC LEME Program 3 Environmental Applications of Regolith Geoscience. Board Report May 2004

Steve Rogers

1. Program Leaders Activities

- SR commenced P3 Leaders position in late February 2004
- SR with Paul Wilkes and Ken Lawrie involved in LEME P3/P4 NRM planning meetings and workshops in Canberra and McLaren Vale
- Development of P3 business plan and prioritization
- Presentation of business plan to LEME board and LUAC
- Visits to LEME researchers at ANU
- Visits to LEME researchers at ARRC/Curtin University
- Discussions with Agriculture WA and WA Department of the Environment regarding WA Government/LEME initiative in Acid drainage waters and Acid Sulfate Soils (Sulfidic regolith).
- Meeting with representatives of CRC Plant Based Management of Dryland Salinity to discuss possible joint projects in landscape biogeochemistry
- Presentations on LEME P3 and biogeochemistry at University WA, ANU, University of Adelaide, University of Alaska, CSIRO Land & Water.

2. LEME Project 3.6 Airborne EM
(Project Leader: Jason Meyers)

i. Scientific Activity and Project Progress

During the Quarter, research relating to AMIRA project P407b was ongoing and there was direct involvement between the Principle Researcher James McNae and LEME researchers Tim Munday and Richard Lane. Developments on the calibration of HoistEM data were carried out at Curtin University by Jayson Meyers and Anousha Hashimi, and results of this were accepted for publication at the ASEG annual meeting in Sydney in August 2004.

EM inversion software being developed un P407b was modified to accommodate LEME projects in South Australia, principally Riverland, whereby data from Fugro Airborne's new Resolve FDHEM system data could be inverted to conductivity at depth inversions (CDIs). Further refinements in the mathematics for inversion and noise reduction, code and programming were carried out to accommodate old data sets and get better CDIs. Beta test trails were run on historical CRC-AMET owned SALTMAP and TEMPEST TDAEM data and Cawse Geophex FDHEM data, and the preliminary results are very encouraging. The better noise removal and CDI processing is leading to more reliable and calibrated CDIs, without having to collect ground verification data and carry out long winded noise removal processes.

Continued research into HoistEM inversion and exploration targeting was carried out on the Woodie Woodie data sets. A new manganese ore discovery was made adjacent to the old Radio Hill pit at Woodie by drilling a HoistEM target. Preliminary resource

estimates are showing this blind discovery to be a large tonnage deposit. Calibration experiments incorporating ground data from drillholes has lead to a dramatic improvement in noise reduction and more reliable CDIs. An extended abstract has been accepted for publication and was submitted to the ASEG for the Sydney ASEG conference.

TEMPEST TDAEM data is still being processed in Adelaide as part of the Gawler Craton project involving Nick Dureen and Lisa Worrall.

ii. Student activity
EM Flow training was given to students using the AMIRA project software by John Joseph.

3. Project 3.14, Regolith Mapping Standards
(Project Leader: Colin Pain)

i. Scientific activity and progress within project
Continued discussions with State and Territory people interested in regolith mapping.

ii. Student activity
None

iii. Significant presentations and publications
Seminar at GA early in 2004.

4. Project 3.12 Regional Geochemical Surveys-MDB Pilot
(Project Leader: Patrice de Caritat)

i. Scientific activity and progress within project

Analysis of all samples from the Eastern Riverina region by XRF, ICP-MS and INAA, for 63 elements in total (<180 um fraction). Determination of soil pH, texture, Munsell colour (wet & dry), pH 1:5, EC 1:5 and laser particle size distribution for all samples from the Eastern Riverina. Preparation of all selective extracts, ready for ICP-MS analysis (next Quarter). Preparation of preliminary diagrams (EDA stats, maps, QA/QC) Planning fieldtrips to Western and Northern Riverina, groundwater collection trip in Eastern Riverina (next Quarter). Liaising with scientist from UofQ who's done similar work in Queensland

ii. Student activity within projects

Alexis Hickey was a LEME Summer Student (ANU) in Jan-Feb

iii. Significant presentations and publications

Presentation at the Australian Geological Convention (Hobart, 8-13 Feb 2004)

5. Project 3.13 Regional Geochemical Surveys, South Western Australia (Project Leader: Charles Butt)

i. Scientific activity and progress within project

On being given access to some compelling confidential data, the original intent of this project - "To conduct scoping studies…." was changed in favour of moving directly to the preparation of a full project proposal to the GRDC in November. Unfortunately, despite some initially encouraging responses, the proposal was rejected. This year, the funding available to GRDC is greatly reduced over previous years, a situation unlikely to change until 2006-7. We understand that whilst the issue was recognised as potentially significant to the wheat industry in WA and the project well thought-out and likely to achieve its aims, other issues were regarded as more pressing. That, coupled with existing commitments, has greatly reduced the funding available to GRDC for new investments. We now have to decide whether to seek alternative funding for the whole project and, if so, whether to continue with the same argument and project proposal, or to consider whether the case might be boosted by conducting some scoping studies.

ii. Student activity within projects.

Nil

iii. Significant presentations and publications

Nil

6. Project 3.7 High Resolution Geophysics/Seismoelectric Layer Detection (Project Leader: Anton Kepic)

i. Scientific Activity

Field tests conducted at the Nannup test area (southwest WA) of the seismoelectric method. A new technique of gathering the data was trialed successfully at three different borehole locations. The method correctly detected many sand/clay interfaces from 5 metres to depths of more than 120 metres. Normally, only 50% of the soundings are successful in producing any interpretable data, so this is a great improvement. New records for depth of detection were also achieved. We are able to see an 3 to 10x deeper than other researchers in the field.

Work on the ANSTO equipment proceeded slowly with the engineers in Qld now expecting to deliver prototypes of the new data acquisition equipment to Dr Kepic in May for evaluation.

ii. Student Activity

Margarita Norvill and Mohommad Rosid worked in the Nanup field trials, and produced conference abstracts based upon the work in the quarter. These will be presented in August (ASEG, Sydney), and in October (SEG, Denver).

iii. Presentations and Publications

The previous seismoelectric work at Nanup of Rosid and Kepic was presented at the Symposium for the Application of Geophysics for Environment and Engineering (SAGEEP) in Colorado Springs, US. A full paper was written for the conference proceedings.

EDUCATION & TRAINING PROGRAM QUARTERLY REPORT

JANUARY – MARCH 2004

Steve Hill
7 May 2004

Since the end of this period (April 26) Pat James has concluded as Education & Training Program Leader and has been replaced by Steve Hill.

STUDENTS AND SCHOLARSHIPS

New Scholarships Awarded During the Quarter

Honours

ANU (5) Kehoe; Leonard; Reisz; Woolrych; Bamford
AU (4) Anderson; Pfeiffer; Tylkowski, Wittwer
CUT (1) Whitford

Postgraduate

ANU (5) Drewry; Wallace; Wong; Carlile; Worthy
AU (4) Dart; Gibbins; McDermott; Petts
CUT (3) Abbott, Cook, Kreige

Summer Research

ANU (1) McRae
AU (8) Davey; Kropinksi; Lawley; Loye, Madonna; Pewkliang; Reid; Wellby
CUT (1) Schafer

Student Quarterly Reports

The first round of Quarterly Reports from our Postgraduate Students was requested during the period. Some of these were incorporated in the inaugural 'Mineral Exploration Electronic Bulletin' circulated by the CEO. The majority of 2nd Quarterly reports from Postgraduate students has been forwarded to Head Office for the next update.

Other Student Activities

Leanne Hill (ANU) submitted her PhD thesis in January 2004. She has since commenced employment within the graduate program of Department of Environment and Heritage (DEH). [please note: this corrects a previous entry on this item in the last executive meeting report]

Andrew McPherson (submitted PhD at ANU in December 2003) has since commenced employment with Geoscience Australia

MTEC ACTIVITY

MTEC activities over the period 1 January-31 March included the teaching of three highly successful Honours-level courses:

- Regolith Geology and Geochemistry (RGG), 23-27 February, Wilsons Promontory Victoria

- Regolith Mapping and Field Techniques (RMF), 15-19 March, Fowlers Gap NSW
- Introduction to Hydrogeochemistry (HGC), 29 March-2 April, University of Melbourne.

Students came from a range of Australian universities including those within all three CRC LEME core party universities, the MTEC network and other universities including La Trobe, Macquarie and Wollongong. Numbers were relatively healthy: RGG 15; RMF 15; and HGC 13. Teaching staff came from all three CRC LEME core party universities plus Geoscience Australia.
Projected student numbers for the remainder of the 2004 Honours program continue to look healthy. Planning continues for the remainder of the 2004 program, and for much of the 2005 program, owing to the need to pre-book accommodation.

Following the Melbourne meeting of the MTEC partners on Dec 5, copies of the MTEC Schedule and Agreement (Draft 1) were received from Alison Way on Jan.21. The documents were sent to the CEO and Gary Kong who have recently received and distributed legal advice concerning details of the documents.

VIRTUAL REGOLITH WORLDS
Pat James presented a project review report as a part of the CRC LEME project reviews. There was little progress on this project, mainly due to departure of the research assistant (Andrew McPherson) who left to begin work in GA.. This project is presently being resubmitted for the next (2004-5) financial year by Steve Hill.

OTHER ACTIVITIES

17TH AGC
More than 600 delegates attended the 17th AGC at the Wrest Point Convention Centre in Hobart from 8-13 February 2004.

CRC LEME had a significant presence at the event, being a Silver Sponsor, an exhibitor, as well as contributing in excess of 30 papers to the technical program, including a number of student presentations.

Education and Training Committee
No formal meetings, but all members were contacted a number of times for comment and advice concerning scholarship applicants, rankings, projects and offers.