*pmd*CRC* Quarterly Report

April 2005 to June 2005

Stage 2, Project Y4
Name of Project: Concepts to targets: a scale integrated mineral systems study of the Eastern Yilgarn Craton

Project leader: Richard Blewett
Project team:
GA R. Blewett, T. Brennan, K. Cassidy, D. Champion, K. Czarnota, B. Goleby, P. Henson, M. Nicoll, Geophysicist (to be appointed).
UWA Louis Gauthier, Klaus Gessner, Steffen Hagemann, Johanna Hodge, Mehrdad Heydari, Klaus Petersen, Peter Neumayr
JCU James Cleverley, Nick Oliver, Gerard Tripp.
CSIRO Alison Ord, plus one full time equivalent modeller
Uni Melb Mark Kendrick, Roland Maas, John Miller, Dave Phillips, Tony Roache, Carl Young, embedded researcher (Wallaby) to be appointed
Monash Anthony Morey

Partner institutions: Geoscience Australia, The University of Western Australia, CSIRO EM, Monash University, The University of Melbourne, James Cook University

Contents

1. Introduction / aims of project:

The principal outcome for the Y4 project will be a multi-scaled 4D understanding of the world-class orogenic gold mineral system of the Eastern Yilgarn. A measure of our success will be the successful application of this understanding to the predictive targeting of undiscovered resources in near mine areas, as well as concepts and hypotheses that can be applied to targeting in data-poor areas.

To achieve this outcome the project aims to produce a series of well-constrained 3D maps at a variety of scales that integrate the structural–stratigraphic history and the alteration–fluid history with the evolution of the architecture. Using this scale integrated approach, the project will develop criteria to improve area selection, near mine exploration and ore shoot identification. It is envisaged that many of these criteria will apply in a generic sense to other terranes.

The project aims to develop a range of hypotheses from the geodynamic (whole of orogen to base of lithosphere) scale to the mine-site specific scale. These hypotheses will be tested with numerical models that will have local as well as generic applications.

The project will work closely with the sponsors to ensure that the research results and deliverables meet their needs and expectations, have an impact and deliver tangible value for predictive mineral discovery.

The project has fifteen (15) key deliverables, each with a set of milestones.

1. New time-space event history database, charts, and maps

Work in progress

- Proposal submitted to the *pmd**CRC History programme funds for additional detrital zircon geochronology for Rick Squire. These funds are additional leaverage to extend the scope of his MERIWA project to Late Basins other than those around Kalgoorlie. (Richard Blewett)

2. Reports on an updated structural history/stratigraphy (unravelling the D's)

Work in progress

- Targeted structural mapping and sampling (thin section work) in Kalgoorlie region (Gerard Tripp)
- Structural compilation and data reduction for Bardoc tectonic zone (Anthony Morey)

3. Maps and reports of regional metamorphism and PT*t* history integrated with structural and alteration history

Work in progress

- Report on pyrite dating (Mt Charlotte and Kanowna Belle) in progress (John Miller)
- Masters student undertaking a project to test fluid flow and the thermal consequences of convection and downflow to reproduce the metamorphic isograds around Kalgoorlie and Kanowna Belle. Modelling will be completed early next quarter (Julia Blockeel).

4. Report on likely geodynamic models of the Yilgarn, with appropriate tests and possible analogues, and a workshop

5. 3D maps/GIS of specific districts to be build on Y2 regional 3D map (*Laverton, Kalgoorlie-Kambalda, Agnew*)

Work in progress

- Kalgoorlie-Kambalda 3D map stratigraphic infill ongoing. Progress to date ~40% complete (Terry Brennan)
- Regional solid geology GIS Qa/Qc process completed with checking labels and polygons from the AMIRA granite map merge with Y2 solid geology map (Richard Blewett)
- STOMP paper abstract accepted for oral presentation on dome architecture and fluid flow (Paul Henson)
- Appointment of geophysicist Dr Indrajit Roy (16th June)
- Progress on merging Laverton detailed geophysical datasets kindly supplied by sponsors (Indrajit Roy)
- Compilation of various solid geology maps of Laverton area nearly complete and await workshopping and approval from sponsors in late July-early August.
- GIS of merged and compiled data for Laverton for sponsor delivery next quarter. (Paul Henson).
- Significant progress in building 3D models of the Victory – Defiance – Conqueror, and Junction deposits, and focused on integrating the architecture with the alteration patterns. The Leapfrog and alteration model for Junction and Victory-Defiance are essentially completed and currently interpreted. However, during the interpretation of the models it is expected that some minor additions to these models will be made. (Tony Roache, Carl Young, Peter Neumayr and Klaus Petersen)
- Working with Kanowna Belle geologists to extend the 3D model of the Kanowna Belle deposit to depth. The work has involved compiling and checking existing geological data as well as building the 3D model. (Carl Young)

Issues

- The Kalgoorlie-Kambalda 3D map infill is lagging, and should have been 'completed' at the end of this quarter.
- The project is acquiring the gocad plugin SPARSE, which should speed up the intricate elements of the model building. At our present rate, the Kalgoorlie-Kambalda 3D map would take to the end of the project!

- An updated version of the Kalgoorlie-Kambalda 3D map is being prepared for release to sponsors along with documentation early next quarter. (Richard Blewett)

6. Map and report on the early extensional architecture and history

7. Reports on the character of key faults, especially the deep-tapping 'cracks'. Acquire new data (*MT and tomography*).

Milestones

- Morey, A.A., Weinberg, R.F., and Bierlein, F.P., (*in press*), Deformation history and multiple mineralisation events within the Bardoc Tectonic Zone, Eastern Goldfields, Western Australia, In Mao and Bierlein (eds), 8th Biennial SGA meeting, extended abstracts volume
- Manuscript submitted to Mineralium Deposita: Morey, A.A., Weinberg, R.F., and Bierlein, F.P., Multiple gold mineralisation events within the Bardoc Tectonic Zone, Eastern Goldfields Province, Western Australia

8. Report on an improved geologically intelligent geophysical inversions, supported by a rock property database

Results

New mineral estimation filter can now be applied to inversion results. (Nick Williams)

Work in progress

- Further developed and expanded the mineral estimation filter. Developed application for IOCG inversion results, refined procedure, and optimised code.
- Developing a step-by-step guide to preparing and running inversions for mineral exploration based on Perseverance inversion work.
- Prepared an abstract entitled "Identifying sulfide mineralization from physical property measurements: its development and application to mineral exploration inversions" for the Geological Society of America Annual Meeting and Exposition in Salt Lake City, Utah, in October 2005.
- Continue compiling a work-flow for the Perseverance gravity inversion case study.
- Prepare presentation of the magnetic susceptibility of rocks and minerals for UBC-GIF Physical Properties working group.
- Incorporate WMC's 3D geological model of Perseverance into the gravity inversions, once more information on rock types and names and properties is obtained (see issues). (Nick Williams).

9. Reports and chemical models on the end-member fluids (magmatic, basinal, meteoric, metamorphic, mantle?)

Milestones

- Completed a sulphide paragenesis study of five mineralised sites within the Bardoc Tectonic Zone (BTZ); this includes multiple mineralised phases at Paddington, and one each at Talbot South (Broad Arrow Camp), Nerrin Nerrin (gold prospect) New Boddington and Yunndaga. These findings have been augmented with in depth *in-situ* S-isotope analyses of key mineralised and selected unmineralised sulphide phases. (Anthony Morey)
- Analysed the reduced end member fluid in the Conqueror area at St. Ives. This is a **breakthrough**, because fluid inclusion preservation of the reduced fluid system is extremely poor. The fluid inclusions were discovered in quartz inclusions in pyrrhotite in a gently SW dipping reduced fluid conduit, distal to the Conqueror ore system. Microthermometry and laser Raman analyses (the latter in collaboration with Terry Mernagh, Geoscience Australia) revealed that the reduced fluids are composed of CH4, CO2, and N2. Water, if present, is a subordinate component. (Klaus Petersen)

Work in Progress

- A report on the major outcomes of the sulphide paragenesis within the BTZ is presently in preparation (for 3rd quarter) (Anthony Morey)
- A noble gas study on selected samples from Wallaby and St. Ives was initiated in collaboration with Mark Kendrick (Univ. Melbourne). A proposal for the noble gas work was submitted to the *pmd**CRC. It is hoped that the data will add to information on fluid sourcing and depositional processes (e.g., phase separation). Especially information on fluid sources will have significant impact on area selection based on conceptual models. (Klaus Petersen)

10. Reports, maps and databases on integrated mineral paragenesis and architecture and chemical modelling for selected camps and deposits

Work in Progress

- Using optical and SEM imagery of sulphide- + gold-bearing assemblages has revealed a distinctive sulphide paragenesis of these phases for the Bardoc Tectonic Zone. At a number of localities, mineralised structures are typified by early arsenopyrite (asp) overprinted by pyrite (py) + visible Au ± base metal sulphides -> rutile/Fe-bearing oxides. The trace element geochemistry of the sulphide + Au grains using LA-ICPMS will be conducted (July 2005) to determine if the gold is remobilised out of solid solution from the early asp or if the Au-bearing phase represents a separate influx of hydrothermal fluids. (Anthony Morey)
- Sampling at Sunrise Dam and processing of samples in progress. (James Cleverly)
- Spent time working the CSIRO MERIWA Hylogger project assisting with the interpretation for the St Ives and Kanowna Belle sites and integrating results into the M358 project. (Tony Roache, Carl Young and John Walshe)
- Whole-rock multi-element analyses from across the silicified zone in CD10662 (St Ives) were received on the 23rd June, as were a suite of thin-sections predominantly from the same hole. PIMA analyses were taken across D3 foliation zones and spatially-associated felsic porphyries. Foliations and porphyries are associated with muscovite-paragonite and phengite compositions, respectively. (Tony Roache)
- A report on the findings of multi-element, petrographic, PIMA and structural work from Maximus will be released next quarter. A complete model of felsic intrusion, foliation development, and fluid history will be tested during underground mapping at Leviathan, which represents a well-mineralised environment. (Tony Roache)
- Completed petrography at the Hannons Lake and Otter-Juan areas and carefully selected samples for whole-rock geochemistry based on the petrography results. The selection process was slow because all rocks show multiple alteration overprints and samples with end member alteration without overprints is rare. (Mherdad Heydari)
- Summarised the geochemical evolution of the porphyries at the Golden Mile in a scientific paper and analysed selected alteration minerals with the microprobe. (Louis Gauthier)

11. Reports on integrated numerical models of fluid flow for generic and site specific scenarios

12. Regional footprint maps of alteration and fluid flow based on geochemistry, ASTER, HYMAP etc

Milestones

- ASTER data presented to sponsors at April Kalgoorlie meeting. Most sponsors have now received the data. Data includes an ERMapper script dedicated to Aster data for calculating band ratios of many mineral species. Presentations include 15 separate mineral ratios (including muscovite and phengite) for each scene. Around 170 scenes have been mosaiced into composite band ratio maps of the entire Eastern Yilgarn. Data volumes are around 170 Gb.

13. Map the chemical and PT gradients for selected sites (e.g., Wallaby, Sunrise, St Ives, KB), and regionally

Work in progress

- Kai Yang, CSIRO examined the Conqueror and Belleisle drill holes in order to differentiate between chlorite, amphibole, epidote and biotite from mixed spectra, and determine the differences in the composition of alteration minerals with proximity to Au mineralisation. (Tony Roache).
- Initial results indicate that Mg- and Fe-rich chlorite represent two proximal alteration styles. Mg-rich chlorite is detected as a partial or complete replacement of biotite, the latter being a diagnostic mineral within ore zones. Fe-rich chlorite represents a mix of minerals – biotite, carbonate veins and magnetite, with pyrite and chlorite that overprinted the former assemblage. Microprobe analyses of both types of alteration are needed to understand the spectra and identify true alteration signatures. A review of Leo Horn's microprobe data from CD10095W2 will provide information before proceeding with new data collection. (Tony Roache).

Results

- HyLogger mapping of the core revealed structures associated with particular spectral responses, including a paragonite/muscovite fabric documented within St Ives and Kanowna Belle. The white mica zones, were important fluid conduits at the time of Au mineralization, so mapping their distribution and orientation will add greatly to the knowledge of Au-stage architecture, and aid vectoring in exploration. A demonstration of the importance and recognition of these white mica zones was given in a presentation and core farm trip during June. (Tony Roache)

14. Reports on the integrated structural controls of ore shoots with the regional framework, linked to alteration and mineralogy (e.g., Wallaby, Sunrise, St Ives, KB)

Milestones achieved

Sunrise Dam field work complete for John Miller.

4th to 8th April: Sunrise Dam field work, Laverton, W.A. Presentation of Wallaby work to sponsors on site.

19th to 27th April: Sunrise Dam field work (with Peter Neumayr, Nick Oliver and James Cleverley), Laverton, W.A.

28th to 29th April: Yilgarn Planning (Y4) meeting, Kalgoorlie, W.A. Presentation of Wallaby, St Ives and Kanowna-Belle work to sponsors.

30th April to 6th May: Sunrise Dam field work, Laverton, W.A.

Work in progress

- Final touches to Wallaby report (will be delivered early in 3rd quarter)(John Miller)

15. Report on reactive transport models tested against specific sites where paragenesis and structure understood

2. Student details (if applicable)

Activities included within the project deliverables and results

Key Performance Indicators (see guidelines for definitions)

3. Publications.

Please report publications under the following headings

Conference Abstracts

STOMP Townsville abstracts accepted

- Testing the fool's clock: $^{40}Ar/^{39}Ar$ dating of pyrite, by Miller, J. McL. & Phillips, D

- Domes: the characteristic 3D architecture of the world-class lode-Au deposits of the Eastern Yilgarn, by Henson, P.A. et al
- Structural and geochemical architecture of intrusion-associated lode-gold deposits, Eastern Goldfields, Yilgarn Craton, by Neumayr, P., et al.
- Integrated structural and spectroscopic identification of foliation zones and alteration related to Au mineralization at St Ives, Kambalda, Western Australia, by Roache, T. & Yang, K.
- Palaeohydrological evolution of the St. Ives gold camp, by Petersen, K., et al.
- Two boxes we don't need: orogenic and intrusion-related gold systems, by Walshe, J., et al.
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Workshop notes
Journal Articles
Periodical/Newsletter Articles

- Date of publication
- Citation

Promotional Presentations

- Richard Blewett gave a presentation on the Y2 3D model to the CRCA (Association) Annual conference in Melbourne (19th May 2005)
- Paul Henson demonstrated the Y2 and I1 3D models to the pmd*CRC board at GA (24th May 2005)

Visiting Lecture

- Date:
- Title:
- Venue:

4. Training courses

5. Project meetings

Name	*Date*	*Venue*	*Number of Researchers*	*Number of sponsors*
John Walshe, Kas Deluca and Scott Halley held discussions on the future of the embedded researcher program at Granny Smith	April 6th	ARRC, Perth	1	2
Discussion with Placer Dome and St Ives re future of the MERIWA project	April 20th-22nd	Kalgoorlie – St Ives	1	various
Fieldwork and scoping	April 22-27th	Sunrise Dam	2	various
Y4 – project planning and delivery to sponsors	28-29 April	Kalgoorlie	15	30
CSIRO Hylogger	May 2nd –	Kalgoorlie/St	3	various

project	May 6th	Ives		
John Walshe and Peter Neumayr met with the MRAC subcommittee re the new MERIWA project	13th May			
John Walshe & James Cleverley discuss a petrographic program on Kanowna Belle and environs.	May 23rd-25th	Kanowna Belle	2	various
Klaus Petersen and Peter Neumayr at to work on identifying and sampling cross-structures in the Victory-Defiance area, work with Tony Roache and supervise Steve Whitehead.	May 23-27th	St Ives		

6. Workshops

Workshops					
Name	Date	Venue	Number of researchers	Number of industry/sponsors	E&T affiliated event (Y/N)
One-day work shop at based on the MERIWA research	June 24th	CODES, University of Tasmania,	1	Various, but included Scott Halley as presenter	

7. Conferences/Symposia

Conferences/Symposia					
Name	Date	Venue	Number of researchers	Number of industry/sponsors	E&T affiliated event (Y/N)

8. Shortcourses

Shortcourses					
Name	Date	Venue	Number of researchers	Number of sponsors	E&T affiliated event
John Miller, Peter and John Walshe continue to provide on-site training and development for	During field visits through the quarter	On site: Wallaby, St Ives, KB, SRD	variable	variable	No

sponsors					

9. Media

Media releases					
Title of media release	Date of release	Originator (Author)	Originator/Author organisation	Subject of the media release	
Media Reports					
Name of report	Date of report	Reporter's name	Media type (print, radio, TV, web, other	Media Organisation	Subject of report

10. Intellectual property created by project

11. Collaboration
    - Immense collaboration between researchers and sponsors. Details may be found in work in progress reports above under each deliverable
    - MERIWA project 377 was successfully established to support the embedded researcher program through 2005-2007.
    - It expected a new Embedded Researcher will be appointed to the Wallaby site in the next quarter.

12. Issues / problems
    - Requested from WMC more information on rock types, rock codes, and physical properties for the units in the 3D model they have developed, however, this information has not yet been provided.
    - Waiting for clarification from WMC as to what implications the recent acquisition by BHPB will have on my PhD work and my reporting requirements. (Nick Williams)
    - Susan Drieberg will complete her contract end of July 2005. It is expected a replacement for Susan will begin work on the Wallaby site in the next quarter.
    - Joanna Hodge suspended studies for 3 months for work reasons and recommenced work on fluid analyses at Conqueror end of June.