April-June 2006

Y4 Project Quarterly Report

predictive mineral discovery CRC

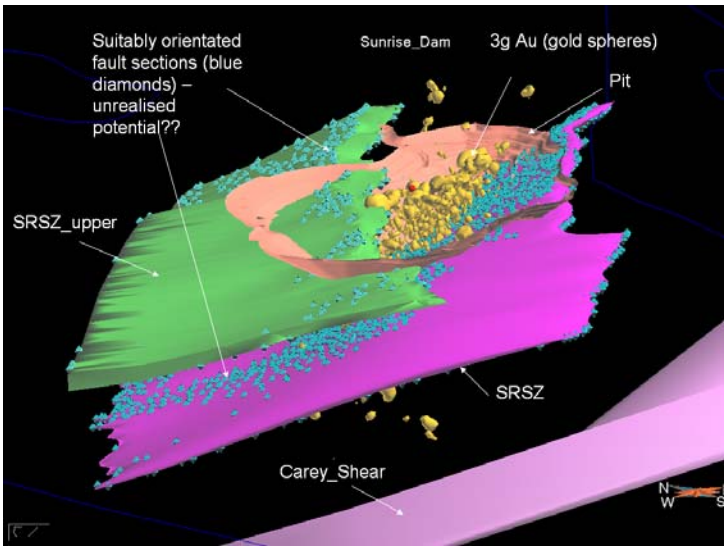
Highlights:

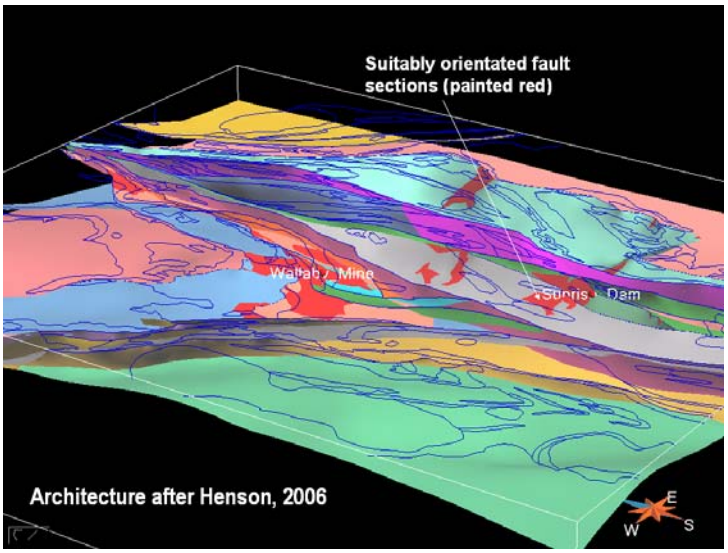
- Painting the faults
- MT survey news
- Detrital zircon story
- Metamorphic guru now onboard
- Successful *pmd**CRC conference for Y4
- Y4 successful in 3 History fund bids
- Release of 3D maps
- Embedded Researcher and Student News

Painting the faults: new results from Laverton

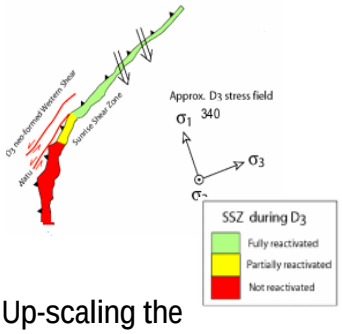
Detailed structural analysis of the Sunrise Dam deposit showed that not all segments of the Sunrise Shear were reactivated. Most favourable segments were oriented ~30º to 310 (Miller, 2006). Hypothesis – can we upscale this mine-scale understanding and map similarly favourably oriented faults into the district architecture? This is a first pass attempt to 'paint' faults in true 3D that were favourably oriented for Au mineralisation during local/district D3 (~NNW-SSE compression).

For more details see the Y4 Twiki page on:
https://pmd-twiki.arrc.csiro.au/twiki/pub/Pmdcrc/ProjectY4/paintedfaultsatlaverton.ppt





Calibration of the gold grade shells (yellow) of favourably oriented regions (sketch below) on the Sunrise Shear (blue spheres). The correlation is very good and deeper extensions that are favourably oriented are highlighted down dip and along strike.



Up-scaling the learnings to the district correctly predicts Wallaby as well as other (painted red) unknown (to us) sites worthy of consideration.

pmd*CRC

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PROJECT TEAM

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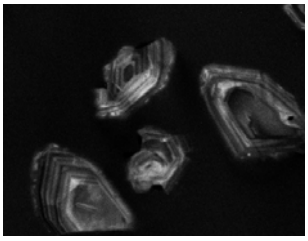
Johanna Hodge,
John Miller,
John Walshe,
Karol Czarnota,
Kevin Cassidy,
Klaus Gessner,
Klaus Petersen,
Malcolm Nicoll,
Mark Kendrick,
Mark Pirlo,
Nick Williams,
Paul Henson,
Peter Frikken,
Peter Neumayr,
Roland Maas,
Rick Squire
Terry Brennan,
Tony Roache,
Yanhua Zhang.

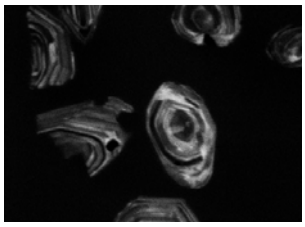
Magneto-telluric survey completed in May

The MT survey was completed over a 2 week period following the CRC conference. The team consisted of Richard Blewett and Indrajit Roy from Y4 (GA), together w/ Graham Heinson (Adelaide Uni) and Goran Boren (Flinders Uni). We acquired 20 of the 30 stations we initially planned, and encountered some instrument problems so dropped from 5 to 3 working instruments. This meant that we had to skip some stations and not do the cross lines. Results should still be good the others were icing on the cake.

We covered about 130 kms traversing along what is a ghost of seismic line (EGF1). Site 1 was 20 kms west of the Ida fault in some feral Youanmi Terrane (Southern Cross) country, and Site 25 was across the Ockerburry F well into the Kurnapli terrane (Gindalbi domain). Graham, Goran and Indrajit will be processing these data and I will keep everyone posted as results come through.

Rick's zapping zircons with a laser



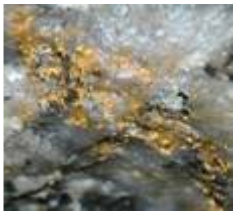


Preliminary results for analyses of Archaean detrital-zircon samples from St Ives that were dated using the laser ablation ICP-MS have produced results within error of SHRIMP detrital-zircon ages of the same units. This is a **significant outcome** for reliable, cheap, rapid and accurate dating of many more sedimentary sequences than 'traditional' SHRIMP techniques.

A feldspar-rich sandstone from the Black Flag Group near Nelson's Fleet produced a ^{208}Pb-corrected LA-ICP-MS age of 2689±6 Ma from 85 concordant grains (MSWD =0.8) and a ^{204}Pb-corrected SHRIMP age of 2686±11 Ma from a subset of 19 of those grains. A ^{208}Pb-corrected LA-ICP-MS age of 2662±7 Ma (MSWD=1.06) from 79 concordant grains was obtained for the Merougil Sandstone, which is almost identical to the ^{204}Pb-corrected SHRIMP age of 2664±6 Ma obtained by Krapez et al. (2000) for 22 concordant grains from the same unit. About 1,400 additional zircons from seven samples will be analysed over the next few months. For more information contact Rick.Squire@sci.monash.edu.au

Major deliverables next quarter

- Solid voxets of Kalgoorlie regional 3D map
- Report on Sunrise Dam structural evolution
- Report on detrital zircon study in Late-stage basins and Black Flag equivalents
- 5 Oral papers and a poster paper presentation at AESC (AGC) Melbourne
- Report on metamorphic studies with accompanying database
- Preliminary processing MT survey
- Presentations to Penrose conference at Durham UK on 3D Geoscience
- Targeting report for St Ives Goldfields



Underground Victory-Defiance

Embedded Researcher (ER) News

Peter Frikken in Kalgoorlie:

- Research and development into spectral science with application to routine exploration
- Collation of data into a proposal entitled "Target Generation by Mineral Mapping" - A Proposal for HyChipper/Logger. Proposal delivered to Barrick divisions in the Yilgarn, interest is positive and meetings with companies pending
- HyChipper will be available to clients in the goldfields late July

Tony Roache at St Ives:

- Talks and posters at CRC Conference, MERIWA 358/377, AIG Conference
- Initial Hychipper results presented to GoldFields
- Improving spectra import methodology to gocad
- Ongoing targeting with Leviatian Underground

Carl Young at KB:

- Modified and extended the Molar Mineralogy calculation worksheet
- Processed the geochemistry for drill holes from the Gordons district (NE Kanowna)
- Refined lithogeochemistry modelling of the Kanowna and Gordons Districts
- Regenerated lithology, alteration gold and vein type models in Leapfrog for Kanowna Belle and the greater Kanowna District. These models will be used to define the alteration architecture that is to be sampled in the next phase of logging and sampling (July – Sept)
- Compiled the Leapfrog modelling data and other available data into a Gocad model for the Kanowna District
- Prepared 3-D models of the Hylogger Data for KB and co-authored a poster showing the Hylogger results for the AIG-AMEC meeting in Kalgoorlie

Mark Pirlo at Granny Smith:

- Interpreting Lake Carey Hychipper spectra
- Lake Carey sediments submitted for multi-element analysis
- Processed geochemistry and PIMA spectra from the latest LEJV drilling
- Presentation at MERIWA 358/377 workshop in Kalgoorlie
- Received a number of site visits from pmd*CRC researchers
- Selected and arranged for samples of Wallaby core to be made available to other researchers (Andreas Mueller and Genalysis Laboratories)
- Summary of previous research at Wallaby and the Laverton district, most recently the Ph.D. thesis by Amanda Stoltze.

Student News

Joanna Hodge:

- Completed laser-Raman analyses of New Celebration (NC) fluid inclusions
- Completed first draft of NC paper
- Presented poster SEG Student Chapter Conference and attended SEG 2006 Attended post-conference fieldtrip to Bingham Canyon and Carlin

Anthony Morey:

- Report on Twiki available, regarding the alteration, mineralogy and S-isotope systematics of the BTZ
- Report in progress: Major- and trace-element geochemistry of arsenopyrite from the BTZ - implications for the bimodal distribution of gold. To be posted in Twiki in July 2006.
- Report in progress: Architecture of the BTZ and why it is not as mineralised as other major shear systems within the EGP. To be posted on Twiki August 2006

Nick Williams:

- Preparation for gravity and magnetic inversions over Perseverance
- Compiled 1200+ mag sus measurements from last November visit
- Completed coursework and wrote a 2D gravity inversion code for a term project. The UBC-GIF group is currently looking at ways to further develop my code into a tutorial for wider use.
- Preparing extended abstract and presentation for July AGC (Melbourne)

Y4 @ the Sharp End conference: an integral success for Y4

The Y4 team made a major contribution to the April 19-20 conference in Perth. We delivered eight oral papers from the team (including one on seismic from Richard Chopping of the A3 project). The team also presented 12 poster papers on a range of topics, including shows of the latest 3D maps on a plasma screen.

The presentations focussed on the integration of the Five Questions across the scales and use this integrated understanding to be predictive in terms of targets at a range scales. If you were not fortunate to join us at the conference, then please obtain a copy of the abstracts and talks/posters on Twiki.

view along EG01 seismic line site of MT

Y4 a partner in new CET Phd proposal

The Centre for Exploration Targeting has recently advertised for a Phd entitled "A Calibrated Predictive Model and Tool for Targeting Archaean Lode-Gold Systems of the Eastern Goldfields Province, Yilgarn Craton". The project is to be jointly supervised by Dr Oliver Kreuzer (CET), Prof Cam McCuaig (CET), Dr Richard Blewett (Geoscience Australia) and Dr Dan Core (Geoinformatics Exploration). A strong field was attracted to the position and candidates being shortlisted. I hope to welcome the new member to the team next quarter.

Geochronology and other 'History' activities

Roland Maas (Uni Melbourne) has samples for Lu-Hf dating of garnet from pelites in Late-stage Basins and mafic amphibolites from Ben Goscombe. Trace element data for eight exploratory garnet separates were of variable purity but of the kind we can produce quickly. Data look OK to the extent that we get decent Lu/Hf and Sm/Nd in most of the present separates, and need a little more picking for 2 of them to improve purity. We do have zircon present, Zr contents in the garnets were about 100 ppm, which is comparable to those I would expect in the whole rocks, or a little lower. I expected this. Pure garnet would only have a few ppm Zr.

Our three bids for History funding were successful:
Richard Blewett (GA) plans to complement the Lu-Hf dating of garnets by dating monazite using the SHRIMP hosted by metamorphic fabrics. There is a major weakness in our understanding of the temporal component of the Yilgarn's metamorphic evolution.

James Cleverley (JCU) aims to use in-situ laser ablation techniques to analyse Sr isotopes in apatite from the Sunrise Dam deposit to determine the role of mantle- versus crustal-derived fluids, in particular the more volatile-rich fluids associated with the apatite growth. The role of mantle or deeply derived fluids is controversial and typically unproven. These deposits have been chosen because the samples are already prepared and well characterized and their context within the terrane projects is well established.
John Miller (UWA) and Birger Rasmussen will date (using the U-Pb system) well constrained samples from the Wallaby deposit to obtain an age on the radial extension associated with the plutonism (magmatic calcite veins), the haematite-associated lodes linked to NW-SE compression and the late-stage sinistral-slip lodes. (see also painting faults story). The project would utilise TIMS analyses on monazite from the magmatic calcite veins and insitu SHRIMP analyses on monazite and xenotime from the ore-related alteration.

The project is also infilling the Sm-Nd map from Dave Champion in key northern areas.

Y2 Final Report released open file

The Y2 Final Report has been recently released as GA Record 2006/05. Copies may be purchased from the GA Sales Centre. It is essentially the same as the report released to sponsors in January 2005. The advantages of the release are that the 3D maps can be used in the public domain. Requests have been received for tomographic volumes from gocad. All these objects are on this comprehensive DVD. See http://www.ga.gov.au/ausgeonews/ausgeonews200606/productnews.jsp#product1
Follow link for a 'paper' on Yilgarn domes http://www.ga.gov.au/image_cache/GA8248.pdf

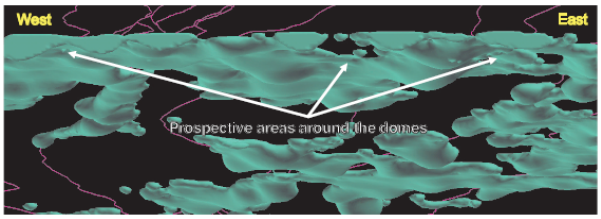


Figure 5. Perspective view looking north from underneath the geologically constrained gravity inversion model (green volume), showing the undulous nature of this surface. Purple lines are the regional fault traces on the Earth's surface.

Qualitative Foliation Intensity Index (QFII*):
For field-based classification of strain from developed fabrics and structures.

QFII	Grain refinement (mechanism)		Deformation at low to medium grade Greenschist and sub-Greenschist facies (<500 °C)			Deformation at high grade Amphibolite & Granulite facies (>500 °C)		Other Structures (First appearance)
			Micaceous Pelites	Massive Granular Mafics, Granitoids, Gneisses	Monomineralic Carbonate, Quartzite	Micaceous Pelites	Massive Granular Mafic, Granitoid, Gneiss, Carbonate, Quartzite	
10	Ultramylonite	100-95%	Ultramylonite	Ultramylonite	Ultramylonite	Ultramylonite	Ultramylonite	Flat Sheath folds
9	Mylonite	95-85%	Mylonite	Mylonite	Mylonite	Mylonite	Mylonite	CMS, Elliptical sheaths
8	Mylonite to Prob-	85-70%	Mylonite to Protomylonite	Mylonite to Protomylonite	Mylonite to Protomylonite	Mylonite to Protomylonite	Mylonite to Protomylonite	A-folds
7	Protomylonite	70-50%	Pervasive/ Intense schistosity	Schistose / Protomylonite	Elongate grainshapes = Ribbons	Protomylonite / Ribbons		C/ Sheeted & Drawn boudins
6	Sub-protomylonite	<50%	Strongly schistose	Foliated gneiss / Strong grainshape fabric	Strong grainshape fabric	Strongly foliated gneiss		C-S, Domino boudins
5	Ductile		Cleavage / Fine schist / Spaced schist	Gneissic fabric / Moderate grainshape fabric	Moderate grainshape fabric	Foliated gneiss = Strong grainshape fabric		Tom & Nacked boudins
4	Ductile		Cleavage / Slate / Phyllonite	Weak grainshape fabric	Weak grainshape fabric	Strong grainshape fabric		Pressure fringes, Gash boudins
3	Ductile-Brittle		Spaced cleavage	Cleavage / Spaced seams	Subtle grainshape fabric / Seams	Moderate grainshape fabric = Spaced seams		Crenulations
2	Ductile-Brittle		Crenulation cleavage	Spaced cleavage	Spaced seams	Weak grainshape fabric = Spaced seams		Pendi cleavage
1	Ductile-Brittle		Spaced disjunctive cleavage	Spaced disjunctive cleavage	Stylolites / Disjunctive cleavage	Subtle grain alignment = Wide spaced seams		Kinkbands
0	None		None	None	None	None		None

* Proposed scale indicating approximate strain, to aid in mapping strain distribution. "Intensity" = (grainshape aspect ratio / spacing), an arbitrary ratio from planar elements.
Problems: QFII can be obscured by annealing and is dependent on deformation mechanisms, rheology, rock type, mica proportion, grainsize & metamorphic grade etc.

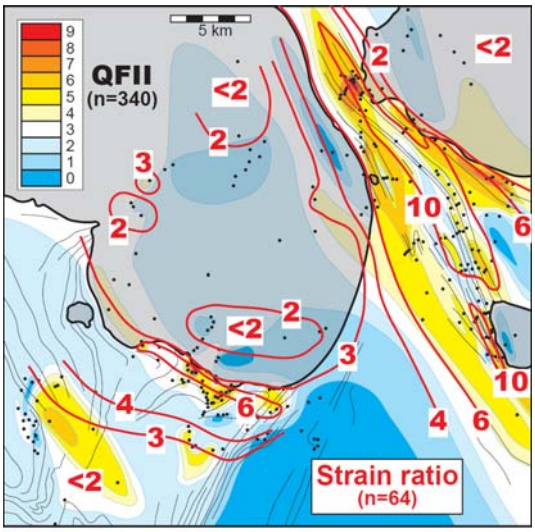
Ben Goscombe: Y4's new metamorphic guru

It is great pleasure to welcome Dr Ben Goscombe to the project. He brings a wealth of knowledge and experience in metamorphic-structural-geodynamic geology to bear on the critical of questions regarding the how, why and when metamorphism occurred in the Yilgarn. Most of the Y4 contract funds have been allocated to pay for this work, but it still only funds a part time salary. I will be looking to boost this by approaching the sponsors for additional money, probably through a MERIWA route. Ben is with us at least until the end of January 2008 (Final Report time) and I would hope to have him contribute the Final CRC conference (probably April 2008). A report (digital database) of Ben's extensive compilations to date will be released to sponsors in July. Ben can be contacted at ben.goscombe@adelaide.edu.au

First report from Y4's new metamorphic guru

Ben Goscombe has posted his first report on Twiki (https://pmd-twiki.arrc.csiro.au/twiki/bin/view/Pmdcrc/ProjectY4).
The report includes:

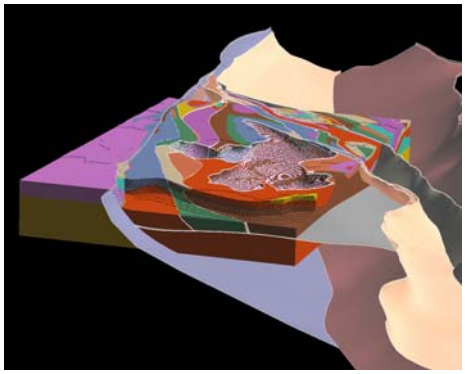
- a compilation database of the very extensive GSWA and Mickuki metamorphic data holdings for the Eastern Goldfields Superterrane. The database has spatial, chemical, mineralogical/alteration, textural, paragenetic, and strain attributes
- several methodology documents including strain mapping and Diagnostic Mineral Fields. A useful table and field guide to quantify strain (see map on right) is included.



Strain map of the eastern half of the Minerie 100K sheet.

Kalgoorlie regional 3D map with 'solid' stratigraphy: released

New tool for strain estimation



Terry Brennan, the Y4 project's main 3D map builder, has completed the infill of the stratigraphy of the Kalgoorlie regional 3D map. The release of this revised map (CD to be sent to sponsors) marks a significant effort in R&D for the project, especially considering the 3D map's unprecedented size and complexity. The project is reviewing the attributes (properties) it will attach to the voxets and surfaces. The first task will be to attach density estimates for each voxet and invert the 3D map and test it against the observed gravity field.

List of project events for the quarter

Project meetings

Name	*Date*	*Venue*	*Number of Researchers*	*Number of sponsors*
Y4 project meeting Perth-based team	3 April	UWA	10	0
MERIWA M377 and CRC meeting in Kalgoorlie with sponsors	29 April	Kalgoorlie	5	15
MERIWA and CRC dinner in the desert with Barrick and St. Ives sponsors	29 April	Kalgoorlie	5	15
Sponsor presentation to GSWA	24 April	Kalgoorlie	3	5
Fieldwork and sponsor presentations: Paul H and Richard Chopping	22 April – 29 April	St Ives, Wallaby, SRD	2	>30 across the 3 sites
Field work: Richard B, Indrajit R – MT survey	22 April – 6 May	Kalgoorlie terrane	2+2(Adelaide & Flinders)	N/A
Peter N and John W present to Goldfields head office: research results and CRC targeting strategies	9 May	Perth	2	2
Fieldwork Rick S	May	St Ives, Wallaby, Lawlers	1	Various at sites
John W, Peter N targeting meeting with Leviathan underground geologists to define targets under Victory	2-4 May	St Ives	3	2
John, Peter, Peter Frikken tour of Laverton – Lawlers area to report to sponsors on site and identify opportunities for further work with sponsors	15 May - 19 May	Lawlers, SRD, Walaby	3	various
John W and Peter N presentation invited to Darlot	26 May	Darlot	2	6
Peter N and John W meeting with MERIWA executives to discuss M358 report	31 May	Perth	2	N/A
Peter N meets Mark Doyle re SRD program	8 June	Perth	1	1
Project team meeting for Perth-based	26 June	CET	10	N/A
Fieldwork and Targeting workshops: John W, Peter N, Richard B, Tony R, Richard C	27-28 June	St. Ives	4	15
John W, Peter N, Peter F, Carl Y	29-30 June	KB and Kalgoorlie	4	various

Workshops

Name	Date	Venue	Number of researchers	Number of sponsors

Conferences/Symposia

Name	Date	Venue	Number of researchers	Number of sponsors
Science at the Sharp End *pmd**CRC conference		UWA	14	~30
AIG (John W and Peter N), Peter edited the abstract volume. Presentations by John M, Richard B and Tony R.	30 April - 3 May	Kalgoorlie	6	lots

Shortcourses

Name	Date	Venue	Number of researchers	Number of sponsors
Peter Neumayr, Klaus Petersen and John Walshe continue to provide on-site training and development for sponsors	See above	On site: St Ives, KB,	variable	variable