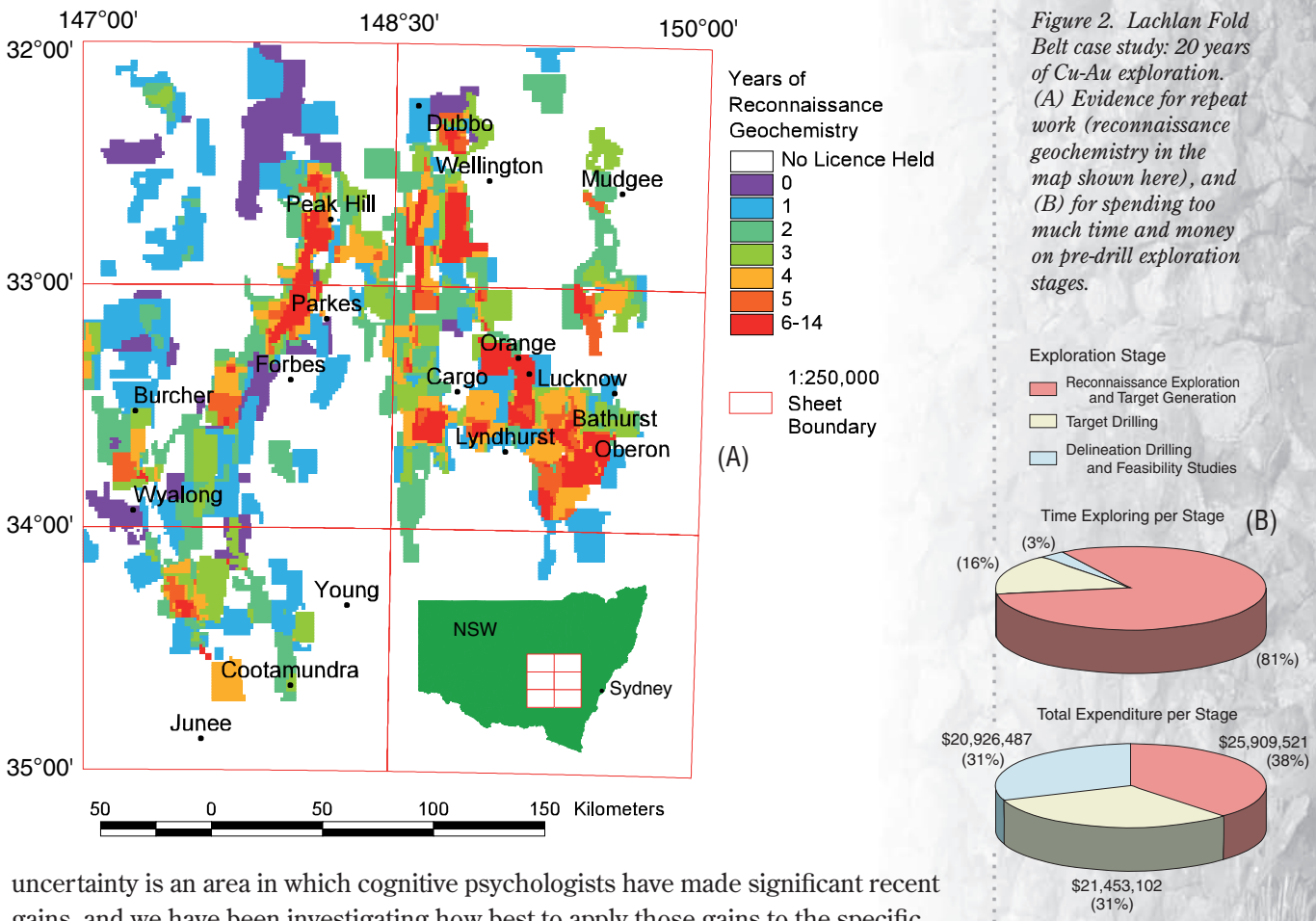


Figure 2. Lachlan Fold Belt case study: 20 years of Cu-Au exploration. (A) Evidence for repeat work (reconnaissance geochemistry in the map shown here), and (B) for spending too much time and money on pre-drill exploration stages.

uncertainty is an area in which cognitive psychologists have made significant recent gains, and we have been investigating how best to apply those gains to the specific issues around decision making in exploration. We have designed and provided an in-house workshop on Decision Making Under Uncertainty to each of our sponsors, and will undertake surveys and cognitive tests with our sponsor staff during 2005.

Contacts: Mike Etheridge, Oliver Kreuzer, Maureen McMahon
Funded by: BHP Billiton, Codelco - Chile, Geoinformatics Exploration Australia, Gold Fields Australasia, Jackeroo Drill Fund, Newmont Australia, Placer Dome Asia Pacific, Teck Cominco, WMC Resources and the Macquarie University VC Research Development fund

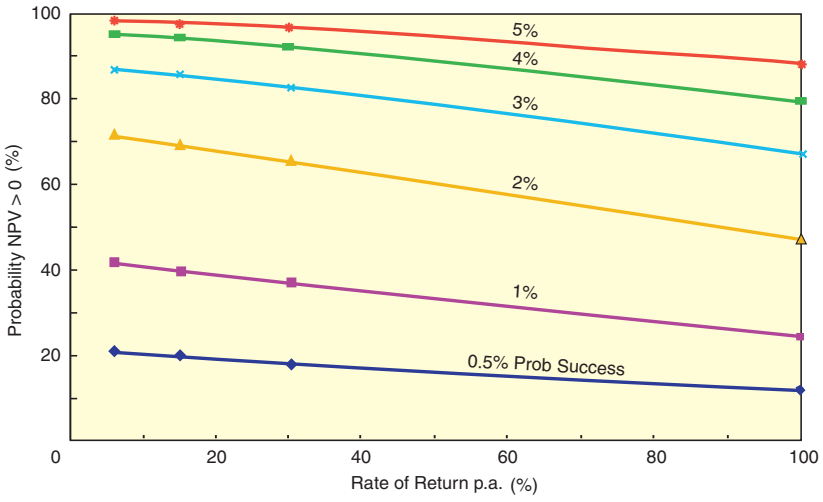


Figure 3. Example of an output from the exploration value simulation in @RISK. The graph shows the probability of achieving (NPV>0) rates of return on exploration funds invested of between 5% and 100%, at probabilities of discovery success ranging from 0.5% to 5%. This result illustrates the remarkably low sensitivity to rate of return (low slope on curves), and the high sensitivity to average probability of success (wide separation of curves).

Teaching and training program

undergraduate




GEMOC's teaching program aims to:

- provide undergraduate and postgraduate students with a broad, integrative understanding of Earth architecture and processes, bridging the discipline boundaries of geology and geophysics
- train undergraduate and postgraduate students in new conceptual approaches and the applications of advanced technology, including geochemical analysis techniques and the integrated field and laboratory use of geographic information systems (GIS)
- develop international links in teaching programs (especially postgraduate) relevant to GEMOC's goals
- develop formal tailored course work components at postgraduate level which also can be packaged for distance education delivery and as short courses available to the mining industry
- enhance the pool of high quality geoscience graduates by restructuring academic programs to attract a new clientele

HIGHLIGHTS 2004

Curriculum Development

- Our tailored problem-based learning (TPBL) units GEOS116 Marine Geoscience and GEOS115 Earth Dynamics, Materials and the Environment continue to be revised and were, again, well received by students. The format includes lectures, problem-based workshops and traditional skill-based practicals. The workshops are completed as group work projects and are modelled on real-life scenarios with the students adopting a role as part of a geoscience team.
- GEOS377 "Environmental Geology" was redesigned with the help of a Macquarie University Teaching Development Grant. The project was titled: Bringing the workplace into the classroom – the redesign of GEOS377 using Tailored Problem-Based Learning and real workplace scenarios. This unit utilised the TPBL model but also aimed to introduce professional and generic skills that are seen as important by employers of graduates in the environmental geology area.

Mapping an outcrop near Broken Hill, GEOS307 Field Geology and Mapping.

The unit is based around 3 projects that develop scientific problems from an initial tender stage to the preparation of final reports. All work is completed as group work with students taking the role of small consulting teams. GEOS377 Environmental Geology is a core unit of the new Bachelor of Enviromental Science in Environmental Geology.

Mapping an area at Hill End, GEOS230 Field and Laboratory Studies in Geosciences.

- Nathan Daczko co-ordinated three units in 2004 - GEOS115, GEOS230, and GEOS307. GEOS230 Field and Laboratory Studies in Geoscience was run for the first time. This unit uses projects integrated with lectures and laboratory classes to develop the theoretical knowledge and hands-on experience needed to map, describe and interpret rocks (and other materials – eg soils, fossils, etc) in the field and the laboratory. Laboratory techniques covered include petrographic microscopy, x-ray diffraction, x-ray fluorescence, electron microprobe, geoscience computing and the construction and interpretation of geological and other maps. A new field trip to the historic gold mining town of Hill End provided an excellent opportunity to apply these laboratory practices in the field. This new unit attracted 19 students from the Department of Earth and Planetary Sciences in 2004 and will be offered externally for the first time next year.
- GEOS307 Field Geology and Mapping was again run in the Broken Hill/Olary region in conjunction with the University of Sydney. Field studies in the Broken Hill/Olary region allow students to gain experience mapping in a geological province not encountered before in their course. The unit attracted 21 students from the Department of Earth and Planetary Sciences in 2004.
- Another successfull field-based unit GEOS373 “Volcanic Geology Fieldwork”, centred on a trip to New Zealand, was run again in 2004.

Scaling the heights of Mt Tarawera on the GEOS373 "Volcanic Geology Fieldwork" trip to New Zealand.

- The use of computer packages and web interfaces in Earth and Planetary Sciences continues as a routine feature of content and skills delivery. Both geology and geophysics units incorporate packages used by industry into classroom and field teaching. Our portable computer lab allows students access to up-to-date computer software for use in both the classroom and field.

Geophysics teaching progress 2004

- The named degree, Bachelor of Geophysics, continued in 2004 after its inception in 1998 to increase the visibility of Geophysics. It has evolved into the advanced geophysics stream in the Bachelor of Science degree.
- The Bachelor of Technology in Exploration Geoscience has a Geophysics strand initiated in 1999, streamed from second year level (see flow sheet in *Appendix 6*).
- Use of an extensive pool of GPS units for undergraduate (and postgraduate) fieldwork continued.
- Extended implementation of new seismic, gravity GPS and resistivity equipment for student field projects in exploration, groundwater, environmental and engineering geophysics.
- Equipment upgrades funded by Macquarie University over the last five years have resulted in an excellent array of new instrumentation. Acquisitions include:
  - GEOMETRICS G856 Proton Precession Magnetometer
  - GEOSOFT, MODELVISION, EMVISION, ERMAPPER and Claritas software was either purchased or upgraded
  - Seismic trigger cable modifications
  - ABEM SAS4000 Resistivity System and an ABEM LUND system
  - ASHTECH Z-Xtreme Differential GPS system
  - DUALEM Frequency Domain EM System

OUTCOMES AT MACQUARIE

The introduction of new units and restructuring of existing undergraduate units at Macquarie as described in each Annual Report has achieved the goals of attracting new clientele. However, this is within an environment of a contracting pool of science undergraduates. Despite this, GEMOC core units at 100 level have maintained average enrolments. Reorganisation of course structures and acquisition of teaching infrastructure (computers, high-technology instruments, GIS units) have increased the visibility of geoscience and have resulted in the presentation of geoscience with an interdisciplinary and innovative approach using state-of-the art technology and concepts.

THE UNIVERSITY MEDAL was awarded to GEMOC honours student Kathleen McMahon in 2004 for her honours thesis "Seismic reflection studies of the Amery Ice Shelf, East Antarctica".

The following honours projects in GEMOC were commenced mid 2004:

Stéphanie Carroll: Plutonism and metamorphism at the root of a Cretaceous magmatic arc, Fiordland, New Zealand

Kirsty Liddicoat: Chemical and isotopic signatures of opal genesis at Lightning Ridge, NSW

Alice Plioplis: The geology of the Frampton Volcanics

Penelope Littlewood: Geochemistry of the Phoenix Tungsten mine, Frogmore NSW

The following Honours projects are relevant to GEMOC in 2005:

Zoe Demidjuk: A geological study of the Newer Volcanics Province of southeast Australia

Martyn Allen: The 3D shape of the Mole Granite and the thickness of the Torrington Pendant

Natalie Staib: The geophysical expression of Tertiary igneous activity in south-central Queensland

Heather Skeen: Finding graves: The best methods for grave detection using geophysics

Glenn Gooch: A geophysical investigation of the Hunter Fault, New South Wales, Australia, using gravity and magnetics

Dania Perez: An EMP and ICPMS study of some glassy rocks of the New England Fold Belt

Teaching and training program

GEMOC honours

GEMOC offers scholarships for students with excellent undergraduate records who are carrying out GEMOC-related projects.

Teaching and training program

GEMOC postgraduate




GEMOC POSTGRADUATE STUDENTS once more provided a high profile for our postgraduate training through 2004 with presentations at international conferences including the 14th Goldschmidt Conference in Copenhagen (Denmark), 32 International Geological Conference in Florence, and the 17th Australian Geological Convention (Hobart).

GEMOC's active international exchange program continued including the program with the University of Jean Monnet, St Etienne. Guillaume Delpech's successful thesis defence was held in June and Stéphanie Touron continued her co-tutelle PhD project. A new co-tutelle PhD student commences in 2005.

See advertisement for GEMOC postgraduate opportunities, Appendix 7.

completed

Olivier Alard (PhD): Trace element geochemistry and mantle domains, emphasis on PGE and Re/Os; *IPRS with MUIPRA stipend* (graduated 2001)

Sonja Aulbach (PhD): Depletion and metasomatic processes in cratonic mantle; *IPRS with MUIPRA stipend* (graduated 2004)

Kari Anderson (PhD): Defining the APWP for early to mid Palaeozoic eastern Gondwanaland: paleomagnetic pole information from the northern Tasman Orogen; *IPRS with MUIPRA stipend* (graduated 2003)

Elena Belousova (PhD): Zircon and apatite geochemistry: applications to petrology and mineral exploration; *APA and sponsorship by Rio Tinto* (graduated 2000)

Eloise Beyer (PhD): Contrasting characteristics of Proterozoic and Phanerozoic mantle types; *Field assistance from Ashton Mining* (graduated 2003)

Rondi Davies (PhD): East Australian Diamonds: Characterisation and origin; *Sponsored by Rio Tinto, Kennecott Canada* (graduated 1999)

Guillaume Delpech (PhD): Isotopic characteristics of lithosphere processes beneath Kerguelen; *Co-tutelle with University of Jean Monnet, IPRS with GEMOC stipend and EURODOC scholarship* (graduated 2005)

Oliver Gaul (PhD): Composition of the lithospheric mantle beneath Australia; *APAI collaborative with Stockdale Prospecting, CSIRO EM* (graduated 2000)

Bin Guo (PhD): An integrated geophysical investigation of the Hunter-Mooki and Peel Fault; *IPRS with MUIPRA stipend* (graduated 2005)

Joanne McCarron (MSc): Mantle xenoliths from Queensland and South Australia (graduated 1997)

Bertrand Moine (PhD): The role of fluids in the genesis, segregation and crystallisation of intraplate oceanic mantle magmas: implications for crustal accretion; *Co-tutelle with University of Jean Monnet* (graduated 2000)

Mark Pirlo (PhD): Australian groundwater geochemistry; applications to heat flow and exploration; *APA and Queen's Trust for Young Australians Award* (graduated 2003)

Esmé van Achterbergh (PhD): Trace-element fingerprints of metasomatic processes in lithospheric mantle (graduated 2005)

Shixin Yao (PhD): Chromite as a petrogenetic indicator in ultramafic rocks; *Collaborative with Rio Tinto* (graduated 2000)

Xu Xisheng (PhD): The lithospheric mantle beneath eastern China; *Formal exchange PhD, Nanjing and Macquarie* (graduated 2000)

current

Brad Bailey (PhD): Law Dome: Ice and Crust Mass Balance Studies (commenced 2004)

Steven Cooper (PhD): Diamonds and mantle-derived minerals, NW Australia and South Australia (commenced part time 2003)

Kathleen McMahon (PhD): Fracturing and deformation along the Amery Ice Shelf: A seismic study (commenced 2004) (see *Research Highlights*)

Luke Milan (PhD): The emplacement, pressure-temperature-time path and structural evolution of lower crustal gneisses in Fiordland, New Zealand (commenced 2004)

Valeria Murgulov (PhD): Crust-mantle evolution and metallogeny, eastern Australia; *APA* (commenced 2003) (see *Research Highlights*)

Nenad Nikolic (PhD): Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway (commenced 2004)

Kathlene Oliver (MSc): Depth and subsurface shape of the Dundee Ignimbrite (part-time, commenced 2001)

Will Powell (PhD): Nature of the lithospheric mantle in the New England Region, NSW; *APA* (part-time, commenced 1997)

Sonal Rege (PhD): Trace-element geochemistry of diamonds; *IPRS with iMURS scholarship* (commenced 2002)

Stéphanie Touron (PhD): Geochemical fingerprints of the mantle beneath the Massif Central; *IPRS with MURAACE scholarship*

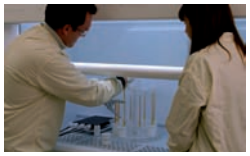
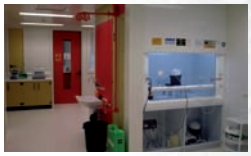
commencing 2005

Jacques Batumike (PhD): The origin of kimberlites from the Kundelungu region (D.R. Congo) and the nature of the underlying lithospheric mantle

June Chevet (PhD): Gabbroic rocks from the Kerguelen Islands (Indian Ocean): a petrologic, geochemical and isotopic investigation of their origin

Some of GEMOC's 2004 postgraduate students: Will Powell, Valeria Murgulov, Luke Milan, Nenad Nikolic and Sonal Rege .



Technology development program

Background

GEMOC's research, training and Industry Interaction programs require a high level of geochemical analytical technology, which is provided by the state-of-the-art facilities available to the Key Centre. Continual development of both technology and innovative analytical and microanalytical approaches is required to meet our research aims and the needs of our industry collaborators. GEMOC develops new analytical strategies as required, to determine the chemical and isotopic composition of geological materials (both solid and fluid) in solution and *in situ*. Special emphasis is being placed on the development of advanced *in situ* microbeam methods. These developments are transmitted to industry via open and collaborative research, through technology exchange visits and workshops, and as an integral part of the training program.

THE ANALYTICAL INSTRUMENTATION and support facilities of the Macquarie University Geochemical Analysis Unit (GAU) represent a state-of-the-art geochemical facility. In 2005 this will be enhanced by installation of the Triton (TIMS) and the relocation of the stable-isotope operations of the former Centre for Isotope Studies, previously housed at CSIRO, North Ryde, to GEMOC.

- The GAU *contains:*
  - a Cameca SX-50 electron microprobe
  - a Cameca SX-100 electron microprobe (installed January 2003)
  - three Agilent 7500 ICPMS (industry collaboration (two installed October 2004))
  - a custom-built UV laser microprobe, usable on the Agilent ICPMS
  - five New Wave/Merchantek laser microprobes (two 266 nm, three 213 nm) for the MC-ICPMS and ICPMS laboratories (industry collaboration)
  - a New Wave/Merchantek excimer (193 nm) laser microprobe, based on a Lambda Physik OPTex laser
  - a Nu Plasma multi-collector ICPMS
  - a Nu Plasma high resolution multi-collector ICPMS (installed November 2003)
  - a Spectro XLAB2000 energy-dispersive XRF with rocker-furnace sample preparation equipment
  - a LECO RC412 H_2O-CO_2 analyser (delivered September 2003)
  - clean labs and sampling facilities provide infrastructure for ICPMS, XRF and isotopic analyses of small and/or low-level samples

"The analytical instrumentation and support facilities of the Macquarie University Geochemical Analysis Unit (GAU) represent a state-of-the-art geochemical facility."

One of the new clean-room laboratories.

- Experimental petrology laboratories in GEMOC include piston-cylinder presses (9, 15 and 40 kb), hydrothermal apparatus, and controlled atmosphere furnaces.
- The Centre for Isotope Studies has provided access to extraction lines and gas-source mass-spectrometers for stable-isotope analysis of fluids and minerals; these facilities will be moved to GEMOC during 2005.

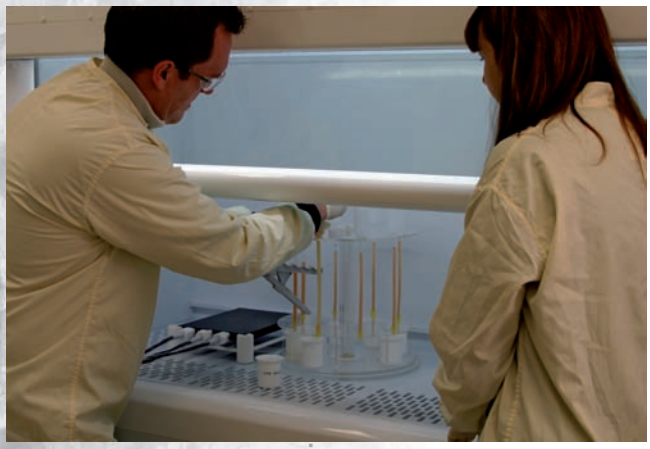
THE GEMOC FACILITY FOR INTEGRATED MICROANALYSIS (FIM) AND MICRO GIS DEVELOPMENT

GEMOC is continuing to develop a unique, world-class geochemical facility, based on *in situ* imaging and microanalysis of trace elements and isotopic ratios in minerals, rocks and fluids. The Facility for Integrated Microanalysis now consists of four different types of analytical instrument, linked by a single sample positioning and referencing system to combine spot analysis with images of spatial variations in composition ("micro-GIS"). All instruments in the FIM have been operating since mid-1999. Major instruments are being replaced or upgraded in 2002-2004 through the $5.125 million DEST Infrastructure grant awarded to Macquarie University with the Universities of Newcastle, Sydney, Western Sydney and Wollongong as partners.

the facility provides:

- The capability to image both major- and trace-element distribution in a sample, as an interpretive tool and as the basis for higher precision spot analysis of trace-element concentrations and isotopic ratios
- Co-registration of images and spot data from different instruments, and use of digitised images to locate spots with a precision of better than 5 µm
- Analytical capability for most elements of the periodic table at ppm to sub-ppb levels
- *In situ* isotopic-ratio measurement for a range of elements, at the precision required for geologically useful results
- New approaches to data interpretation through application of micro-GIS principles

Ion exchange in action in the new clean laboratories for isotope separation.



Electron Microprobe: for imaging and point analysis of major and minor elements

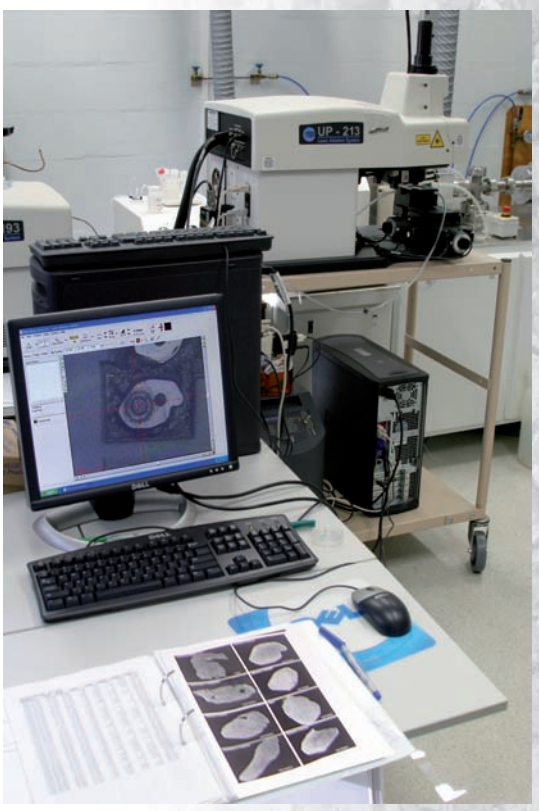
Scanning Nuclear Microprobe: for imaging and point analysis of trace elements at ppm levels

Laser-ablation ICPMS Microprobes: for point analysis of a wide range of trace elements at low ppb levels

Multi-collector Sector ICPMS with laser microprobe: for high-precision *in situ* analysis of isotopic ratios

Micro-GIS system: A key aspect of the Facility is the co-registration of images and point analyses collected on all instruments. All data for a sample, from any of the instruments or from a bench microscope, are in the same coordinate system and can be overlaid in the computer to enhance interpretation.

When fully developed, images from one instrument will be read into the computer of another instrument and used to guide the analysis. Major-element maps from EMP, or trace-element maps from the nuclear microprobe, can be linked directly to images from petrographic or cathodoluminescence microscopes, BSE or SEM, or to spot analyses.



Zircon analysis for TerraneChron™ using the LAM-ICPMS.

CURRENT STATUS

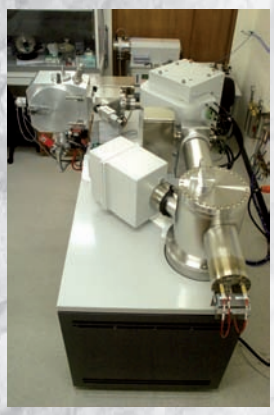
Electron microprobe (EMP): The original GEMOC EMP is a CAMECA SX50, installed in 1993; it routinely produces high-precision analyses of major and minor elements with a spatial resolution of one micron, as well as high-quality images of major-element (> 0.1 wt%) distribution over areas up to 45 x 45 mm, by stage-scanning with five fixed wavelength-dispersive spectrometers. In early 1999 the EMP was upgraded with an energy-dispersive X-ray detector to allow rapid and simultaneous mapping of all major elements. In early 2003 a new CAMECA SX100, with a similar configuration of spectrometers, was installed and the SX50 is now used mainly for the imaging and analysis of zircons, in connection with *TerraneChron*™ applications and basic research.

Scanning nuclear microprobe (SNMP): This instrument was built by Dr C. G. Ryan (with GEMOC funding contribution) as a separate beam line on the HIAF particle accelerator at CSIRO, North Ryde. The design incorporates several complementary types of detector, a new high-resolution probe-forming system and an innovative optical system, and provides both images of trace-element distribution and spot analyses, with a lateral resolution of 1-3 µm. Current capabilities cover micro-PIXE, micro-PIGE and quantitative element imaging. Due to the closure of CSIRO's North Ryde site during 2004, the SNMP beam line has been relocated to the accelerator facility at the University of Melbourne.

Laser Ablation ICPMS microprobe (LAM-ICPMS): The original GEMOC LAM was installed in December 1994 using a Perkin-Elmer ELAN 5100 ICPMS (later replaced by an ELAN 6000), attached to a UV laser ablation microprobe built for GEMOC by Memorial University, Newfoundland. In 1999 the ICPMS was replaced by a Hewlett Packard 4500, and in 2000 an Agilent 7500S ICPMS was added. In 2004 two new Agilent 7500CS instruments were purchased (one primarily for solution work), and the 7500S replaced the HP4500 for zircon analysis at the end of 2004. The 7500S and one 7500CS now routinely provide quantitative analyses of > 30 elements at sub-ppm levels in minerals, glasses and metals, as well as precise U-Pb dating of zircons. The laboratory currently uses three Nd:YAG LAM systems: a Quantel Brilliant laser that can deliver beams of either 266nm or 213nm light, a Merchantek LUV 266nm system, and a Merchantek/New Wave LUV213 nm system. Spatial resolution varies with the application, but typically is on the order of 30-40 µm. Each LAM is fitted with a computer-driven sample stage to provide co-registration of X-Y coordinates with the other instruments. On-line data reduction with the GEMOC-developed "GLITTER" software enhances laboratory productivity and data interpretation; the software is marketed internationally by New Wave Research.

Multi-collector LAM-ICPMS microprobe (MC-LAM-ICPMS): A fully-equipped Nu Plasma MC-ICPMS is an integral part of the Facility. This instrument combines a laser ablation microsampler, an Ar-plasma ionisation source, and a multi-collector magnetic-sector mass spectrometer, to provide high-precision *in situ* analysis of isotope ratios in geological materials. The instrument uses either a New Wave 193 nm system based on an Lambda Physik OPTex excimer laser, a New Wave 266 nm Nd:YAG laser, or a New Wave 213 nm Nd:LAG laser. The MC-ICPMS also can be used in solution mode, with either a standard nebuliser or a desolvating nebuliser, to provide high-precision isotopic analysis of a wide range of elements, including many not accessible by standard thermal ionisation mass spectrometry. A second Nu Plasma instrument, with high-resolution capabilities and a retardation filter to enable U-series work, was installed late in 2003.

Above: Installation of the new TIMS, early 2005. Below: The assembled machine.



A Triton thermal ionization mass spectrometer (TIMS): was purchased in 2004 following a successful ARC LIEF application led by Professor Simon Turner and Dr Bruce Schaefer (Monash University), and was installed early in 2005.

Applications in use and under development include:

Laser Analysis (*in situ* point analysis)

- U-Pb geochronology of zircons from igneous and metamorphic rocks
- Hf isotope analysis in zircon for studies of crustal generation, mantle evolution and crust-mantle interaction
- Re-Os dating of sulfides in mantle-derived xenoliths
- Nd isotope analysis in apatites, titanites and other REE-rich minerals
- Sr isotope analysis of carbonates, feldspars, apatites, pyroxenes
- Pb isotope analysis of sulfides and silicates
- Stable isotope ratios of Fe, Mg, Zn, Cu and other cations in appropriate minerals from ore systems and mantle rocks
- Multi-element trace element analysis of silicates, sulfides, oxides and diamonds

Solution Analysis

- Re-Os — determination of mantle depletion ages and isochron ages in whole rocks, ilmenites and chromites; dating of sulfide assemblages in ore bodies
- Lu-Hf — crustal genesis, mantle metasomatism; Lu-Hf dating of garnet peridotites, eclogites, granulites; basalt genesis
- Rb-Sr, Sm-Nd, U-Pb, Pb-Pb — faster than TIMS; simplified low-blank chemistry, no time-dependent mass fractionation, hence greater precision

- U, Th-series analysis – for dating of young processes, ranging from magma genesis to weathering and erosion
- Multi-element analysis of trace elements in whole-rock samples

PROGRESS IN 2004

1. Facility for Integrated Microanalysis

a. Electron Microprobe: A fully optioned Cameca SX-100 electron microprobe with five crystal spectrometers and an energy-dispersive spectrometer, to replace GEMOC's aging but still highly functional SX-50 instrument, arrived in late December 2002, and was installed in January 2003.

b. Laser-ablation ICPMS microprobe (LAM): During 2004, the LAM laboratory produced large volumes of data for eight Macquarie PhD thesis projects, several projects carried out by international visitors and Honours students, in-house funded research projects and industry collaboration. These projects included the analysis of trace elements in the minerals of mantle-derived rocks, in sulfide minerals and in a range of unusual matrices. *Over 5000 U-Pb analyses of zircons were carried out*, related to projects (including *TerraneChron*™ applications) in Scandinavia, China, Italy, southern Africa and Australia. The LAM laboratory also routinely provides data for projects related to mineral exploration (diamonds, base metals, Au) as a value-added service to the industry (see *Research Highlights*).

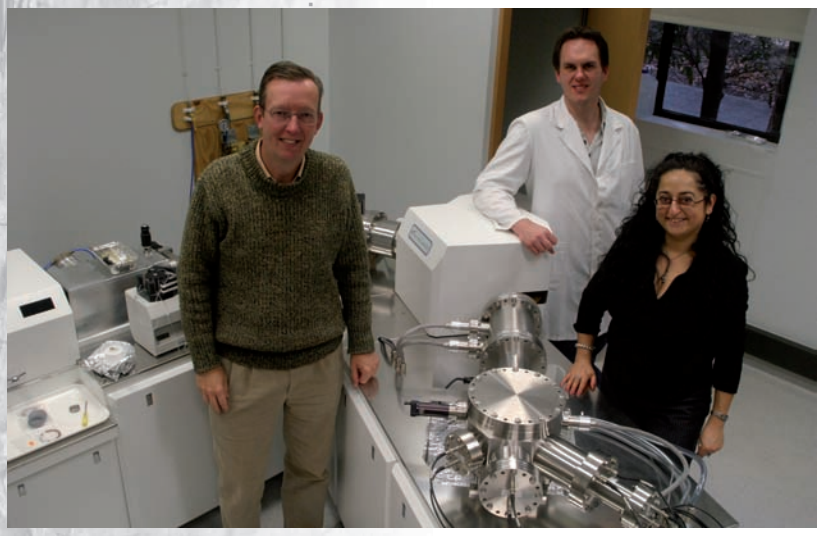
Three of the TerraneChron™ team: Ayesha Saeed, Elena Belousova and Eloise Beyer.

The HP 4500 instrument which has been dedicated primarily to U-Pb dating of zircons, was replaced late in 2004 with the existing Agilent 7500S, while two new Agilent 7500CS instruments were acquired to allow one instrument to be dedicated permanently to laser-probe applications, while the other is available for solution analysis.

c. MC-ICPMS: A multi-collector magnetic sector ICPMS for *in situ* (laser-ablation) and solution analysis of isotopic ratios was installed in November 1998. The instrument is the Nu Plasma (Nu05), designed and manufactured by Nu Instruments of Wrexham, UK. The instrument was producing good data only a few days after installation, and has continued to do so. Merchantek EO (now New Wave Research) provided a 266 nm UV laser microprobe (under a collaborative agreement; see below) for use with the MC-ICPMS and a 213 nm laser microprobe was purchased in 2000. During 2002 the MC-ICPMS was fitted with a New Wave/Merchantek excimer (193 nm) laser microprobe, based on a Lamba Physik OPTex laser. This has been used mainly for the analyis of Hf isotopes in zircon, where its different absorption characteristics have provided somewhat greater spatial resolution and beam intensity than were available using the 213 nm laser. In 2004, we purchased three new New Wave Nd:YAG lasers, two 213 nm and one 266 nm, and these also have been used on the MC-ICPMS for different applications.

The rapid growth in the use of the *TerraneChron*™ application (see *Research Highlights*), coupled with the demand for *in situ* Re-Os analysis and stable isotope analysis, led to severe competition for instrument time on the MC-ICPMS. An order was placed early in 2003 for a second instrument, funded by the DEST infrastructure grant, and this instrument (Nu34) was installed in November 2003; it has operated satisfactorily throughout 2004. Nu34 is equipped with a retardation filter and high-resolution capability, specifically for U-series analysis. Methods for the analysis of other isotopic systems (Re-Os, Sm-Nd, Lu-Hf, Pb) have been transferred to Nu34 as well, and considerable time was spent in 2004 doing comparisons of the performance of Nu05 and Nu34 with respect to these isotopic systems.

Major applications during 2004 (see *Research Highlights*) included the high-precision analysis of Hf in zircons to trace lithosphere evolution and magma-mixing histories in granitic rocks, the analysis of copper and iron isotope compositions in minerals from ore bodies, the analysis of Sr isotopes in clinopyroxene phenocrysts from lavas, and Re-Os dating of single grains of Fe-Ni sulfides in mantle-derived rocks. We carried out Re-Os studies on xenoliths from the Kerguelen oceanic plateau, S. Africa, eastern China and Taiwan, north Africa and Sicily.



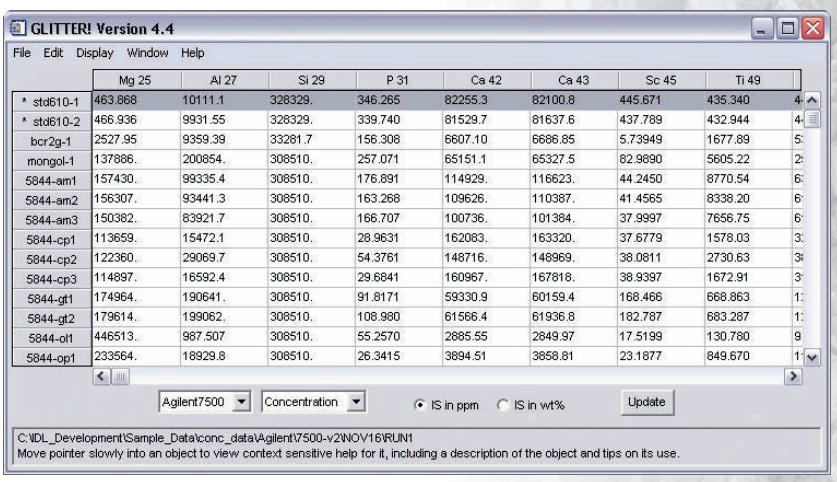
Norm Pearson (manager, GAU), Peter Wieland and Suzy Elhlou with the Nu34 MC-ICPMS.

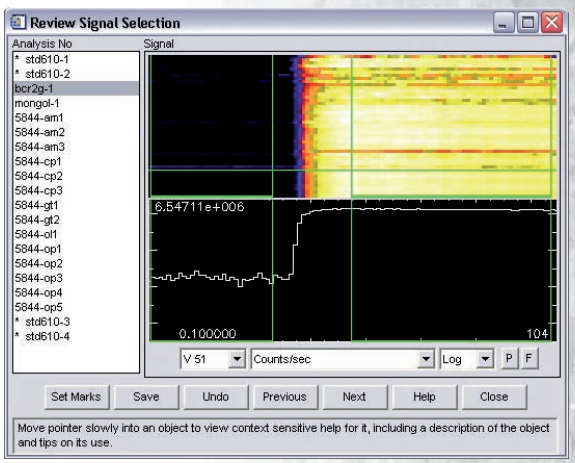
A major project was started on the isotopic composition of Fe, Cu and selected other elements in sulfides and whole rocks from major ore bodies, in a collaboration with Anglo American. Further developments were made in 2004 for the *in situ* analysis of Mg isotope compositions in mantle olivine and other phases in mantle peridotites. This involved the characterisation of potential standard materials and the investigation of the matrix effects on isotopic fractionation. Detailed studies were undertaken (both by laser and in solution) on olivine, pyroxene and amphibole in spinel peridotites from several localities, with the results providing further evidence of significant Mg isotopic fractionation during partial melting and metasomatism.

d. Scanning Nuclear Microprobe: The pending closure of the CSIRO North Ryde site forced the shutdown of the SNMP in late 2003. The beam line was dismantled, and re-installed on the University of Melbourne accelerator during 2004. It is in operation for 2-3 days/week.

e. Laboratory development: Funding from the DEST infrastructure grant contributed toward the building of a new suite of clean-room laboratories on the second floor of building E5B, which include facilities for the work on U-series chemistry to be carried out by Dr Simon Turner and his group. Construction began in September 2003, and the facility was handed over in April 2004. The new facility, which is being used primarily for isotope separations, provides an ultra-clean environment within a 3-stage pressurized volume; it contains 6 Class 3500 work areas, three for radioactive isotopes and three for other activities.

f. Software: Chris Ryan further refined the GLITTER (GEMOC Laser ICPMS Total Trace Element Reduction) software, our on-line interactive program featuring linked graphics and analysis tables. This package provides the first real-time interactive data reduction for LAM-ICPMS analysis, allowing inspection and evaluation of each result before the next analysis spot is chosen. Its capabilities include the on-line reduction of U-Pb data. The use of GLITTER has greatly increased both the flexibility of analysis and the productivity of the laboratory. New Wave Research market the software together with their laser microprobe equipment; GEMOC provides customer service and backup through Macquarie Research Limited. Ten copies of GLITTER were sold worldwide in 2004, and the software appears to have achieved industry-standard status; more than 45 copies are in use worldwide, in forensics and materials science, as well as earth science applications. During 2005, Norm Pearson, Will Powell and Chris Ryan are further developing GLITTER, and Will Powell is the customer interface for the distribution of a new version (GLITTER 4.4).





The new GLITTER 4.4.

2. Laser development

GEMOC continues to benefit from an industry partnership with New Wave Research (formerly Merchantek EO), a major US manufacturer of laser ablation systems, which has made Macquarie its Alpha Test Site. New Wave donated their 266 nm Nd:YAG UV laser ablation sampling system to GEMOC and their new 213 nm system was delivered early in 2000. Both lasers can be coupled to the Nu Plasma MC-ICPMS, allowing high precision isotope ratio determinations to be performed on minerals *in situ*. The mobility of the probes has allowed them to be used on the quadrupole ICPMS instruments as well, in a range of applications. A Merchantek/New Wave Research 193 nm excimer system based on a Lambda Physik OPTex laser was delivered in March 2002 and was finally commissioned late in the year. Three more New Wave laser systems were acquired during 2004, a 266 nm and two 213 nm, representing a major upgrading of the instrument park and giving redundancy to limit downtime.

The 213 nm lasers are now used for most of the U-Pb work, especially where small grains are being analysed, while the excimer system is used mainly for Hf-isotope analysis. The 266 nm systems have proven most useful for analysis of sulfides, and for other stable-isotope applications.

"During 2005, Norm Pearson, Will Powell and Chris Ryan are... developing... GLITTER 4.4."

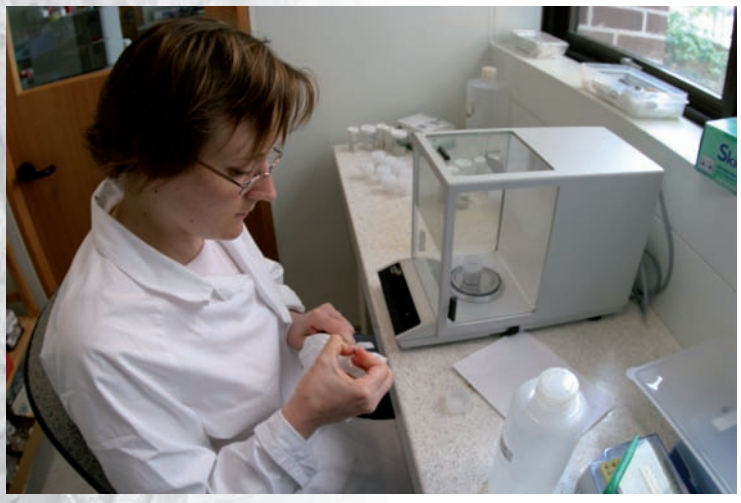
3. Energy Dispersive XRF

A Spectro XLAB2000 energy-dispersive X-ray spectrometer was installed in November 2000 in a joint venture with Tasman Resources. This instrument utilises the polarisation of scattered X-rays to substantially reduce backgrounds and enhance detection limits. The XLAB2000 uses a specially designed 300 W palladium X-ray tube that improves its performance for the lighter trace elements, and also for major elements, relative to the earlier instrument. In addition, this spectrometer is fitted with a silicon detector, of a type recently developed, that eliminates the low-energy "tail" from the lightest elements, and enables all major elements to be measured in a fused glass to levels below 0.01%. The capability of the instrument to provide major element analyses of a quality at least comparable to the more expensive conventional crystal spectrometers has been thoroughly evaluated and confirmed. This instrument provides highest-quality data for major elements and for most trace elements to sub-ppm levels. The operation of the equipment is enhanced by a 100 position sample loader, one of the first to be installed on a Spectro instrument, and the purchase of a rocker furnace for sample preparation. During 2003 over 5000 samples were analysed for major and trace elements, providing data to student theses, in-house research projects, and industry collaborators.

4. Solution analysis

An Agilent 7500 ICPMS is regularly used to provide trace-element analyses of dissolved rock samples for the projects of GEMOC researchers and students, and external users, supplementing the data from the XRF.

The *in situ* analysis of the Rb-Sr, Lu-Hf, Sm-Nd and Re-Os systems by laser ablation microprobe has required the development of corrections for isobaric overlaps (eg ^{87}Rb on ^{87}Sr), and has demonstrated that these corrections can be done with very high precision in the Nu Plasma MC-ICPMS. This has allowed us to simplify the ion-exchange chemistry traditionally used to obtain clean element separations for standard mass-spectrometry analysis. A new scheme for the dissolution of rocks, separation of Sr, Nd, Hf and Pb, and isotopic analysis using the MC-ICPMS in solution mode provides precise whole-rock isotopic analyses that are faster, simpler and ultimately cheaper than those obtained by traditional methods.



Stéphanie Touron preparing samples for isotopic analysis.

During 2004 improvements were made to the separation procedures for Cu and Fe, in support of the laser-probe studies, and the procedures for separation of Sr, Nd and Hf were modified.

A new LECO RC412 H_2O-CO_2 analyser (delivered September 2003) replaced an outdated unit, and is providing high-quality analyses to complete whole-rock analyses by XRF and solution-ICPMS.

5. Centre for Isotope Studies (CIS)

The Centre for Isotope Studies (CIS) was a consortium operated by the geoscience departments of the New South Wales Universities, CSIRO Exploration and Mining, and Petroleum Resources using jointly-purchased mass-spectrometers housed at the CSIRO in North Ryde. The facility allowed staff and students to obtain both radiogenic and stable isotopic analyses and used technical staff jointly funded by the University members; Dr Richard Flood of GEMOC has been University Consortium Convenor.

GEMOC has developed its own clean laboratories to prepare solutions for radiogenic isotope analysis by MC-ICPMS, but has used the stable isotope separation facilities at North Ryde. CIS was one of the rare laboratories where staff and students could obtain C, O, N, S and D analyses including the routine determination of O in silicates. Dr Anita Andrew developed techniques for C-isotope analysis of diamonds using very small sample sizes (0.1 mg), which allows analysis of microdiamonds or multiple fragments of different zones of small stones. This is now an essential part of GEMOC capabilities.

CSIRO's North Ryde site was closed in 2004, but the laboratories are still in operation. During 2005 Dr Andrew will move the stable isotope facilities to GEMOC, where they will form a self-funded entity, and GEMOC will continue to benefit from this collaboration.

Industry interaction




INDUSTRY INTERACTION, TECHNOLOGY TRANSFER AND COMMERCIALISATION PROGRAM

GEMOC RELIES on a vigorous interaction with the mineral exploration industry at both the research and the teaching/training levels. The research results of the Centre's work are transferred to the industry and to the scientific community by:

- collaborative industry-supported Honours, MSc and PhD projects
- short courses relevant to the industry and government sector users, designed to communicate and transfer new technologies, techniques and knowledge in the discipline areas covered by the Key Centre
- one-on-one research collaborations and shorter-term consultancies on industry problems involving national and international partners
- provision of high quality geochemical analyses with value-added interpretations to industry and government organisations, extending our industry interface
- use of Macquarie Research Limited consultancies, which employ and disseminate the technological developments carried out by the Centre
- GLITTER, an on-line data-reduction program for Laser Ablation ICPMS analysis developed by GEMOC and CSIRO GEMOC participants has been successfully commercialised and is available commercially through New Wave Research (http://www.es.mq.edu.au/GEMOC/)
- collaborative relationships with technology manufacturers (more detail in the section on *Technology Development*):
  - GEMOC (Macquarie) is the Agilent Technologies LAM-ICPMS Australian demonstration site
  - GEMOC (Macquarie) is the international Alpha test site for New Wave Research Lasers

GLITTER - the industry standard for LAM-ICPMS online data reduction.

SUPPORT SOURCES

GEMOC industry support includes:

- direct funding of research programs
- "in kind" funding including field support (Australia and overseas), access to proprietary databases, sample collections, digital datasets
- collaborative research programs through ARC Linkage Projects and the Macquarie University External Collaborative Grants (MUECRG) and PhD program support

- assistance in the implementation of GIS technology in postgraduate programs
- participation of industry colleagues as guest lecturers in undergraduate units
- extended visits to Macquarie by industry personnel for interaction and research
- ongoing informal provision of advice and formal input as members of the Advisory Board

ACTIVITIES IN 2004

Nine Industry Reports were completed for collaborative and consulting projects.

TerraneChron™ studies (see *Research Highlights*) have been adopted by a significant segment of the global mineral exploration industry. This methodology, currently unique to GEMOC, requires the integration of data from three instruments (electron microprobe, LAM-ICPMS and LAM-MC-ICPMS) and delivers fast, cost-effective information on the tectonic history (with ages) of regional terranes.

The ARC Linkage Project with WMC titled "Global Lithosphere Architecture Mapping" continued. Planning and workshop sessions at Macquarie with participants from WMC and GEMOC, and a visit by Macquarie staff to WMC in Perth, were key activities in 2004. Dr Graham Begg spent significant research time at GEMOC through 2004 as part of the close collaborative working pattern for this project.

Professor J. Harris (on behalf of de Beers) provided further samples for the PhD project of Sonal Rege aimed at developing a methodology for the trace-element analysis of diamonds.

A new collaborative project with Anglo American is investigating the isotopic composition of Cu, Fe and several other elements in sulfides and whole rocks from a major ore deposit.

Rio Tinto supplied samples and funding for a Macquarie University Collaborative Grant (2004) project that uses garnets, chromites and pyroxenes from kimberlites to study the composition of the lithospheric mantle beneath the Dharwar Craton of India.

A pilot study on detrital zircons from Paleozoic sediments was carried out with the New South Wales Geological Survey; the results were used to support a successful proposal for a Macquarie University Collaborative Grant (2004). The project is investigating the provenance of the Paleozoic sedimentary rocks of the western Lachlan Fold Belt.

A very successful project on Continental Flood Basalts related to Ni and PGE deposits was carried out with WMC and resulted in a new project commencing 2005, exploring a novel framework for the origin of magmatic Ni-deposits.

A new alliance with PIRSA (Primary Industries and Resources, South Australia) commenced in 2004 with a funded *TerraneChron*™ project.

GEMOC researchers presented invited and keynote addresses at the de Beers Diamond Conference in Warwick in July, 2004 and at the SEG in Perth in September. Both of these conferences had a large industry attendance.

Numerous industry visitors spent varying periods at GEMOC in 2003 to discuss our research and technology development (see visitor list, *Appendix 3*).

DIATREEM continued to provide LAM-ICPMS analyses of garnets and chromites to the diamond-exploration industry on a routine basis.

GEMOC publications, preprints and non-proprietary reports are available on request for industry libraries.

CURRENT INDUSTRY-FUNDED COLLABORATIVE RESEARCH PROJECTS

THESE ARE BRIEF DESCRIPTIONS of current GEMOC projects that have direct cash support from industry and timeframes of at least one year. Projects are both national and global.

GEMOC's industry collaborative projects are designed to develop the strategic and applied aspects of the basic research programs based on understanding the architecture of the lithosphere and the nature of Earth's geodynamic processes that have controlled the evolution of the lithosphere and its important discontinuities. Most of the industry collaborative projects rely on geochemical information from the Geochemical Analysis Unit in GEMOC and especially on novel methodologies developed by (and some unique to) GEMOC.

Elena Belousova and Michael Schwarz from PIRSA collecting zircon TerraneChron samples during field work at the Gawler Craton for the collaborative GEMOC/ PIRSA project.

Geochemical data on crustal and mantle rocks are being integrated with tectonic analyses and large-scale datasets (including geophysical data) to understand the relationship between lithosphere domains and large-scale mineralisation.

The new methodologies of using mantle sulfides to date mantle events, and of characterising crustal terrane development using U-Pb dating and Hf isotopic compositions of zircons provides more information for integration with the geophysical modelling. *TerraneChron*™ (see *Research Highlights*) is proving an important new approach to characterising the tectonic history and crustal evolution of terranes on the scale of 10 – 100 km as well as delivering a cost-effective exploration tool to the mineral (and potentially petroleum) exploration industry.

Global Lithosphere Architecture Mapping

Supported by ARC Linkage (2004-2006)

Industry Collaborator: WMC Resources

Summary: **Compositional domains in the subcontinental lithospheric mantle reflect the processes of continental assembly and breakup through Earth's history. Their boundaries may focus the fluid movements that produce giant ore deposits. Mapping these boundaries will provide fundamental insights into Earth processes and a basis for the targeting of mineral exploration. We will integrate mantle petrology, tectonic synthesis and geophysical analysis to produce the first maps of the architecture of the continental lithosphere, to depths of ca 250 km. These maps will provide a unique perspective on global dynamics and continental evolution, and on the relationships between lithosphere domains and large-scale mineralisation.**

Links between plume-mantle interaction, mantle sulfides and Ni-PGE endowment in Large Igneous Provinces

Supported by a matching Macquarie University Collaborative grant (2004-2005)
Industry Collaborator: WMC Resources
Summary: Most large Ni-PGE (Platinum Group Elements) deposits are associated with some, but not all, Large Igneous Provinces (LIP=plume-related flood basalts). Isotopic and trace-element data suggests that the magmas of "fertile" LIPs have interacted with the deep mantle roots of ancient continents. We will test the hypothesis that the Ni-PGE enrichment in some LIP magmas reflects the mobilisation of pre-existing Ni,PGE-rich sulfide phases as the magmas pass through these old, highly modified mantle roots. This model, if confirmed, will be a major advance on traditional models for Ni-PGE concentration, and will have a significant impact on exploration models.

Developing a geochronological framework for the Gawler Craton, South Australia

Supported by a matching Macquarie University Collaborative grant (2004-2005)
Industry Collaborator: PIRSA (Primary Industries and Resources, South Australia)
Summary: The aim of the project is to supply a geochronological framework for the evolution of the Gawler Craton of South Australia, by dating major Archean and Proterozoic magmatic and tectonic events across the Craton. At present, the geochronology of this large region is poorly known, and this is one main reason why the minerals industry is choosing better-known regions to explore. The development of a better geochronological base will support the industry partner's goal of establishing an integrated tectonic model as an aid to mineral exploration, and provide new insights into crustal evolution.

Lithosphere mapping beneath the Dharwar Craton, India

Supported by a matching Macquarie University Collaborative grant (2004)
Industry Collaborator: Rio Tinto
Summary: The project uses major- and trace-element analysis of mantle-derived minerals in kimberlites to map vertical and lateral variations in the composition and thermal state of the lithospheric mantle across the Archean Dharwar Craton in central India. The kimberlites are 900-1200 million years old, and may provide information on a relatively unmodified lithospheric root. Comparison with geophysical data (today's situation) will help to define the fate of this root during India's northward movement after its separation from Gondwanaland. The results will be directly relevant to diamond exploration models for the Dharwar Craton, and for other areas in India.

Application of metal isotopes in exploration for magmatic nickel and volcanic-hosted copper deposits

Supported by a matching Macquarie University Collaborative grant (2004-2005)
Industry Collaborator: Anglo-American PLC
Summary: **The major aim is to study, for the first time, the isotope geochemistry of Ni and Pd in a magmatic nickel deposit. Cu and Fe isotopic studies will also be carried out on a volcanic-hosted copper deposit. The aims are to determine whether isotopic data for commodity metals can be used to discriminate between barren and fertile host rocks and whether these isotopic ratios can provide vectors to ore within a mineralised system. The expected outcomes are development of new analytical methodologies and new isotopic exploration tools for blind ore deposits, which could be adopted by the Australian mineral exploration industry.**

Continental Flood Basalts: geochemical discrimination with relevance to exploration for nickel and platinum-group elements

Supported by a matching Macquarie University Collaborative grant (2004)
Industry Collaborator: WMC Resources
Summary: **A major proportion of magmatic Ni- platinum group element (PGE) deposits are hosted in mantle-plume-derived continental flood basalts (CFB). Therefore, geochemical discrimination of CFB from other mantle-derived rocks and identification of Ni-PGE-prospective CFB are significant for Ni-PGE exploration. This project is exploring existing geochemical databases for mantle-derived rocks to provide user-friendly practical discrimination parameters to identify CFB-related mafic rocks and to evaluate their Ni and PGE economic potential. The research will also further constrain the role of mantle plumes in formation and evolution of subcontinental lithosphere and the behaviour of sulfides during the process of mantle evolution.**

Where was Baltica? Testing continental reconstructions with *TerraneChron*™

Supported by a matching Macquarie University Collaborative grant (2003-2004)
Industry Collaborator: University of Oslo and Norwegian Geological Survey
Summary: **Norway represents the western margin of the ancient landmass of Baltica, which was partly destroyed in the Caledonian Orogeny ~550-400 million years (Ma) ago. Its position before 600 Ma is debated. This project is using U-Pb dating and Hf-isotope analysis of zircons in basement rocks in SW Norway and in far-transported thrust sheets (nappes) derived from the vanished western margin of Baltica, to reconstruct the geological history of this margin. The results will allow evaluation of models for continental assembly, and will be relevant to studies of the provenance of sediments in the oil/gas basins of the North Sea.**

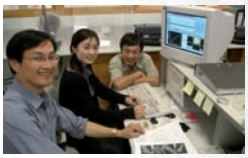
Testing Ordovician-Devonian tectonic models for the Lachlan Orogen

Supported by a matching Macquarie University Collaborative grant (2004)
Industry Collaborator: NSW Geological Survey
Summary: **This project combines the *TerraneChron*™ technology developed at GEMOC with tectonic and structural concepts developed at the Geological Survey of NSW, to understand the plate-tectonic evolution of SE Australia. U/Pb dating and Hf-isotope analysis of detrital and primary zircon grains will shed light on potential terrane accretion and on the timing of crustal growth and will be used to test published models of the Ordovician–Devonian tectonic development of Eastern Australia. This in turn will help to understand the nature of the interaction between the Australian plate and the proto-Pacific margin of the Gondwana supercontinent.**

Improving Mineral Exploration Performance by Superior Management of Risk, Uncertainty and Value

Supported by Macquarie University Industry Collaborative Grant
Industry Sponsors: BHP Billiton, Codelco, Geoinformatics Exploration, Gold Fields, Jackaroo Drill Fund, Newmont, Placer Dome, Teck Cominco, WMC Resources.
Summary: **Mineral exploration performance has deteriorated significantly over the past 15-20 years, especially with respect to the rate and cost of the large, 'greenfields' discoveries that generate so much value for the industry and underpin its future resource base. This research project is analysing past industry performance to identify opportunities for improvement, building probabilistic models of the mineral exploration business to provide a better decision framework, investigating the role of the high natural uncertainty and complexity on decision making, and developing a range of tools to improve risk and value management. The project involves collaboration between geoscientists, statisticians, psychologists and business management across the university.**



GEMOC's international links

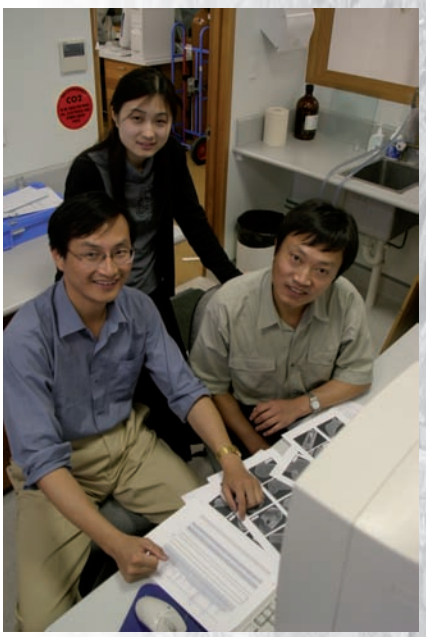
BACKGROUND

GEMOC HAS STRONG INTERNATIONAL LINKS and these broadened through 2004. Active links include funded programs, but have since broadened to include substantial collaborative programs in France, Norway, Germany, United Kingdom, Canada, USA, Taiwan, Italy, South Africa, China, Brazil, Japan, Myanmar, Thailand and the former USSR.

EXAMPLES OF PROJECTS IN ASIA

- nature and geophysical signature of the lithosphere in southeastern China
- crust-mantle interaction in southeastern China: the origin of the Yanshanian Granites and evolution of southeastern China
- trace element and isotopic characteristics of zircon as indicators of granite magma evolution
- evolution of the lithosphere in northwestern China (Tienshan Mountains in Xinjian)
- metallogenesis of southeastern China
- crustal evolution, basaltic volcanism and basin development, north China
- mantle processes in the mantle wedge above the subduction zone in Japan
- thermal contrasts and paleogeotherms in Siberia, Mongolia, eastern China
- diamond exploration, tectonism, and geophysical nature of the lithosphere, Siberia and East Asia
- mantle terranes and tectonic analysis, Siberia
- lithosphere extension and geodynamic processes in east Asia (including the Taiwan region and Tibet)

Professor Jinhai Yu and postgraduate student Ms Lei Zhao from Nanjing University with Ming Zhang and the LAM-ICPMS.



FUNDED COLLABORATIVE PROJECTS COMMENCED OR ONGOING IN 2004 INCLUDE:

- The time scales of magmatic and erosional cycles, with Professor C. Hawkesworth (Bristol University), Dr M. Reagan (University of Iowa) and Dr J. Kirchner (University of California).
- The nature of lithosphere extension in the Taiwan region and implications for geodynamics in eastern China, with Professor S-L Chung, National University of Taiwan, relevant to the research project of Dr Kuo-Lung Wang (Macquarie University Research Fellow)
- *TerraneChron*™ studies to unravel the timing and tectonic history of regions in Tibet was initiated as a collaborative program with the National University of Taiwan.

GEMOC's international links

Postgraduate students Yn-Hsuang Liang and Mei-Fei Chu from Taiwan.

- Collaboration with colleagues at the University of Jean Monnet, St Etienne, including Professor Jean-Yves Cottin and Dr Bertrand Moine (with reciprocal funding from both sides). A formal agreement between the two universities includes PhD exchange, academic exchange and research collaboration relevant to the nature of the lithosphere in the Kerguelen Archipelago, Crozet Islands and Hoggar.
- Visit to GEMOC by Professor Michel Grégoire and Dr Rémi Freydier for a collaborative project on Malaita mantle samples.
- A project on the geochemistry of amphiboles and metasomatic styles was commenced with Professor Massimo Coltorti and Dr Costanza Bonadiman from the University of Ferrara and Professor Coltorti scheduled a visit to GEMOC in early 2005.
- Igneous rocks, mineral deposits, lithosphere structure and tectonic setting: southeastern China and eastern Australia. This collaboration with Nanjing University has expanded from an AusAID grant under the ACILP scheme. Visits to GEMOC by Professors Xisheng Xu and Jinhai Yu, with postgraduate student Ms Lei Zhao in 2004, continued the close collaboration with Nanjing University.
- Lithosphere Mapping and crustal evolution in the Dharwar Craton, India with Dr E. Babu (funded by a Boyscast fellowship from India) and Dr Bashkar Rao, both from the National Geophysical Research Institute, Hyderabad. Rio Tinto also contributed funding and samples.
- Studies with Professor Jianping Zheng (China University of Geosciences, Wuhan) continued on the evolution of the lithosphere beneath several parts of China, and the UHP metamorphism of Dabie-Sulu peridotites.
- Analysis of off-craton lithospheric mantle in East Central Asia Orogenic Belt, with Dr V. Malkovets, Novosibirsk
- *TerraneChron*™ analysis of the edge of the Kalahari Craton in Botswana, with WMC Resources
- Canary Islands lithosphere and volcanism with Prof. E.-R. Neumann (Oslo)
- Tectonic domains in southern Norway using *TerraneChron*™ with Prof. T. Andersen (University of Oslo) and Dr B. Bingen (Norwegian Geological Survey)
- Seismic analysis of data collected on the 2003 *RV Sonne* cruises to investigate the nature of the Campbell Plateau, Southern Ocean with a 3-month visit by Dr Karsten Gohl (Alfred Wegener Institute, Bremerhaven)
- *In situ* Sr isotope analysis of marine fossils to constrain stratigraphic/tectonic reconstruction of terranes in New Zealand, with Dr C. Adams (Institute of Geological and Nuclear Sciences, New Zealand)
- Age and magma sources of Chilean Cu-porphyries, with Codelco (Chile) and the CSIRO Division of Exploration and Mining (Perth)

New MOUs were signed with the National Geophysical Research Institute, Hyderabad (India), the University of Ferrara (Italy) and negotiations are underway for collaboration with the United Arab Emirates University.

Refer to the *Research Program* and *Postgraduate* sections of this Report for details of other projects.

WAS THE FUNDING STRATEGY FOR GEMOC CONTINUATION (AFTER COMMONWEALTH CENTRE FUNDING CEASED) SUCCESSFUL?

GEMOC's business plan has proved to be a successful blueprint, resulting in viable funding to continue GEMOC's activities beyond the Commonwealth funding period that ended in 2001.

Key elements of funding continuation include:

- Macquarie University Centre Administration support ($120,000 in 2004)
- Macquarie University Postgraduate Scholarships for Australian and international students
- ARC Program Grant 2002-2006 for basic research component and other ARC Discovery Grants to GEMOC researchers (see *Appendix 5*)
- DEST Systemic Infrastructure Initiative Grant ($5.125 million) for 2002-2004
- Award of two Federation Fellowships (Professors Simon Turner and Bernard Wood)
- Industry funding has increased through substantial collaborative ventures and value-added consulting
- Independent Research Fellowships to support Postdoctoral Fellows
- Continuation of existing funding sources for other ongoing activities such as postgraduate scholarships, undergraduate teaching development and pilot research projects.
- 2 new academic staff members (Drs Kelsie Dadd and Simon Jackson) appointed to GEMOC in 1995 and 1996 have continuing appointments; 1 subsequent new academic staff member appointed (Dr Nathan Daczko)
- Postgraduate funding strategy exceeded goals
- Strategy for equipment and analytical funding exceeded goals

Macquarie University support has been exceptional in all areas including cash, in-kind and space guarantees, and in policy support. Macquarie's Research Strategic Plan recognises GEMOC's research programs as Areas of Excellence (lithosphere and planetary evolution and metallogeny; isotopic and global geochemistry; and paleomagnetism, geodynamics and geophysical modelling) and GEMOC as a Centre of Excellence.

Strategy for ongoing Geochemical Analysis Unit funding

GEMOC's outstanding analytical facilities are vital to our innovative research programs and to attracting research and industry income. This technology concentration also represents a high-budget item in terms of maintenance, running costs, replacement and especially for new purchases to maintain frontline developments. Funding strategies in place include:

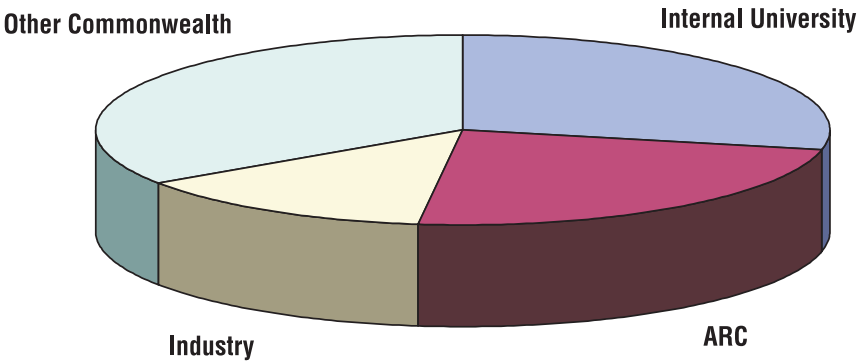
- User-pays system for running, maintenance and development costs
- University annual contributions through competitive schemes and capital equipment allocations
- Annual contribution from the Department of Earth and Planetary Sciences
- Macquarie University's guarantee of a strategic plan to ensure the integrity, maintenance and appropriate staffing of the Geochemical Analysis Unit
- Collaborative project building with industry partners

- Delivery of new exploration tools to industry through novel analytical methodologies
- Research and Development ventures with manufacturers leading to equipment replacement
- Applications to funding schemes for matching funds for new purchases
- Provision of services to external clients including industry
- Industry capital investment in return for access equity, negotiated intellectual property and collaborative rates

GEMOC INCOME 2004

This is a summary of 2004 Income. A full audited statement of detailed expenditure and income is prepared by Macquarie University. *No in-kind support is included.*

	$1000
ARC	
Discovery, (including Fellowships), Linkage (Project and International), Federation Fellowships	
Total ARC	1,300.0
OTHER COMMONWEALTH	
Postgraduate awards	78.0
DEST Systemic Infrastructure	1,830.0
INDUSTRY	
Nu Instruments Fellowship	313.0
Collaborative Research grants (MUECRG, AMIRA)	234.0
Collaborative and commercial through MRL	215.0
INTERNAL UNIVERSITY	
Annual Key Centre Contribution	120.0
GAU maintenance (Department)	30.0
Internal competitive schemes	
Macquarie Fellowships	99.0
Matching to ARC schemes	190.0
Research grants	303.0
Development and Innovation Grants	373.0
Postgraduate awards	113.0
Postgraduate research grants	3.5
Infrastructure (RIBG)	78.0
Capital Equipment	132.0
Teaching Development	52.0
TOTAL	**5463.5**



PIE-CHART OF INCOME SOURCES 2004

Monaco Glacier, Spitsbergen.

BENEFITS TO AUSTRALIA

- Scientific innovation relevant to National Priority Areas

  Research Priority 1: An Environmentally Sustainable Australia (Goal 1: Water – a Critical Resource and Goal 3: Developing Deep Earth Resources) and

  Research Priority 3: Frontier Technologies for Building and Transforming Australian Industries (Goal 1: Breakthrough Sciences and Goal 2: Frontier Technologies)
- Excellence in training of our future generation of geoscientists
- Enhanced industry links nationally and internationally
- Improved criteria for exploration by Australian mining companies both on- and off-shore
- Technological innovation (scientific advances, intellectual property, commercialisation, value-added consulting services)
- Enhanced international links

Appendix 1: Participants

GEMOC PARTICIPANTS 2004/2005

MACQUARIE UNIVERSITY

Department of Earth and Planetary Sciences

Academic Staff (Teaching and Research)

Dr Kelsie Dadd (Physical vulcanology, geochemistry, tectonics)

Dr Nathan Daczko (Structural and metamorphic geology, tectonics, geodynamics)

Dr Richard Flood (Volcanic geology, application of magnetic fabrics to reconstruction of volcanic terrains)

Professor W.L. Griffin, Program Leader (Technology development and industry liaison)

Dr Simon Jackson (Trace element geochemistry, metallogeny)

Dr Mark Lackie (Rock magnetism, paleomagnetic reconstructions)

Professor Suzanne Y. O'Reilly, Director (Crust and mantle evolution, lithosphere modelling)

Professor Simon Turner (Isotopic Geochemistry)

Research Staff

Dr John Adam

Dr Elena Belousova

Ms Tara Deen

Dr Anthony Dosseto

Dr Lev Natapov

Dr Yvette Poudjom Djomani

Dr Rhiannon George

Emeritus Professor Trevor Green

Dr Vladimir Malkovets

Professor Simon Turner

Emeritus Professor John Veevers

Emeritus Professor Ron Vernon

Dr Kuo-Lung Wang

Dr Ming Zhang

Adjunct Professors

Professor Bruce Chappell (Granite petrogenesis, geochemistry)

Professor Nicholas Fisher

Dr Richard Glen

Professor W.L. Griffin

Dr Jingfeng Guo

Dr John Hronsky (WMC Resources Ltd)

Professor Paul Morgan (University of Northern Arizona, Geophysics and tectonics)

Professor Mike Etheridge

Professor Else-Ragnhild Neumann

Professor Xisheng Xu

Visiting Professors

Professor Tom Andersen (University of Oslo)

Professor Jean-Yves Cottin (University Jean-Monnet, St Etienne)

Dr Yong-Joo Jwa (Korea)

Professor Nicholas Fisher (Statistics, quality management)

Dr Phil Schmidt (see CSIRO)

Visiting Fellows

Dr Gilles Chazot (University of Clermont-Ferrand)

Associate Professor Ian Metcalfe (Tectonics, Asian terrain reconstructions, Gondwana breakup)

Honorary Associates

Dr Natsue Abe

Dr Kari Anderson

Ms Sonja Aulbach

Dr Evssk Babu

Dr Graham Begg

Dr Yerraguntia Bhaskar Rao

Dr Phillip L. Blevin

Ms Rosa Maria Bomparola

Professor Hannes Brueckner

Dr Robert Bultitude

Dr Gilles Chazot

Mr David Clark (CSIRO)

Dr Jean-Yves Cottin

Professor Kent Condie

Dr Richard Glen

Dr Karsten Gohl

Dr Michel Grégoire

Dr Bram Janse

Dr Mel Jones

Dr Felix Kaminsky

Dr Bertrand Moine

Dr Geoff Nichols

Dr Boris Panov

Dr Mark C. Pirlo

Dr Peter Robinson

Dr Chris Ryan (CSIRO)

Dr Stirling Shaw

Dr Simon Shee

Dr Zdislav Spetsius

Dr Nancy van Wagoner

Dr Steve Walters

Professor Xiang Wang

Mr Bruce Wyatt

Ms Chunmei Yu

Professor Jin-Hai Yu

Professor Jianping Zheng

Professional Staff

Ms Manal Bebbington (rock preparation)

Dr Eloise Beyer (Geochemist)

Mrs Nikki Bohan (Administrator from May 2005)

Mr Stephen Craven (rock preparation)

Ms Suzy Elhlou (Scientific Officer)

Dr Oliver Gaul (Research Officer)

Ms Sally-Ann Hodgekiss (Research Officer, Design consultant)

Dr John Ketchum (Geochemist)

Ms Carol Lawson (XRF, Laboratories)

Ms Valeria Murgulov (Geochemist)

Ms Leigh Newton (Administrator until September 2004)

Dr Norman Pearson (Manager, GAU)

Dr Ayesha Saeed (Geochemist)

Dr Kirsty Tomlinson (Geochemist)

Mr Peter Wieland (Geochemist)

Mr William Powell (Research Assistant)

FORMAL COLLABORATORS

University of Wollongong

Professor Allan Chivas (DEST Systemic Infrastructure partner)

Monash University

Dr Bruce Schaefer

University of Newcastle and James Cook University

Professor W. Collins (DEST Systemic Infrastructure partner)

University of Sydney

Dr G. Clarke (DEST Systemic Infrastructure partner)

Dr Dietmar Muller

University of Western Sydney

Professor Peter Williams (DEST Systemic Infrastructure partner)

CSIRO Division of Exploration and Mining

Dr Anita Andrew (Stable isotopes)

Mr D. Clark (Paleomagnetism, magnetic modelling)

Dr N. Evans (PGE geochemistry and Re/Os systematics)

Dr Brent McInnes (Cu/Au metallogeny)

Dr C.G. Ryan (Proton microprobe, fluid analysis)

Dr P. Schmidt (Rock magnetism, terrane evolution)

Ms Tin Tin Win (Hydrothermal systems, mantle petrology)

Australian National University (Research School of Earth Sciences)

Professor Geoff Davies

Professor Brian Kennett

Professor Gordon Lister

GA

Dr Barry Drummond (Geophysics)

Dr L. Wyborn (Crustal evolution, metallogeny through time, implementation of GPS/GIS)

Geological Survey of Western Australia

Dr I. Tyler (zircon U-Pb/Hf isotopes)

OTHER COLLABORATORS ON PROJECT BASIS

Dr Bernard Bingen (Geological Survey of Norway, Trondheim)

Professor J.-L. Bodinier (Universitè Montpellier, France)

Professor Chen-Hong Chen, (National Taiwan University)

Professor Chen Daogong (University of Science and Technology of China, Hefei)

Professor Sun-Ling Chung (National Taiwan University)

Dr Massimo Coltorti (University of Ferrara, Italy)

Dr Yuriy Erinchek (VSEGEI)

Professor Weiming Fan (Resource and Environment Department, Chinese Academy of Sciences)

Professor A. Giret (Université Jean Monnet, St Etienne)

Dr T.-L. Knudsen (Geologisk Museum, Norway)

Dr L.M. Larsen (Greenland Geological Survey)

Dr J.-P. Lorand (Museum National d'Histoire Naturelle)

Professor Fengxiang Lu (China University of Geosciences at Wuhan)

Professor Ma Hongwen (China University of Geosciences at Beijing)

Professor S.R. Paterson (University of Southern California)

Dr Patrice Rey (University of Sydney)

Mr Michael Schwarz (PIRSA)

Dr Csaba Szabo (Eotvos University Budapest)

Professor O.T. Tobisch (University of California, Santa Cruz)

Professor P. F. Williams (University of New Brunswick)

Professor Xue Jiyue (Nanjing University)

Professor Yuan Xuecheng (China Geological Survey)

Professor Zhou Xinmin (Nanjing University)

Technology Partners

Agilent Technologies (Hewlett Packard)

New Wave Research

Spectro Instruments

Nu Instruments

Appendix 2: Publications

A full list of GEMOC Publications is available at http://www.es.mq.edu.au/GEMOC/

300. **Griffin, W.L., Belousova, E.A., Shee, S.R., Pearson, N.J. and O'Reilly, S.Y.** 2004. Archean crustal evolution in the northern Yilgarn Craton: U-Pb and Hf-isotope evidence from detrital zircons. *Precambrian Research, 131, 231-282.*

301. **Yu, J., O'Reilly, S.Y., Griffin, W.L., Xu, X. and Zhou, X.** 2003. The thermal state and composition of the lithospheric mantle beneath the Leizhou Peninsula, South China. *Journal of Volcanology and Geothermal Research, 122, 165-189.*

302. **Yu, J., Xu, X., O'Reilly, S.Y., Griffin, W.L. and Zhang, M.** 2003. Granulite xenoliths from Cenozoic Basalts in SE China provide geochemical fingerprints to distinguish lower crust terranes from the North and South China tectonic blocks. *Lithos, 67, 77-102.*

303. **Griffin, W.L., O'Reilly, S.Y., Abe, N., Aulbach, S., Davies, R.M., Pearson, N.J., Doyle, B.J. and Kivi, K.** 2003. The origin and evolution of Archean lithospheric mantle. *Precambrian Research, 127, 19-41.*

304. **Pisarevsky, S.A. and Natapov, L.M.** 2003. Siberia and Rodinia. *Tectonophysics, 375, 221-245.*

305. **Xu, X., Deng, P., O'Reilly, S.Y., Griffin, W. L., Zhou, X. and Tan, Z.** 2003. Single zircon LAM-ICPMS U-Pb dating of the Guidong Complex (SE China) and its petrogenic significance. *Chinese Scientific Bulletin, 48, 17, 1892-1899.*

306. **Johnson, S.E., Fletcher, J.M., Fanning, C.M., Vernon, R.H., Paterson, S.R. and Tate, M.C.** 2003. Structure, emplacement and lateral expansion of the San Jose tonalite pluton, Peninsular Ranges batholith, Baja California, Mexico. *Journal of Structural Geology, 25, 219-232.*

307. **Vernon, R.H., Collins, W.J. and Richards, S.W.** 2003. Contrasting leucosomes in metapelitic and metapsammitic migmatites in the Cooma Complex, Australia. *Visual Geoscience, 8, 45-54.*

308. **Paterson, S.R., Pignotta, G.S. and Vernon, R.H.** 2004. The significance of microgranitoid enclave shapes and orientations. *Journal of Structural Geology, 26, 1465-1481.*

309. **Bryant, C.J., Chappell, B.W., Bennett, V.C. and McCulloch, M.T.** 2004 Lithium isotopic compositions of the New England Batholith: correlations with inferred source rock compositions. *Transactions of the Royal Society of Edinburgh: Earth Sciences, 95, 199-214.*

310. **Abe, N., Takami, M. and Arai, S.** 2003. Petrological feature of spinel lherzolite from Oki-Dogo Island: an implication for variety of the upper mantle peridotite beneath SW Japan. *Island ARC, 12, 219-232.*

311. **Jackson, S.E. and Gunther, D.** 2003. The nature and sources of laser induced-isotopic fractionation in laser ablation-multi collector-inductively coupled plasma-mass spectrometry. *Journal of Analytical Atomic Spectrometry, 18, 205-212.*

312. **Gagnevin, D., Ethien, R., Bonin, B., Moine, B., Feraud, G., Gerbe, M.C., Cottin, J.-Y., Michon, G., Tourpin, S., Mamias, G., Perrache, C. and Giret, A.** 2003. Open-system processes in the genesis of silica-oversaturated alkaline rocks of the Rallier-du-Baty Peninsula, Kerguelen Archipelago (Indian Ocean). *Journal of Volcanology and Geothermal Research, 123, 267-300.*

313. **Adam, J. and Green, T.** 2003. The influence of pressure, mineral composition and water on trace element partitioning clinopyroxene, amphibole and basanitic melts. *European Journal of Mineralogy, 15, 831-841.*

314. **Veevers, J.J.** 2003. Pan-African is Pan-Gondwanaland: oblique convergence drives rotation during 650-500 Ma assembly. *Geology, 31 (6), 501-504.*

315. **Clarke, D.B., McCuish, K.L., Vernon, R.H., Maksaev, V. and Miller, B.V.** 2002. The Port Mouton Shear Zone: intersection of a regional fault with a crystallizing granitoid pluton. *Lithos, 61, 141-159.*

316. **Green, T.H. and Adam, J.** 2003. Experimentally-determined trace element characteristics of aqueous fluid from partially dehydrated mafic oceanic crust at 3.0 GPa, 650-700°C. *European Journal of Mineralogy, 15, 815-830.*

317. **Kurosawa, M., Jackson, S.E. and Sueno, S.** 2002. Trace element analysis of NIST SRM 614 and 616 glass reference materials by laser ablation microprobe-inductively coupled plasma-mass spectrometry. *Geostandards Newsletter – The Journal of Geostandards and Goeoanalysis, 26, 75-84.*

318. **Gaul, O.F., O'Reilly, S.Y. and Griffin, W.L.** 2003. Lithosphere structure and evolution in southeastern Australia. *Geological Society of Australia Special Publication, 22, 179-196.*

319. **Wang, K., O'Reilly, S.Y., Griffin, W.L., Chung, S. and Pearson, N.J.** 2003. Proterozoic mantle lithosphere beneath the extended margin of the South China block: *In situ* Re-Os evidence. *Geology, 31 (8), 709-712.*

320. **Brueckner, H.K., Van Roermund, H.L.M. and Pearson, N.J.** 2004. An Archean (?) to Paleozoic evolution for a garnet peridotite lens with sub-Baltic Shield Affinity within the Seve Nappe Complex of Jamtland, Sweden, Central Scandinavian Caledonides. *Journal of Petrology, 45 (2), 415-437.*

321. **Davies, R.M., Griffin, W.L., O'Reilly, S.Y. and Andrew, A.** 2003. Unusual mineral inclusions and carbon isotopes of alluvial diamonds from Bingara, eastern Australia. *Lithos, 69, 51-66.*

322. **Poudjom Djomani, Y.H., O'Reilly, S.Y., Griffin, W.L., Natapov, L., Erincheck, Y. and Hronsky, J.** 2003. Upper mantle beneath Eastern Siberia: Evidence from gravity modelling and mantle petrology. *Geochemistry, Geophysics and Geosystems, 4 (7), 1066, doi:10.1029/2002GC000420.*

323. **Anderson, K.L., Lackie, M.A., Clark, D.A. and Schmidt, W.** 2004. Return to Black Mountain: palaeomagnetic reassessment of the Chatsworth and Ninmaroo formations, western Queensland, Australia. *Geophysical Journal International, 157, 87-104.*

324. **Anderson, K.L., Lackie, M.A. and Clark, D.A.** 2004. Palaeomagnetic Results from the Palaeozoic basement of the Southern Drummond Basin, Central Queensland. *Geophysical Journal International, 159, 473-485.*

325. **Lorand, J.-P., Delpech, G., Grégoire, M., Moine, B., O'Reilly, S.Y. and Cottin, J.-Y.** 2004. Platinum-group elements and the multi-stage metasomatic history of Kerguelen lithospheric mantle (South Indian Ocean). *Chemical Geology, 208, 195-215.*

326. **Griffin, W.L., Graham, S., O'Reilly, S.Y. and Pearson, N.J.** 2004. Lithospheric evolution beneath the Kaapvaal Craton: Re-Os systematics of sulfides in mantle-derived peridotites. *Chemical Geology, 208, 89-118.*

327. **Pirlo, M. and Giblin, A.** 2004. Application of groundwater-mineral equilibrium calculations to geochemical exploration for sediment-hosted uranium: observations from the Frome Embayment, South Australia. *Geochemistry: Exploration, Environment, Analysis, 4, 113-127.*

328. **Schroter, F.C., Stevenson, J.A., Daczko, N.R., Clarke, G.L. and Pearson, N.J. and Klepeis, K.A.** 2004. Trace element partitioning during high-P partial melting and melt-rock interaction; an example from northern Fiordland, New Zealand. *Journal of Metamorphic Geology, 22, 443-457.*

329. **Moine, B.N., Grégoire, M., O'Reilly, S.Y., Delpech, G., Sheppard, S.M.F., Lorand, J.P., Renac, C., Giret, A. and Cottin, J.Y.** 2004. Carbonatite melt in oceanic upper mantle beneath the Kerguelen Archipelago. *Lithos, 239-252.*

330. **Zheng, J., O'Reilly, S.Y., Griffin, W.L., Zhang, M., Lu, F. and Liu, G.** 2004. Nature and evolution of Mesozoic-Cenozoic lithospheric mantle beneath the Cathaysia block, SE China. *Lithos, 74, 41-65.*

331. **Delpech, G., Grégoire, M., O'Reilly, S.Y., Cottin, J.Y., Moine, B., Michon, G. and Giret, A.** 2004. Feldspar from carbonate-rich silicate metasomatism in the shallow oceanic mantle under Kerguelen Islands (South Indian Ocean). *Lithos, 75, 209-237.*

332. **Powell, W., Zhang, M., O'Reilly, S.Y. and Tiepolo, M.** 2004. Mantle amphibole trace-element and isotopic signatures trace multiple metasomatic episodes in lithospheric mantle, western Victoria, Australia. *Lithos, 75, 141-171.*

333. **Andersen, T., Griffin, W.L., Jackson, S.E., Knudsen, T.-L. and Pearson, N.J.** 2004. Mid-Proterozoic magmatic arc evolution at the southwest margin of the Baltic Shield. *Lithos, 73, 289-318.*

334. **Andersen, T. and Griffin, W.L.** 2004. Lu-Hf and U-Pb isotope systematics of zircons from the Storgangen intrusion, Rogaland Intrusive Complex, SW Norway: Implications for the composition and evolution of Precambrian lower crust in the Baltic Shield. *Lithos, 73, 271-288.*

335. **Wang, K-L., Chung, S-L., O'Reilly, S.Y., Sun, S-S., Shinjo, R. and Chen, C-H.** 2004. Geochemical constraints for the genesis of post-collisional magmatism and the geodynamic evolution of the northern Taiwan region. *Journal of Petrology, 45, 5, 975-1011.*

336. **Nairn, I.A., Shane, P.R., Cole, J.W., Leonard, G.J., Self, S. and Pearson, N.** 2004. Rhyolite magma processes of the ~AD 1315 Kaharoa eruption episode, Tarawera volcano, New Zealand. *Journal of Volcanology and Geothermal Research, 131, 265-294.*

337. **Reid, A.J., Wilson, C.J.L., Belousova, E. and Pearson, N.J.** 2005. Mesozoic plutons of the Yidun Arc, SW China: U/Pb geochronology and Hf isotopic signature. *Ore Geology Reviews.* (in press)

338. **Lorand, J.-P., Alard, O., Luguet, A. and Keays, R.R.** 2003. Sulfur and selenium systematics of the subcontinental lithospheric mantle: Inferences from the Massif Central xenolith suite (France). *Geochimica et Cosmochimica Acta, 67(21), 4137-4151.*

339. **Zheng, J., Griffin, W.L., O'Reilly, S.Y., Lu, F., Wang, C., Zhang, M., Wang, F. and Li, H.** 2004. 3.6 Ga lower crust in central China: New evidence on the assembly of the North China craton. *Geology, 32 (3), 229-232.*

Appendix 2: Publications

340. **Luguet, A., Lorand, J-P., Alard, O. and Cottin, J-Y.** 2004. A multi-technique study of platinum group elements systematic in some Ligurian ophiolitic peridotites, Italy. *Chemical Geology, 208, 175-194.*

341. **Yu, J-H., Xu, X., O'Reilly, S.Y., Griffin, W.L. and Zhang, M.** 2004. Granulite xenoliths from Cenozoic basalts in SE China provide geochemical fingerprints to distinguish lower crust terranes from the North and South China tectonic blocks – Reply. *Lithos, 73, 135-144.*

342. **Van Achterbergh, E., Griffin, W.L., Ryan, C.G., O'Reilly, S.Y., Pearson, N.J., Kivi, K. and Doyle, B.J.** 2004. Melt inclusions from the deep Slave lithosphere: Implications for the origin and evolution of mantle-derived carbonatite kimberlite. *Lithos, 76, 461-474.*

343. **Davies, R.M., Griffin, W.L., O'Reilly, S.Y. and McCandless, T.E.** 2004. Inclusions in diamonds from the K14 and K10 kimberlites, Buffalo Hills, Alberta, Canada: diamond growth in a plume? *Lithos, 77, 99-111.*

344. **Graham, S., Pearson, N., Jackson, S., Griffin, W. and O'Reilly, S.Y.** 2004. Tracing Cu and Fe from source to porphyry: *in situ* determination of Cu and Fe isotope ratios in sulfides from the Grasberg Cu-Au deposit. *Chemical Geology, 207, 147-169.*

345. **Jackson, S.E., Pearson, N.J., Griffin, W.L. and Belousova, E.A.** 2004. The application of laser ablation-inductively coupled plasma-mass spectrometry to *in situ* U-Pb zircon geochronology. *Chemical Geology, 211, 47-69.*

346. **Aulbach, S., Griffin, W.L., O'Reilly, S.Y. and McCandless, T.E.** 2004. Genesis and evolution of the lithospheric mantle beneath the Buffalo Head Terrane, Alberta. *Lithos, 77, 413-451.*

347. **Shaw, S.E., Todd, V.R. and Grove, M.** 2003. Jurassic peraluminous gneissic granites in the axial zone of the Peninsular Ranges, southern California. *Geological Society of America Special Paper, 374, 157-183.*

348. **Griffin, W.L., O'Reilly, S.Y., Doyle, B.J., Pearson, N.J., Coopersmith, H., Kivi, K., Malkovets, V. and Pokhilenko, N.** 2004. Lithosphere Mapping beneath the North American plate. *Lithos, 77, 873-922.*

349. **Graham, S., Lambert, D. and Shee, S.** 2004. The petrogenesis of carbonatite, melnoite and kimberlite from the Eastern Goldfields Province, Yilgarn Craton. *Lithos, 76, 519-533.*

350. **Todd, V.R., Shaw, S.E. and Hammarstrom, J.M.** 2003. Cretaceous plutons of the Peninsular Ranges batholith, San Diego and westernmost Imperial Counties, California: Intrusion across a Late Jurassic continental margin. *Geological Society of America Special Paper, 374, 185-235.*

351. **Condie, K., Cox, J., O'Reilly, S.Y., Griffin, W.L. and Kerrich, R.** 2004. Distribution of high field strength and rare earth elements in mantle and lower crustal xenoliths from the southwestern United States: the role of grain-boundary phases. *Geochimica Cosmochimica Acta, 68, 3919-3942.*

352. **Aulbach, S., Griffin, W.L., Pearson, N.J., O'Reilly, S.Y., Kivi, K. and Doyle, B.J.** 2004. Mantle formation and evolution, Slave Craton: constraints from HSE abundances and Re-Os isotope systematics of sulfide inclusions in mantle xenocrysts. *Chemical Geology, 208, 61-88.*

353. **Poudjom Djomani, Y., O'Reilly, S.Y., Griffin, W.L., Natapov, L.M., Pearson, N. J. and Doyle, B.J.** 2005. Variations of the effective elastic thickness (Te) and structure of the lithosphere beneath the Slave Province, Canada. *Exploration Geophysics, 36 (3).* (in press)

354. **Zheng, J., Griffin, W.L., O'Reilly, S.Y., Lu, F., Yu, C., Zhang, M. and Li, H.** 2004. U-Pb and Hf-isotope analysis of zircons in mafic xenoliths from Fuxian kimberlites: evolution of the lower crust beneath the North China Craton. *Contributions to Mineralogy and Petrology, 148, 79-103.*

355. **Beyer, E.E., Brueckner, H.K., Griffin, W.L., O'Reilly, S.Y. and Graham, S.** 2004. Archean mantle fragments in Proterozoic crust, Western Gneiss Region, Norway. *Geology, 32(7), 609-612.*

356. **Veevers, J.J.** 2004. Gondwanaland from 600-570 Ma assembly through 320 Ma merger in Pangea to 180-100 Ma breakup: Supercontinental tectonics via stratigraphy and radiometric dating. *Earth Science Reviews, 68, 1-132.*

357. **Matsumoto, T., Honda, M., McDougall, I., Yatsevich, I and O'Reilly, S.Y.** 2004. Isotope fractionation of neon during stepheating extraction?: A comment on "Re-interpretation of the existence of a primitive plume under Australia based on neon isotope fractionation during step heating" by Gautheron and Moreira (2003). *Terra Nova, 16, 23-26.*

358. **Veevers, J.J., Saeed, A., Belousova, E.A. and Griffin, W.L.** 2005. U-Pb ages and source composition of detrital zircons in Permian sandstone and modern sand from southwestern Australia and a review of the palaeogeographical and denudational history of the Yilgarn Craton. *Earth Science Reviews, 68, 245-279.*

359. **Prendergast, K., Clarke, G., Pearson, N.J. and Harris, K.** 2005. Genesis of pyrite-Au-As-Zn-Bi-Te zones associated with Cu-Au skarns: Evidence from Big Gossan and Wanagon Gold deposits, Ertsberg District, Papua, Indonesia. *Economic Geology*. (in press)

360. **Neumann, E., Griffin, W.L., Pearson, N.J. and O'Reilly, S.Y.** 2004. The evolution of the upper mantle beneath the Canary Islands: Information from trace elements and Sr isotope ratios in minerals in mantle xenoliths. *Journal of Petrology, 45, 2573-2612.*

361. **Davies, R.M., Griffin, W.L., O'Reilly, S.Y. and Doyle, B.J.** 2004. Mineral inclusions and geochemical characteristics of microdiamonds from D027, A154, A21, A418, D018, DD17 and Ranch Lake kimberlites at Lac de Gras, Slave Craton, Canada. *Lithos, 77, 39-55.*

362. **Xu, X., Fan, Q., O'Reilly, S.Y., Jiang, S., Griffin, W.L., Wang, R. and Qui, J.** 2004. U-Pb dating of zircons from quartz diorite and its enclaves at Tongguanshan in Anhui and its petrogenetic implication. *Chinese Science Bulletin, 49, 2073-2082.*

363. **Wang, X. and Griffin, W.L.** 2004. Unusual Hf contents in metamorphic zircons from coesite-bearing eclogites of the Dabie Mountains, east-central China: implications for the dating of ultrahigh-pressure metamorphism. *Journal of Metamorphic Geology, 22, 629-637.*

364. **Andersen, T., Laajoki, K. and Saeed, A.** 2004. Age, provenance and tectonostratigraphic status of the Mesoproterozoic Blefjell quartzite, Telemark sector, southern Norway. *Precambrian Research, 135, 217-244.*

365. **Pirlo, M.C.** 2004. Hydrogeochemistry and geothermometry of thermal groundwaters from the Birdsville Track Ridge, Great Artesian Basin, South Australia. *Geothermics, 33, 743-774.*

366. **Cooper, S.A. and Belousova, E.A.** 2004. Granite gneiss basement on Flinders Island, South Australia. *Australian Journal of Earth Sciences, 51, 611-619.*

367. **Moore, A. and Belousova, E.** 2005. Crystallization of Cr-poor and Cr-rich megacryst suites from the host kimberlite magma: implications for mantle structure and the generation of kimberlite magmas. *Contributions to Mineralogy and Petrology, 149 (4), 462-481.*

368. **Zheng, J.P., Zhang, R.Y., Liou, J.G., Griffin, W.L. and O'Reilly, S.Y.** 2005. Heterogeneous and metasomatised mantle recorded by trace elements in minerals of the Donghai garnet peridotites, Sulu UHP terrane, China. *Chemical Geology.* (in press)

369. **Blevin, P.L.** 2004. Redox and compositional parameters for interpreting the granitoid metallogeny of eastern Australia: Implications for gold-rich ore systems. *Resource Geology, 54, 241-252.*

370. **Karmalkar, N.R., Rege, S., Griffin, W.L. and O'Reilly, S.Y.** 2005. Alkaline magmatism from Kutch, NW India: Implications for plume-lithosphere interaction. *Lithos, 81, 101-119.*

371. **Choukroun, M., O'Reilly, S.Y., Griffin, W.L., Pearson, N.J. and Dawson, J.B.** 2005. Hf isotopes of MARID (mica-amphibole-rutile-ilmenite-diopside) rutile trace metasomatic processes in the lithospheric mantle. *Geology, 33, 45-48.*

372. **Halpin, J.A., Gerakiteys, C.L., Clarke, G.L., Belousova, E.A. and Griffin, W.L.** 2005. In-situ U-Pb geochronology and Hf isotope analyses of the Rayner Complex, east Antarctica. *Contributions to Mineralogy and Petrology, 148, 689–706.*

373. **Hollis, J.A., Clarke G.L., Klepeis, K.A., Daczko, N.R., and Ireland T.R.** 2004. The regional significance of Cretaceous magmatism and metamorphism in Fiordland, New Zealand, from U-Pb zircon geochronology. *Journal of Metamorphic Geology, 22, 607-627.*

374. **Stevenson, J.A., Daczko, N.R., Clarke, G.L., Pearson, N. and Klepeis, K.A.** 2005. Direct observation of adakite melts generated in the lower continental crust, Fiordland, New Zealand. *Terra Nova, 17, 73-79.*

375. **Andersen, T.** 2005. Detrital zircons as tracers of sedimentary provenance: Limiting conditions from statistics and numerical simulation. *Chemical Geology, 216, 249-270.*

376. **White, A.J.R. and Chappell, B.W.** 2004. Petrographic discrimination of low- and high-temperature I-type granites. *Resource Geology, 54, 215-226.*

377. **Chappell, B.W. and Wyborn, D.** 2004. Cumulate and cumulative granites and associated rocks. *Resource Geology, 54, 227-240.*

378. **Griffin, W.L., Natapov, L.M., O'Reilly, S.Y., van Achterbergh, E., Cherenkova, A.F. and Cherenkov, V.G.** 2005. The Kharamai kimberlite field, Siberia: Modification of the lithospheric mantle by the Siberian Trap event. *Lithos, 81, 167-187.*

379. **Martinez Catalán, J.R., Fernández-Suárez, J., Jenner, G.A., Belousova, E. and Díez Montes, A.** 2004. Provenance constraints from detrital zircon U-Pb ages in the NW Iberian Massif: implications for Palaeozoic plate configuration and Variscan evolution. *Journal of the Geological Society of London, 161, 463-476.*

Appendix 2: Publications

380. **Xu X., O'Reilly, S.Y., Griffin, W.L., Deng, P. and Pearson, N.J.** 2005. Relict Proterozoic basement in the Nanling Mountains (SE China) and its tectonothermal overprinting. *Tectonics, 24, TC2003, doi:10.1029/2004TC00165.*

381. **Chappell, B.W.** 2004. Towards a unified model for granite genesis. *Transactions of the Royal Society of Edinburgh: Earth Sciences, 95, 1-10.*

382. **Chappell, B.W., White, A.J.R., Williams, I.S. and Wyborn, D.** 2004. Low- and high-temperature granites. *Transactions of the Royal Society of Edinburgh: Earth Sciences, 95, 125-140.*

383. **Smith, D. and Griffin, W.L.** 2005. Garnetite xenoliths and mantle-water interactions below the Colorado Plateau, southwestern United States. *Journal of Petrology.* (in press)

384. **Zheng, J.P., Griffin, W.L., O'Reilly, S.Y., Liou, J.G., Zhang, R.Y. and Lu, F.** 2005. Late Mesozoic-Eocene mantle replacement beneath the eastern North China Craton: evidences from the Paleozoic and Cenozoic peridotite xenoliths. *International Geology Review*, 47, 457-472.

385. **Griffin, W.L., Belousova, E.A., Walters, S.G and O'Reilly, S.Y.** 2005. Archean and Proterozoic Crustal Evolution in the Eastern Succession of the Mt Isa District, Australia: U-Pb and Hf-isotope studies of detrital zircons. *Australian Journal of Earth Sciences, (Mt Isa Special Volume)*. (in press)

386. **Bingen, B., Griffin, W.L., Torsvik T.H. and Saeed, A.** 2005. Timing of Late Neoproterozoic glaciation on Baltica constrained by detrital zircon geochronology in the Hedmark Group, Southeast Norway. *Terra Nova, 17, 250-258.*

387. **Xiong, X.L., Adam, J. and Green, T.H.** 2005. Rutile stability and rutile/melt HFSE partitioning during partial melting of hydrous basalt: Implications for TTG genesis. *Chemical Geology, 218, 339-359.*

388. **Daczko, N.R., Mosher, S., Coffin, M.F. and Meckel, T.A.** 2005. Tectonic implications of fault-scarp–derived volcaniclastic deposits on Macquarie Island: Sedimentation at a fossil ridge-transform intersection? *Geological Society of America Bulletin, 117, 18-31.*

389. **Berlo, K., Turner, S., Blundy, J., and Hawkesworth, C.** 2004. The extent of U-series disequilibria produced during partial melting of the lower crust with implications for the formation of the Mount St. Helens dacites. *Contributions to Mineralogy and Petrology, 148, 122-130.*

390. **Berlo, K., Blundy, J., Turner, S., Cashman, K., Hawkesworth, C., and Black, S.** 2004. Geochemical precursors to volcanic activity at Mount St. Helens, U.S.A. *Science, 306, 1167-1169.*

391. **Vernon, R.H.** 2004. *A practical guide to rock microstructure*. Cambridge University Press, Cambridge, 606pp.

392. **Turner, S., Black, S., and Berlo, K.** 2004. ^{210}Pb-^{226}Ra and ^{228}Ra-^{232}Th systematics in young arc lavas: Implications for magma degassing and ascent rates. *Earth and Planetary Science Letters, 227, 1-16.*

393. **Johnson, S.E., Vernon, R.H. and Upton, P.** 2004. Foliation development and progressive strain-rate partitioning in the crystallizing carapace of a tonalite pluton: microstructural evidence and numerical modeling. *Journal of Structural Geology, 26, 1845-1865.*

394. **Haines, P.W., Turner, S.P., Kelley, S.P., Wartho, J.-A., and Sherlock, S.** 2004. ^{40}Ar-^{39}Ar dating of detrital muscovite in provenance investigations: a case study from the Adelaide Rift Complex, South Australia. *Earth and Planetary Science Letters, 227, 297-311.*

395. **George, R., Reagan, M., Turner, S., Gill, J., and Bourdon, B.** 2004. Comment on "Steady-state ^{226}Ra/^{230}Th disequilibrium in mantle minerals: Implications for melt transport rates in island arcs" by M.D. Feineman and D.J. DePaolo [Earth Planet. Sci. Lett. 215 (2003) 339-355]. *Earth and Planetary Science Letters 228, 563-567.*

396. **Zellmer, G.F., Annen, C., Charlier, B.L.A., George, R.M.M., Turner, S.P., and Hawkesworth, C.J.** 2004. Magma evolution and ascent at volcanic arcs: Constraining petrogenetic processes through rates and chronologies. *Journal of Volcanology and Geothermal Research, 140, 171-191.*

397. **Vernon, R.H., Johnson, S.E. and Melis, E.A.** 2004. Emplacement-related microstructures in the margin of a deformed pluton: the San José tonalite, Baja California, México. *Journal of Structural Geology, 26, 1867-1884.*

398. **McDermott, F., Delfin, F.G., Defant, M.J., Turner, S., and Maury, R.** 2005. The petrogenesis of magmas from Mt. Bulusan and Mayon in the Bicol arc, the Philippines. *Contributions to Mineralogy and Petrology.* (in press)

399. **George, R., Turner, S., Morris, J., Plank, T., Hawkesworth, C., and Ryan, J.** 2005. Pressure-temperature-time paths of sediment recycling beneath the Tonga-Kermadec arc. *Earth and Planetary Science Letters, 233, 195-211.*

400. **Adams, C.J., Campbell, H.J. and Griffin, W.L.** 2005. Isotopic microanalysis of seawater strontium in biogenic calcite to assess subsequent rehomogenisation during metamorphism. *Chemical Geology, 220, 67-82.*

401. **Yu, J., Zhou, X., O'Reilly, S.Y., Zhao, L., Griffin, W.L., Wang, R., Wang, L. and Chen, X.** 2005. Formation history and protolith characteristics of granulite facies metamorphic rock in Central Cathaysia deduced from U-Pb and Lu-Hf isotopic studies of single zircon grains. *Chinese Science Bulletin.* (in press)

402. **Yu, J., O'Reilly, S.Y., Xu X. and Wang, R.** 2005. Element diffusion ability in metasomatic agents and its effect on chemical characteristics of metasomatized peridotites. *Science in China.* (in press)

403. **Baker, T., Mustard, R., Brown, V., Pearson, N., Stanley, C.R., Radford, N.W. and Butler, I.** 2005. Textural and Chemical Zonation of Pyrite at Pajingo: A Potential Vector to Epithermal Gold Veins. *Geochemistry - Exploration, Environment and Analysis.* (in press)

404. **Condie, K.C., Beyer, E., Belousova, E., Griffin, W.L. and O'Reilly, S.Y.** 2005. U-Pb Isotopic Ages and Hf Isotopic Composition of Single Zircons: The Search for Juvenile Precambrian Continental Crust. *Precambrian Research.* (in press)

405. **McInnes, B.I.A., Evans, N.J., Fu, F.Q., Garwin, S., Belousova, E., Griffin, W.L., Bertens, A., Sukarna, D., Permanadewi, S., Andrew, R.L. and Deckart, K.** 2005. Thermal History analysis of selected Chilean, Indonesian and Iranian porphyry Cu-Mo-Au deposits. *In Porter, T.M. (ed), Super porphyry copper and gold deposits: a global perspective. PGC Publishing, Adelaide.* (in press)

406. **Belousova, E.A., Griffin, W.L. and O'Reilly, S.Y.** 2005. Zircon Crystal Morphology, Trace-Element Signatures and Hf-Isotope Composition as a Tool for Petrogenetic Modelling: Examples From Eastern Australian Granitoids. *Journal of Petrology.* (submitted)

407. **Rege, S., Jackson, S., Griffin, W.L., Davies, R.M., Pearson, N.J. and O'Reilly, S.Y.** 2005. Quantitative trace-element analysis of diamond by laser ablation inductively coupled plasma mass spectrometry. *Journal of Analytical Atomic Spectrometry, 20 (7), 601-611.*

408. **Pearson, N.J., Griffin, W.L., Alard, O. and O'Reilly, S.Y.** 2005. The isotopic composition of magnesium in mantle olivine: Records of depletion and metasomatism. *Chemical Geology.* (in press)

409. **O'Reilly, S.Y. and Griffin, W.L. 2005.** Imaging global chemical and thermal heterogeneity in the sub-continental lithospheric mantle with garnets and xenoliths: geophysical implications. *Physics of Earth and Planetary Interiors.* (in press)

410. **Kaminsky, F.V., Zakharchenko, O.D., Khachatryan, G.K., Griffin, W.L., Der Channer, D.M.** 2005. Diamond from the Los Coquitos area, Bolivar State, Venezuela. *The Canadian Mineralogist.* (in press)

411. **Alard, O., Luguet, A., Pearson, N.J., Griffin, W.L., Lorand, J.-P., Gannoun, A., Burton, K.W. and O'Reilly, S.Y.** 2005. In-situ Os isotopes in abyssal peridotites: bridging the "isotopic gap" between MORB and their source mantle. *Nature.* (in press)

412. **Odegard, M., Skar, O., Schiellerup, H. and Pearson, N.** 2005. Preparation of a Synthetic Titanite Glass Calibration Material For *In Situ* Microanalysis by Direct Fusion in Graphite Electrodes: A Preliminary Characterisation by EPMA and LA-ICP-MS. *Geostandards and Geoanalytical Research, 29, 2.* (in press)

413. **Veevers, J.J.** 2005. Edge tectonics (trench rollback, terrane export) of Gondwanaland-Pangea synchronized by supercontinental heat. *Gondwana Research.* (in press)

414. **Poudjom Djomani, Y.H., Griffin, W.L., O'Reilly, S.Y. and Doyle, B.J.** 2005 Lithospheric domains and controls on kimberlite emplacement, Slave Province, Canada: evidence from elastic thickness and upper mantle composition. *Geochemistry, Geophysics and Geosystems.* (in press)

415. **Yu, J.-H., O'Reilly, S.Y., Zhang, M., Griffin, W.L. and Xu. X.** 2005. Roles of melting and metasomatism in the formation of the lithospheric mantle beneath Leizhou Peninsula, South China. *Journal of Petrology.* (in press)

Appendix 3: Visitors/ GAU users

GEMOC VISITORS 2004
(Excluding Participants in Conferences and Workshops)
Macquarie

Dr Chris Adams (Institute of Geological and Nuclear Sciences, New Zealand)

Dr Andrew Allibone (James Cook University, Australia)

Dr EVSSK Babu (National Geophysical Research Institute, India)

Dr Graham Begg (Western Mining Resources Limited, Perth)

Prof. Ron Boyd (University of Newcastle)

Mr Steve Bussey (Western Mining Resources Limited, Perth)

Ms Mei-Fei Chu (National Taiwan University, Taipei)

Dr Geoff Clark (University of Sydney)

Dr Massimo Coltorti (University of Ferrara, Italy)

Dr Robert Creaser (University of Alberta, Canada)

Dr Remi Freydier (UMR 5562 "Dynamique Terrestre et Planétaire, Observatoire Midi-Pyrénées)

Dr Richard Glen (NSW Geological Survey)

Dr Michel Grégoire (UMR 5562 "Dynamique Terrestre et Planétaire, Observatoire Midi-Pyrénées)

Dr. Karsten Gohl (Alfred Wegener Instutute for Polar and Marine Research, Germany)

Ms Adriana Heimann (University of Iowa)

Mr Bryce Healy (University of Newcastle)

Prof. Brian Kennett (Australian National University, Canberra)

Ms Yu-Hsuan Liang (National Taiwan University, Taipei)

Prof. Gordon Lister (Australian National University, Canberra)

Dr Bertrand Moine (Université Jean-Monnet, St. Etienne, France)

Dr Catherine McCammon (Universitat Bayreuth, Germany)

Dr Y.J. Bhaskar Rao (National Geophysical Research Institute, India)

Dr Patrice Rey (University of Sydney)

Prof. Mike Sandiford (University of Melbourne)

Dr Giovanna Sapienza (Universita degli Studi di Bologna, Italy)

Dr Anders Schersten (Bristol Univerity, UK)

Mr Michael Schwarz (PIRSA)

Dr Zdislav Spetsius (Institute of Diamond Industry, Russia)

Prof. Paul Spry (University of Iowa)

Dr Csaba Szabo (Eotvos University Budapest)

Dr Jamie Williams (Nu Instruments, UK)

Prof. Bernie Wood (University of Bristol)

Prof. Xisheng Xu (Nanjing University, P. R. China)

Prof. Jinhai Yu (Nanjing University, P. R. China)

Ms Lei Zhao (Nanjing University, P. R. China)

Dr Dmitri Zedgenizov (Institute of Mineralogy and Petrography, Russia)

Dr Jianping Zheng (China University of Geosciences, Wuhan)

EXTERNAL USERS OF THE GEOCHEMICAL ANALYSIS UNIT FACILITIES IN 2004

(Note: this does not include commercial or contract work through Macquarie Research Limited)

Dr Chris Adams (Institute of Geological and Nuclear Sciences, New Zealand)

Dr EVSSK Babu (National Geophysical Research Institute, India)

Ms Verity Borthwick (University of Sydney)

Dr Graziella Caprarelli (University of Technology, Sydney)

Ms Mei-Fei Chu (National Taiwan University, Taipei)

Dr Massimo Coltorti (University of Ferrara, Italy)

Ms Shannon Davies (University of Newcastle)

Dr Joel Fitzherbert (University of Sydney)

Dr Remi Freydier (UMR 5562 Dynamique Terrestre et Planétaire, Observatoire Midi-Pyrénées)

Dr Richard Glen (NSW Geological Survey)

Dr Michel Grégoire (UMR 5562 Dynamique Terrestre et Planétaire, Observatoire Midi-Pyrénées)

Ms Adriana Heimann (University of Iowa)

Mr Bryce Healy (University of Newcastle)

Dr Florence Le Hebel (University of Sydney)

Ms Yu-Hsuan Liang (National Taiwan University, Taipei)

Mr Sam Lui, (University of Sydney)

Dr Terry Mernagh, (Geoscience Australia)

Dr Bertrand Moine (Université Jean-Monnet, St. Etienne, France)

Dr Y.J. Bhaskar Rao (National Geophysical Research Institute, India)

Dr Anthony Reid (University of Adelaide/PIRSA)

Dr Giovanna Sapienza (Universite degli Studi di Bologna, Italy)

Mr Florian Schröter (University of Sydney)

Mr Michael Schwarz (PIRSA)

Dr Zdislav Spetsius (Institute of Diamond Industry, Russia)

Dr Csaba Szabo (Eotvos University Budapest)

Prof. Xisheng Xu (Nanjing University, P. R. China)

Prof. Jinhai Yu (Nanjing University, P. R. China)

Ms Lei Zhao (Nanjing University, P. R. China)

Dr Dmitri Zedgenizov (Institute of Mineralogy and Petrography, Russia)

Dr Jianping Zheng (China University of Geosciences, Wuhan)

Appendix 4: Abstract titles

TITLES OF ABSTRACTS FOR CONFERENCE PRESENTATIONS IN 2004

Full abstracts available at http://www.es.mq.edu.au/GEMOC/

17TH AUSTRALIAN GEOLOGICAL CONVENTION, HOBART, TASMANIA, 8 – 13 FEBRUARY 2004

Zircon as a multi-faceted tool for petrogenic modelling: applications to eastern Australian granitoids
E. A. Belousova[1], W. L. Griffin[1,2] and S. Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia

Archean mantle fragments in Proterozoic crust, Western Gneiss Region, Norway: In-situ and whole-rock Re-Os evidence
E. Beyer, S. Y. O'Reilly and W. L. Griffin
GEMOC, Macquarie

Tectonic implications of fault-scarp-derived volcaniclastic deposits on Macquarie Island: Sedimentation at a fossil ridge-transform intersection?
N. Daczko[1], S. Mosher[2], M. Coffin[3], T. Meckel[4] and A. Hunter[4]
1. GEMOC, Macquarie, 2. University of Texas at Austin, USA, 3. University of Tokyo, Japan, 4. Colby College, USA

Extension along the Australian-Pacific transpressional transform plate boundary near Macquarie Island
N. Daczko[1], K. Wertz[2], S. Mosher[2], M. Coffin[3] and T. Meckel[4]
1. GEMOC, Macquarie, 2. Jackson School of Geosciences, University of Texas at Austin, USA, 3. Ocean Research Institute, University of Tokyo, Japan, 4. Department of Geology, Colby College, USA

The ODP Undergraduate Student Trainee program: taking part in experimental learning at sea
K. Dadd and R. Sandwell
GEMOC, Macquarie

Possible source directions for the Mesoproterozoic Eucarro Rhyolite, Gawler Ranges: evidence from phenocryst lineations
F. Della Pasqua[1], J. McPhie[1], S. Allen[1], R. Berry[1], M. Lackie[2] and G. Ferris[3]
1. School of Earth Sciences, University of Tasmania, 2. GEMOC, Macquarie, 3. Primary Industries and Resources S.A.

Overview of Tasmanian Tertiary basalts
J. L. Everard[1], M. Zhang[2], C-H. Lo[3], S. Y. O'Reilly[2] and S. M. Forsyth[1]
1. Tasmanian Geological Survey, Mineral Resources Tasmania, 2. GEMOC, Macquarie, 3. Department of Geosciences, National Taiwan University, Taipei, Republic of China

Constraints on the mechanism and timing of sediment recycling in the Tonga-Kermadec arc from beryllium isotopes
R. George[1], S. Turner[1], J. Morris[2], T. Plank[3], C. Hawkesworth[4]
1. GEMOC, Macquarie, 2. Department of Earth and Planetary Sciences, Washington University, St. Louis, MO, USA 3. Department of Earth Sciences, Boston University, Boston, MA, USA, 4. Department of Earth Sciences, Queens Road, Bristol, UK

Terranechrone™: A new way to explore crustal evolution
W. L. Griffin, E. A. Belousova, S. Y. O'Reilly and S. G. Walters
GEMOC, Macquarie

A 3D model of the gravity signature of the Moonbi and Bendemeer adamellites
M. Lackie and B. Bailey
GEMOC, Macquarie

Magnesium isotopic composition of olivine by laser ablation multiple collector ICPMS
N. J. Pearson, W. L. Griffin, S. Y. O'Reilly and G. Delpech
GEMOC, Macquarie

Defining age constraints for mantle events from Re-Os isotopes and tracking metasomatic processes in lithospheric mantle domains beneath New England
W. Powell, GEMOC, Macquarie

Trace element analysis of diamond by LAM-ICPMS: Methodology and preliminary results
S. Rege[1], R. Davies[2], W. L. Griffin[1,3], S. Jackson[1], N. Pearson[1] and S. Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. Department Earth and Planetary Sciences, American Museum of Natural History, New York, 3. CSIRO Exploration and Mining, North Ryde, Australia

U-series isotope constraints on melting processes and degassing time scales at island arc volcanoes
S. P. Turner[1], M. Regelous[2], R. George[1] and C. Hawkesworth[1]
1. GEMOC, Macquarie 2. Department of Earth Sciences, University of Bristol, UK

Petrogenesis of Tasmanian Tertiary Basalts
M. Zhang[1], S. Y. O'Reilly[1], J. L. Everard[2] and W. L. Griffin[1,3]
1. GEMOC, Macquarie, 2. Tasmanian Geological Survey, Australia, 3. CSIRO Exploration and Mining

INTERNATIONAL WORKSHOP ON TECTONICS AND EVOLUTION OF THE PRECAMBRIAN SOUTHERN GRANULITE TERRAIN, INDIA AND GONDWANIAN CORRELATIONS, HYDERABAD, INDIA, 18-25 FEBRUARY 2004

Early crustal history of the Slave craton, northwestern Canada
J. W. F. Ketchum, GEMOC, Macquarie

SEISMIC HETEROGENEITY IN THE EARTH'S MANTLE: THERMO-PETROLOGIC AND TECTONIC IMPLICATIONS SYMPOSIUM, COPENHAGEN, 26-28 FEBRUARY 2004

Imaging Petrological and Thermal Heterogeneity in the Lithospheric Mantle: Implications for interpretation of geophysical data
W. L. Griffin, S. Y. O'Reilly and Y. Poudjom Djomani
GEMOC, Macquarie

GEOLOGICAL ASSOCIATION OF CANADA-MINERALOGICAL ASSOCIATION OF CANADA, JOINT ANNUAL MEETING, BROCK UNIVERSITY, ST CATHERINES, ONTARIO, CANADA, 12-14 MAY 2004

Probing the secular evolution of the mid-to lower continental crust
J. W. F. Ketchum[1], J. A. Percival[2] and R. M. Easton[3]
1. GEMOC, Macquarie 2. Geological Survey of Canada, Ottawa, 3. Ontario Geological Survey, Sudbury, Canada

Mid-crustal recrystallization of zircon in Grenvillian eclogites – evidence from a CL and SHRIMP study
T. Rivers[1], J. W. F. Ketchum[2] and R. Cox[3]
1. Department of Earth Sciences, Memorial University, St. John's, NL, Canada, 2. GEMOC, Macquarie, 3. School of Earth and Ocean Sciences, University of Victoria, Victoria, BC, Canada

Combined U-Pb and Hf isotopic study of zircon provenance from till samples northerwestern Superior Province, Manitoba
K. Y. Tomlinson[1], W. L. Griffin[1,2], B. J. Doyle[3] and S. Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia, 3. Kennecott Canada Exploration Inc., Vancouver, BC, Canada

AGU JOINT ASSEMBLY 2004, MONTREAL, CANADA, 17-21 MAY 2004

Correlations between Os isotopic composition and trace element abundance in Chinese Cu-Ni deposit sulfides
S. Graham[1,2], W. J. Griffin[2], S. J. Barnes[1] and G. Begg[3]
1. UQAC, University of Quebec, Chicoutimi, Canada, 2. GEMOC, Macquarie, 3. WMC Resources, Belmont, Perth, Australia

Cu and Fe isotope variation in Candelaria Sulfides: Tracing to origins of fluid components in a stratiform ore deposit
S. Graham[1,3], W. L. Griffin[1], N. J. Pearson[1], S. Jackson[1], S. Y. O'Reilly[1] and R. Rutherford[2]
1. GEMOC, Macquarie, 2. Phelps Dodge, Sydney, Australia, 3. UQAC, University of Quebec, Chicoutimi, Canada

14TH ANNUAL V. M. GOLDSCHMIDT CONFERENCE, UNIVERSITY OF COPENHAGEN, OSTERVOLDGADE, DENMARK, 5-11 JUNE 2004

Os isotopes systematic of magmatic sulfides in abyssal peridotites
O. Alard[1], A. Luguet[2], J. P. Lorand[3], N. J. Pearson[4], W. L. Griffin[4] and S. Y. O'Reilly[4]
1. The Open University, Milton Keynes, UK, 2. DTM-Carnegie, Washington, USA, 3. MNHN, Paris, France, 4. GEMOC, Macquarie

Sveconorwegian underplating and grantic magmatism in the Baltic Shield: LAM-ICPMS Hf isotope evidence
T. Andersen[1], W. L. Griffin[2] and A. G. Sylvester[3]
1. Department of Geosciences, University of Oslo, Blindern, Oslo, Norway, 2. GEMOC, Macquarie, 3. Department of Geological Sciences, Univ. of California, Santa Barbara, USA

Trace element partition coefficients for mica and a variety of mantle derived melts and fluids
T. H. Green and J. Adam
GEMOC, Macquarie

Partitioning of H_2O between mantle minerals and silicate melts
E. H. Hauri,[1], G. A. Gaetani[2] and T. H. Green[3]
1. Department of Terrestrial Magnetism, Carnegie Institution of Washington , 2. Woods Hole Oceanographic Institution, Woods Hole, MA, USA, 3. GEMOC, Macquarie

Source compositional variability beneath the Bicol arc, the Philippines
F. McDermott[1], F. G. Delfin Jr.[2], M. J. Defant[3], S. Turner[4] and R. Maury[5]
1. Department of Geology, University College Dublin, Belfield, Ireland, 2. School of Policy, Planning and Development, University of Southern California, Los Angeles, USA, 3. Department of Geology, University of South Florida, USA, 4. GEMOC, Macquarie, 5. Laboratoire de Petrologie, Université Bretagne Occidentale, France

Earliest stages of formation of oceanic lithosphere in the central Atlantic Ocean: The oceanic plate beneath the Canary Islands
E.-R. Neumann[1], R. Vannucci[2], M. Tiepolo[2], W. L. Griffin[3] and N. J. Pearson[3]
1. Physics of Geological Processes, University of Oslo, Blindern, Oslo, Norway, 2. CNR-Istituto – Institute of Geosciences and Earth Resources, Pavia, Italy, 3. GEMOC, Macquarie

In-situ high pressure Hf isotope ratio measurement using laser ablation MC-ICPMS: Mass bias and isobaric interference corrections
N. J. Pearson[1], W. L. Griffin[1,2], and S. Y. O'Reilly[1]
1. GEMOC, Macquarie 2. CSIRO Exploration and Mining, North Ryde, Australia

Appendix 4: Abstract titles

Geochemistry and origin of mantle sulfides in spinel peridotites xenoliths from Penghu Islands, Taiwan
K.-L. Wang, S. Y. O'Reilly, W. L. Griffin, N. J. Pearson and M. Zhang
GEMOC, Macquarie

Heterogeneous and metasomatised mantle recorded by mineral trace elements in Donghai garnet peridotites of the Sulu UHP terrane eastern China
J. Zheng[1,2,3], R. Y. Zhang[2], J. G. Liou[2], W. L. Griffin[3] and S. Y. O'Reilly[3]
1. Earth Sciences, University of Geoscience, Wuhan, China, 2. Geology and Environmental Science, Stanford University, CA, USA, 3. GEMOC, Macquarie

DE BEERS DIAMOND CONFERENCE, WARWICK, 5TH-7TH JULY 2004

Trace element analyses of diamond by LAM ICPMS: Standardisation, results and directions
W. L. Griffin[1,3], S. Rege[1], R. M. Davies[1,2], S. Jackson[1] and S. Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. Department of Earth and Planetary Sciences, American Museum of Natural History, New York, USA, 3. CSIRO Exploration and Mining, North Ryde, Australia

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS 17TH GEOPHYSICAL CONFERENCE AND EXHIBITION, DARLING HARBOUR, SYDNEY, 15-19 AUGUST 2004

The integration of geophysics and geochemistry reveals the nature of the lithosphere beneath the Slave Craton (Canada)
Y. Poudjom Djomani[1], S. Y. O'Reilly[1], W. L. Griffin[1], L. M. Natapov[1], N. J. Pearson[1] and B. J. Doyle[2]
1. GEMOC, Macquarie, 2. Kennecott Canada Exploration Ltd, Vancouver, Canada

2004 WESTERN PACIFIC GEOPHYSICS MEETING, HONOLULU, HAWAII, 16-20 AUGUST 2004

Rare Earth Element Chemistry of apatites from the Cretaceous to Paleogene Granitoids, Southeastern Tibet
M.F. Chu[1], S.L. Chung[1], X.R. Liang[2], W.L. Griffin[3], N.J. Pearson[3], Y. Iizuka[4], X.H. Li[2], Y.Q. Zhang[2]
1. Department of Geosciences, National Taiwan University, Taipei, Taiwan, 2. Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, China, 3. GEMOC, Macquarie, 4. Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan

32ND INTERNATIONAL GEOLOGICAL CONGRESS, FLORENCE, ITALY, 20-28 AUGUST 2004

Origin and evolution of the lithospheric mantle beneath the Slave Craton (Canada)
S. Aulbach[1], W. L. Griffin[1], N. J. Pearson[1], S. Y. O'Reilly[1] and K. Kivi[2]
1. GEMOC, Macquarie, 2. Kennecott Canada Exploration Ltd, Vancouver, Canada

Origin of garnet peridotites from the Western Gneiss Region, Norway: Refertilisation of depleted Archean lithosphere
E. E. Beyer, W. L. Griffin and S. Y. O'Reilly
GEMOC, Macquarie

Composition of clinopyroxenes from mantle xenoliths as indicator of lithospheric evolution
C. Bonadiman[1], M. Coltorti[1], W. L. Griffin[2] and S. Y. O'Reilly[2]
1. Department of Earth Sciences, Ferrara University, Italy, 2. GEMOC, Macquarie

Amphiboles in mantle xenoliths from anorogenic and orogenic settings. Evidence bearings of different style of metasomatism and implication for Nb and Ti anomalies in calk-alkaline magmas
M. Coltorti[1], C. Bonadiman[1], B. Faccini[1], M. Grégoire[2] and S. O'Reilly[1]
1. Department of Earth Sciences, Ferrara University, Italy, 2. CNRS, Observatoire Midi-Pyrénées, Toulouse, France, 3. GEMOC, Macquarie

Trace element and isotopic fingerprints in clinopyroxenes from the oceanic lithosphere beneath Kerguelen Islands (Indian Ocean)
G. Delpech[1], S. Y. O'Reilly[1], M. Grégoire[2], J.-Y. Cottin[3] and N. J. Pearson[1]
1. GEMOC, Macquarie, 2. "Dynamique Terrestre et Planétaire", Observatoire Midi-Pyrénées, Toulouse, 3. Department of Geology "Magmas et Volcans", University of JeanMonnet, Saint-Etienne, France

Crust-mantle boundary beneath the Kerguelen Plume-Ridge System
M. Grégoire[1], J. Y. Cottin[2], S. Y. O'Reilly[3]
1. CNRS, Observatoire Midi-Pyrénéese, Toulouse, France, 2. Department of Geology "Magmas et Volcans", University of JeanMonnet, Saint-Etienne, France, 3. GEMOC, Macquarie

Imaging Petrological and thermal heterogeneity in the lithospheric mantle: Tectonic and geophysical implications
W. L. Griffin, S. Y. O'Reilly and Y. Poudjom Djomani
GEMOC, Macquarie

Cenozoic thermal and compositional structure of the lithosphere in eastern China: xenolith derived profile of the uppermost mantle
H.-W. Ma[1], S. Y. O'Reilly[2], F.-X. Lu[3] and W. L.Griffin[2,4]
1. National Laboratory of Mineral Materials, China University of Geosciences, Beijing, China, 2. GEMOC, Macquarie, 3. Department of Geology, China University of Geosciences, Beijing, China, 4. CSIRO Exploration and Mining, North Ryde

The upper mantle beneath the Canary Islands: from passive margin to intra-plate magmatism
E. R. Neumann[1], W. L.Griffin[2] and N. J.Pearson[2]
1. PGP, University of Oslo, Norway, 2. GEMOC, Macquarie

Origin and evolution of continental lithospheric mantle: Buoyant blobs, intracratonic eddies and fertile upwellings?
S. Y. O'Reilly and W. L. Griffin
GEMOC, Macquarie

The isotopic composition of magnesium in mantle olivine: Records of depletion and metasomatism
N. J. Pearson[1], W. L. Griffin[1,2], S. Y. O'Reilly[1] and G. Delpech[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde

Nature of the lithospheric mantle beneath the Slave Craton (Canada) from an integration of geophysics and mantle petrology
Y. Poudjom Djomani[1], S. Y. O'Reilly[1], W. L. Griffin[1,2], L. M. Natapov[1], N. J Pearson[1] and B. J. Doyle[3]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia, 3. Kennecott Canada Exploration Ltd, Vancouver, Canada

Evidence for sulfide mobility in mantle fluids beneath eastern Australia: Implications for the interpretation of mantle Re-Os ages
W. Powell and S. Y. O'Reilly
GEMOC, Macquarie

Mechanism of lithosphere extension beneath the eastern margin of the South China Block
K.-L. Wang, S. Y. O'Reilly, W. L. Griffin, N. J. Pearson and M. Zhang
GEMOC, Macquarie

Hf isotopes, U-Pb ages and trace elements of zircons in intermediate granulite xenoliths from Cenozoic Hannuoba basalts: significance for petrogenesis and Neoarchean-Paleoproterozoic crust-mantle interaction beneath the North China Sea
J. Zheng[1], W. L. Griffin[2], S. Y. O'Reilly[2] and M. Zhang[2]
1. Faculty of Earth Sciences, China University of Geosciences, Wuhan, China, 2. GEMOC, Macquarie

2ND INTERNATIONAL MAAR CONFERENCE, HUNGARY, SLOVAKIA, GERMANY 15 SEP -17 SEP 2004

Controls on maar volcanism: evidence from sills and dykes of the Silurian Eastport Formation, Maine, USA
N. A. Van Wagoner[1], R. D. W. Lodge[1], K. A. Dadd[2]
1. Acadia University, Geology Department, Wolfville, Nova Scotia, Canada, 2. GEMOC, Macquarie

SEG 2004 PREDICTIVE MINERAL DISCOVERY UNDER COVER, PERTH, WESTERN AUSTRALIA, 27 SEP – 1 OCT 2004

Research, Exploration and Predictive Mineral Discovery
M. A. Etheridge[1,2]
1. GEMOC, Macquarie, 2. Predictive Mineral Discovery CRC

Thermal histories of Indonesian porphyry copper-gold deposits determined by U-Th-He, U-Pb, Re-Os, K-Ar and Ar-Ar methods
B. I. A. McInnes[1], N .J. Evans[1], D. Sukarna[2], S. Permanadewi[2], S. Garwin[3], E. Belousova[4], W. L.Griffin[4] and F. Fu[5]
1. CSIRO Exploration and Mining, Bentley, WA, Australia, 2. Geological Research and Development Centre, Bundung, Indonesia, 3. Geoinformatics Exploration Australia, West Perth, Australia, 4. GEMOC, Macquarie, 5. Dept of Geosciences, University of Sydney, NSW, Australia

***TerraneChron*™: Delivering a competitive edge in exploration**
S. Y. O'Reilly[1], W. L. Griffin[1,2] and E. A. Belousova[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde

LITHOPROBE – THE CELEBRATORY CONFERENCE, TORONTO, CANADA, 12-15 OCT 2004

Evolution of the Slave Province and Abitibi Subprovince based on U-Pb dating and Hf isotopic composition of zircon
J. W. F. Ketchum[1], W. Bleeker[2], W. L. Griffin[1], S. Y. O'Reilly[1], N. J. Pearson[1] and J. A. Ayer[3]
1. GEMOC, Macquarie, 2. Geological Survey of Canada, Ottawa, ON, Canada, 3. Ontario Geological Survey, Sudbury, ON, Canada

2004 IAVCEI GENERAL ASSEMBLY, PUCON, CHILE, 14-19TH NOVEMBER

Mafic volcanism in a tidal flat environment: facies and eruptive mechanisms with examples from the Silurian of Maine, USA and New Brunswick, Canada
K. Dadd[1] and N. Van Wagoner[2]
1. GEMOC, Macquarie, 2. Department of Geology, Acadia University, Wolfville, Nova Scotia, Canada

Appendix 4: Abstract titles

Interrogating the paradigm of the compositionally-zoned magma chamber: a stratigraphically-constrained ^{238}U-^{230}Th-^{226}Ra study of Katmai-Novarupta 1912

R. George[1], S. Turner[1], M. Reagan[2], C. Hawkesworth[3], W. Hildreth[4].
1. GEMOC, Macquarie, 2. Department of Geoscience, University of Iowa, Iowa City, USA, 3. Department of Earth Sciences, Bristol University, Bristol, UK, 4. US Geological Survey, Menlo Park, CA, USA

^{210}Pb-^{226}Ra-^{230}Th implications for the time scales of differentiation and degassing of island arc magmas

S. Turner[1], S. Black[2], K. Berlo[3]
1. GEMOC, Macquarie, 2. School of Human and Environmental Sciences, University of Reading, Reading, UK, 3. Department of Earth Sciences, University of Bristol, Bristol

2004 AGU FALL MEETING, SAN FRANCISCO, USA 13-17TH DECEMBER

Detrital zircon study along the Tsangpo River, SE Tibet

Y.-H. Liang [1], S.-L. Chung [1], D.-Y. Liu [2], S. Y. O'Reilly [3], M.-F. Chu [1], J.-Q. Ji [4], B. Song [2], N. J. Pearson [3]
1. Department Geosciences, National Taiwan University, Taipei, Taiwan, 2. Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China, 3. GEMOC, Macquarie, 4. School of Earth and Space Sciences, Peking University, Beijing, China

Appendix 5: Funded research projects

GRANTS AND OTHER INCOME FOR 2004

Funding Source	Investigators	Project Title	Amount
Macquarie University Host Institution Support	O'Reilly	GEMOC Key Centre Contribution	$120,000
ARC Discovery	Alard	Toward the use of metal stable isotopes in geosciences	$140,000
ARC Discovery	Belousova	Crustal evolution in Australia: Ancient and young terrains	$99,345
ARC Discovery	O'Reilly, Griffin, Gohl, Morgan, Cottin, Neumann, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$285,000
ARC Discovery	Turner, Hawkesworth, Reagan, Kirchner	The time scales of magmatic and erosional cycles	$100,000
ARC Linkage International	O'Reilly, Griffin, Cottin, Grégoire, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$40,000
ARC Linkage Projects	O'Reilly, Griffin, WMC	Global lithosphere architecture mapping (including industry contribution)	$190,000
ARC Federation Fellowship	Turner	The time scales of geochemical cycles and Earth processes	$290,000
ARC Federation Fellowship (MU contribution)	Turner	The time scales of geochemical cycles and Earth processes	$190,000
ARC Federation Fellowship	Wood	Origin and evolution of Earth's chemical reservoirs	$155,527
Nu Instruments	Griffin, O'Reilly	GEMOC - Nu Instruments Research Fellowship	$312,929
DEST SII	O'Reilly	Advanced technology for a clever geoscience future in Australia	$1,830,000
MU RIBG	O'Reilly	SAMx automation package for Cameca SX50	$55,000
MU RIBG	Turner	A PicoTrace clean air work station equipped with a 16 sample digestion system	$23,000
MUECRG	Daczko	Melt escape and trace element partitioning during high-pressure partial melting in the lower crust, northern Fiordland, New Zealand	$18,615

Appendix 5: Funded research projects

Funding Source	Investigators	Project Title	Amount
MUECRG	Griffin, Pearson, O'Reilly, Daczko, NSWGS	Testing Ordovician-Devonian tectonic models for the Lachlan group (including industry contribution)	$25,000
MUECRG	Griffin, Pearson, O'Reilly, Daczko, NSWGS	Testing Ordovician-Devonian tectonic models for the Lachlan group (including industry contribution)	$25,000
MUECRG - Rio Tinto	Griffin, O'Reilly, Rio Tinto	Lithosphere Mapping beneath the Dharwar Craton, India	$30,000
MUECRG - Rio Tinto	Griffin, O'Reilly, Rio Tinto	Lithosphere Mapping beneath the Dharwar Craton, India (industry contribution)	$30,800
MUECRG - Anglo	Jackson, Griffin, Pearson	Application of metal isotopes in exploration for magmatic nickel and volcanic-hosted copper deposits	$39,870
MUECRG - Anglo	Jackson, Griffin, Pearson	Application of metal isotopes in exploration for magmatic nickel and volcanic-hosted copper deposits (industry contribution)	$39,870
MUECRG	O'Reilly, Zhang, WMC	Continental flood basalts: geochemical discrimination with relevance to exploration for nickel and platinum-group elements	$30,000
MUECRG	O'Reilly, Zhang, WMC	Continental flood basalts: geochemical discrimination with relevance to exploration for nickel and platinum-group elements (industry contribution)	$30,000
MURIF	Smith, O'Reilly, Parfitt, Esselle	Inversion scattering, remote sensing and data inversion	$247,681
MURF	Malkovets	Evolution of the upper mantle beneath the Siberian Craton and the Siberian Platform	$66,949
MURF	Wang	Geochemical characteristics of mantle xenoliths from Taiwan and Penghu Islands, SE China: Implications for mantle process and geodynamics	$32,482
MURDG	Lackie, Flood	3D shape of the Mole Granite and thickness of the Torrington Pendant	$12,000
MURDG	Jackson	Isotopic fractionation of the ore metals (Cu, Fe): A new window on ore-forming processes	$16,700
MURDG	Wang	Lithosphere extension in East Asia: tectonic and geochemical consequences	$19,555
Teaching Development grant	Dadd	Bringing the workplace into the classroom: the redesign of GEOS 377 using problem-based learning and real workplace scenarios	$5,928
VC Development Fund	Etheridge	Improving mineral exploration performance by superior management of risk, uncertainty and value	$100,000

Funding Source	Investigators	Project Title	Amount
Industry partner sponsorship BHP-Billiton, Codelco, Tech Cominco, Gold Fields, Newmont, Placer Dome, WMC Resources, Geoinformatics Exploration, Jackaroo Exploration	Etheridge	Improving mineral exploration performance by superior management of risk, uncertainty and value	$108,000
Capital Equipment	Flood	Precision lapping and polishing machine	$90,000
Capital Equipment	Lackie	Frequency FM Equipment	$42,000
Maintenance Macquarie	O'Reilly, DEPS	GAU Maintenance contribution	$30,000
CRC Discretionary Fund	O'Reilly	System Earth: the mantle engine	$25,000
Postgraduate Research Fund	Brad Bailey	Law Dome: Ice and crust mass balance studies	$3,500
IPRS and MUIPRA	Guo	An integrated geophysical investigation of the Hunter-Mooki and Peel Faults	$39,284
IPRS and iMURS	Rege	Trace elements in diamonds: genetic and forensic implications	$39,284
IPRS and MUIPRA	Touron	Geochemical fingerprinting of the Massif Central (France) mantle	$39,284
iMurs	Nikolic	Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway	$39,284
RAACE	Milan	The emplacement, pressure-temperature-time path and structural evolution of lower crust gneisses in Fiordland, New Zealand	$18,484

FUNDED RESEARCH PROJECTS FOR 2005

Funding Source	Investigators	Project Title	Amount
ARC Discovery	Alard	Toward the use of metal stable isotopes in geosciences	$110,000
ARC Discovery	Belousova	Crustal evolution in Australia: Ancient and young terrains	$99,345
ARC Discovery	Daczko	A new approach to understanding the mechanisms and deep crustal controls of continental rifting	$50,000

Appendix 5: Funded research projects

Funding Source	Investigators	Project Title	Amount
ARC Discovery	Jackson	Isotopic fractionation of the ore minerals (Cu, Fe, Zn): A new window on ore-forming processes	$100,000
ARC Discovery	O'Reilly, Griffin, Gohl, Morgan, Cottin, Neumann, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$255,000
ARC Discovery	Turner, Hawkesworth, Reagan, Kirchner	The time scales of magmatic and erosional cycles	$85,000
ARC Linkage International	O'Reilly, Griffin, Cottin, Grégoire, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$40,000
ARC Linkage Projects	O'Reilly, Griffin, WMC	Global lithosphere architecture mapping (including industry contribution)	$190,000
ARC LIEF Grant	Turner, Schaefer, Brierley, O'Reilly, Griffin, Haydon	A ThermoFinnigan Triton high-sensitivity thermal ionisation mass spectrometer for constraining geoscience rates and environmental processes via Ra and Os analysis	$495,000
ARC LIEF Grant	Turner, Schaefer, Brierley, O'Reilly, Griffin, Haydon	A ThermoFinnigan Triton high-sensitivity thermal ionisation mass spectrometer for constraining geoscience rates and environmental processes via Ra and Os analysis (MU contribution)	$175,000
ARC Federation Fellowship	Turner	The time scales of geochemical cycles and Earth processes	$290,000
ARC Federation Fellowship (MU contribution)	Turner	The time scales of geochemical cycles and Earth processes	$92,243
ARC Federation Fellowship	Wood	Origin and evolution of Earth's chemical reservoirs	$290,000
ARC Federation Fellowship (MU contribution)	Wood	Origin and evolution of Earth's chemical reservoirs	$180,000
Australian Antarctic Division	Daczko, Mosher	The environmental and tectonic implications of volcaniclastic deposits on Macquarie Island	$79,000
Dept. Earth and Planetray Sciences	O'Reilly, DEPS	GAU Maintenance contribution	$30,000
MUECRG Scheme	Belousova	Developing a geochronological framework for the Gawler Craton, South Australia	$20,000

Funding Source	Investigators	Project Title	Amount
MUECRG Scheme	Belousova	Developing a geochronological framework for the Gawler Craton, South Australia (Industry contribution)	$20,000
Industry partner sponsorship BHP-Billiton, Codelco, Tech Cominco, Gold Fields, Newmont, Placer Dome, WMC Resources, Geoinformatics Exploration, Jackaroo Exploration	Etheridge	Improving mineral exploration performance by superior management of risk, uncertainty and value	$179,9280
MUECRG	O'Reilly	Links between plume-mantle interaction, mantle sulfides and N-PGE endowment in large igneous provinces	$40,000
MUECRG WMC	O'Reilly	Links between plume-mantle interaction, mantle sulfides and N-PGE endowment in large igneous provinces (industry contribution)	$40,000
MURDG Safety Net Scheme	Veevers	Zircon analysis of Cretaceous and Eocene sediments of Lambert Graben-Prydz Bay, Antarctica	$17,706
MU Safety Net Scheme	George	Timing and mechanisms of melt migration and interaction at mantle, lithospheric and crustal levels	$20,000
MU New Staff Scheme	Malkovets	Structure and evolution of the upper mantle beneath the Siberian Craton	$19,906
MU New Staff Scheme	Williams	The oxidation state of the early Earth mantle: new clues from iron isotopes	$19,978
IPRS and iMURS	Rege	Trace elements in diamonds: genetic and forensic implications	$30,627
iMurs	Hartman	Tofua Volcano in Northern Tonga: U-series Isotope and Melt Inclusion Studies Along the Tonga-Kermadec Island Arc	$40,837
iMurs	Nikolic	Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway	$40,837
RAACE	Milan	The emplacement, pressure-temperature-time path and structural evolution of lower crust gneisses in Fiordland, New Zealand	$18,847
APA	Murgulov	Crust-mantle evolution and metallogeny, E. Australia	$18,847
Postgraduate Research Fund	McMahon	Fracturing deformation along the Amery Ice Shelf: a seismic study	$4,000

ARC Research Projects initiated prior to 2004 are available at our website: http://www.es.mq.edu.au/GEMOC/ Follow the Annual Report Link to Appendix 5 of the previous Annual Reports.

Appendix 6: Flowsheets for courses in geology and geophysics

BACHELOR OF SCIENCE ENVIRONMENTAL GEOLOGY

Other variations available. Approximate load of 24 credit points per year.

Interested in:
•Earth's Environment •Contaminated Land Remediation
•Geochemistry •Groundwater Contamination

Environmental Geology explores the interaction of people and the geologic environment. The field covers the movement of toxins into the ground and through the groundwater system; the identification of these toxins and the remediation of the site. Environmental Geology combines the classic observation skills of geology with those of geochemistry, geophysics, land use planning and government policy implementation.

FIRST YEAR

GEOS112 Planet Earth,
GEOS114 Global Environmental Crises
GEOS115 Earth Dynamics, Materials and the Environment
GEOS224 Introduction to Field Geology (Vacation Unit)
CHEM103, BIOL114

SECOND YEAR

GEOS230 Field and Laboratory Studies in Geoscience,
GEOS260 Marine Depositional Environments
GEOS265 Intro to Resource and Environmental Management
GEOS266 Earth Surface Processes, GEOS268 Introduction to Geophysics
GEOS251 Minerals, Energy and the Environment

THIRD YEAR

GEOS315 Environmental and Groundwater Geophysics, GEOS399 Soils
GEOS377 Environmental Geology
GEOS437 Geochemical Applications
GEOS398 Applied Geomorphology
or
GEOS307 Field Geology and Mapping
or
GEOS328 Land Management

FOURTH YEAR (HONOURS)

1. Honours: The honours year consists of an 8 or 16 credit point research thesis and 8 or 16 credit points of coursework, generally at 400 or 800 level.
2. Masters Program: A research MSc is undertaken over a two year period; this may include up to 4 Units and a major research project. A coursework program is also possible.

These notes are only intended as a guide, and the Calendar should be referred to for further details. Academic advice should be sought for any program queries.

MACQUARIE UNIVERSITY~SYDNEY

EARTH AND PLANETARY SCIENCES

BACHELOR OF SCIENCE OR ARTS GEOLOGY MAJOR

Course Structure

Other variations available. Approximate load of 24 credit points per year.

Interested in:
•Volcanoes •Earthquakes •Seismology
•Exploration •Earth History

Geologists aim to understand the way the Earth works and how it has evolved over the 4.6 billion years since its formation. Geology can be combined with geophysics, biology, archaeology, history, chemistry, maths, physics and law. Employment can be found in areas such as Mining and Exploration Companies, Teaching,Public Service, Law, Conservation and Environment, Stock Market, Engineering, and Research.

FIRST YEAR

Core
GEOS115 Earth Dynamics, Materials and the Environment
GEOS112 Planet Earth *or* GEOS116 Marine Geoscience *and*
GEOS224 Introduction to Field Geology (Vacation Unit)

Plus additional units from:
BIOL, CHEM, MATH, PHYS140 *or* PHYS , COMP or other.

SECOND YEAR

Core
GEOS235 Palaeontology
GEOS230 Field and Laboratory Studies in Geosciences
GEOS260 Marine Depositional Environments
GEOS268 Introduction to Geophysics

Optional
GEOS251 Minerals, Energy and the Environment, GEOS272 Earth's Evolving Environment
GEOS266 Earth Surface Processes, GEOS237 Natural Hazards
GEOS264 Geographic Information Systems

THIRD YEAR

Core
GEOS307 Field Geology and Mapping
and at least 3 units from: GEOS308 Structural and Metamorphic Geology
GEOS312 Invertebrate Palaeontology, GEOS314 Magmas, Fluids and Ore Deposits
GEOS385 Global Tectonics
GEOS397 Applied Palaeontology and Biogenic Sediments

Suggested additional units
GEOS373 Volcanic Geology Fieldwork, GEOS428 Coral Reef Environments

FOURTH YEAR (HONOURS)

1. Honours: The honours year consists of a 16 credit point research thesis and 8 credit points of coursework, generally at 400 or 800 level.
2. Masters Program: A research MSc is undertaken over a two year period; this may include up to 4 courses and a major research project. A coursework MSc is also possible.

MACQUARIE UNIVERSITY~SYDNEY

EARTH AND PLANETARY SCIENCES

BACHELOR OF SCIENCE GEOPHYSICS MAJOR

Other variations available. Approximate load of 24 credit points per year.

Interested in:
•Understanding How the Earth Works
•Earthquakes •Earth's Environment •Exploration

Geophysics is the study of the physics of the earth. The field of Geophysics can be split into two broad areas - "Global", which is the study of the earth's structure and evolution, and "Exploration", which is concerned with near surface study in the fields of mineral, petroleum, environmental, groundwater and engineering geophysics.

FIRST YEAR

Core
GEOS115 Earth Dynamics, Materials and the Environment

Optional
GEOS112 Planet Earth
GEOS116 Marine Geoscience
GEOS224 Introduction to Field Geology (Vacation Unit)
MATH135, MATH136, PHYS140, PHYS143
COMP123 *or* COMP125, CHEM101

SECOND YEAR

Core
GEOS268 Introduction to Geophysics

Optional
GEOS260 Marine Depositional Environments
GEOS251 Minerals Energy and the Environment
GEOS230 Field and Laboratory Studies in Geosciences
GEOS272 Earth's Evolving Environment
MATH235, MATH236, PHYS201, COMP238

THIRD YEAR

Core
GEOS315 Environmental and Groundwater Geophysics *or*
GEOS316 Exploration Geophysics
GEOS420 Data Image and Processing in Geophysics and Exploration

Optional
Appropriate Geology, Atmospheric Science or Maths,
Physics, and Computing Units, depending on individual interest

FOURTH YEAR (HONOURS)

1. Honours: The honours year consists of an 8 or 16 credit point research thesis and 8 or 16 credit points of coursework, generally at 400 or 800 level.
2. Masters Program: A research MSc is undertaken over a two year period; this may include up to 4 Units and a major research project. A coursework program is also possible.

Students not proceeding to a fourth year may undertake less Units in mathematics, physics and computing. These notes are only intended as a guide, and the Calendar should be referred to for further details. Academic advice should be sought for any program queries.

MACQUARIE UNIVERSITY~SYDNEY

EARTH AND PLANETARY SCIENCES

Bachelor of Technology
Exploration Geoscience
Geochemistry Strand

72 Credit Points Required

Interested in:
•Exploration and Technology • Environment •Mining •Earth's Internal Processes

Exploration geoscientists seek to apply modern techniques that interface between geology, geophysics and geochemistry to assist in targeting major prospective areas on or near the surface and ensuring environmental best practice in developing such areas. This is vital to Australia's future export earnings, underpinned as they are by the mineral industry. Employment may be found in mining, exploration and environment consultancy companies, geoanalytical laboratories, government advisory bodies, research and teaching.

FIRST YEAR

GEOS115 Earth Dynamics, Materials and the Environment
GEOS116 Marine Geoscience
GEOS224 Introduction to Field Geology (vacation unit)
CHEM101
and one of: PHYS140, PHYS143,
MATH135, MATH136, COMP155

SECOND YEAR

Core	Optional
GEOS260 Lithospheric Environments	GEOS266 Earth Surface Processes
GEOS268 Introduction to Geophysics	GEOS272 Earth's Evolving Environment
GEOS230 Field and Laboratory Studies in Geoscience	GEOS315 Environment and Groundwater Geophysics *or*
CHEM207	GEOS316 Exploration Geophysics
	STAT170 or STAT171

THIRD YEAR

Core	Optional
GEOS307 Field Geology and Mapping	GEOS315 Environmental and Groundwater Geophysics *or*
GEOS314 Ore Deposits Geology	GEOS316 Exploration Geophysics
GEOS377 Environmental Geology	GEOS373 Volcanic Geology Fieldwork
GEOS437 Geochemical Applications and Techniques	COMP238
MPCE360	

FOURTH YEAR (HONOURS)

Honours year consists of a thesis of 16 credit points based on research using the latest equipment and 8 credit points of coursework, generally at 400 or 800 level.

MACQUARIE UNIVERSITY~ SYDNEY

EARTH AND PLANETARY SCIENCES

Bachelor of Technology
Exploration Geoscience
Geophysics Strand

72 Credit Points Required

Interested in:
•Exploration and Technology • Environment •Mining •Earth's Internal Processes

Exploration geoscientists seek to apply modern techniques that interface between geology, geophysics and geochemistry to assist in targeting major prospective areas on or near the surface and ensuring environmental best practice in developing such areas. This is vital to Australia's future export earnings, underpinned as they are by the mineral industry. Employment may be found in mining, exploration and environment consultancy companies, geoanalytical laboratories, government advisory bodies, research and teaching.

FIRST YEAR

GEOS115 Earth Dynamics, Materials and the Environment
GEOS116 Marine Geosciences and
GEOS224 Introduction to Field Geology (vacation unit)
PHYS140, PHYS 143
MATH135, MATH136, COMP155
and one of: CHEM101 or CHEM103

SECOND YEAR

Core	Optional
GEOS260 Marine Depositional Environments	GEOS230 Field and Laboratory Studies in Geoscience
GEOS268 Introduction to Geophysics	PHYS201
MATH235, MATH236, ELEC176	PHYS202
GEOS315 Environment and Groundwater Geophysics *or*	
GEOS316 Exploration Geophysics	

THIRD YEAR

Core	Optional
GEOS385 Global Tectonics	GEOS 314 Magmas, Fluids and Ore Deposits
GEOS420 Data and Image Processing in Geophysics and Exploration	GEOS 307 Field Geology and Mapping
GEOS315 Environmental and Groundwater Geophysics *or*	GEOS 373 Volcanic Geology Fieldwork
GEOS316 Exploration Geophysics	COMP238
GEOS460 Solid Earth Geophysics	ELEC260
MPCE360 Technology Management	

FOURTH YEAR (HONOURS)

Honours year consists of a thesis of 16 credit points based on research using the latest equipment and 8 credit points of coursework, generally at 400 or 800 level.

MACQUARIE UNIVERSITY~ SYDNEY

EARTH AND PLANETARY SCIENCES

Appendix 7: GEMOC postgraduate and honours opportunities

POSTGRADUATE OPPORTUNITIES

GEMOC has a flourishing postgraduate research environment with postgraduate students from many countries (including France, Germany, China, Russia and Australia) Scholarships funding tuition fees and a living allowance are available for students with an excellent academic record or equivalent experience. These include:

- **Australian Postgraduate Awards** (APA): available for Commonwealth citizens to cover tuition fees and living allowance, with a closing date in late October annually
- **Research Areas and Centres of Excelence** (RAACE) scholarships: available for Australian citizens who wish to undertake a postgraduate program in a Centre of Excellence at Macquarie University (eg GEMOC)
- **International Postgraduate Research Scholarships** (IPRS): available to overseas students to cover tuition fees with a closing date in late September annually
- **International Macquarie University Research Scholarships** (iMURS): that can provide a living allowance and which can be applied for at any time if the applicant has been accepted for enrolment in a higher degree

Macquarie University also provides research funding through a competitive internal scheme and GEMOC's funded projects (see *Appendix 5*) provide further resources to support postgraduate research projects.

Postgraduate projects are tailored to your expertise and interests within the framework of GEMOC's research goals. GEMOC carries out interdisciplinary research across the boundaries of petrology, geochemistry, tectonics, metallogenesis, geodynamics and geophysics to explore the nature and evolution of the lithosphere and global geodynamics. Current funded projects are based in Australia, Antarctica, Canada, China, Taiwan, Italy, France, Siberia, Norway, North America, South America, Africa, Kerguelen Islands and other global locations (see the section on GEMOC's *Research Program*).

GEMOC postgraduate programs have opportunities through access to our outstanding analytical facility (see *Technology Development* section) with currently unique technologies and instrumentation configurations to tackle exciting large-scale problems in the Geosciences.

Examples of broad PhD project areas include:

- Lithosphere structure and geochemistry: mantle provinciality and tectonism
- Granitoid and mineralised provinces along western Pacific convergent margins
- Fluid-vapour transfer of elements in the crust and mantle
- Heat production and evolution of the crust: crust-mantle interaction
- Geophysical applications to lithosphere studies
- Isotopic and trace element geochemistry: mantle and crustal systems
- Metal isotopes: applications to ore formation
- Magma genesis and crustal evolution: includes trace elements of accessory minerals, isotopic fingerprints

Potential applicants should discuss possible projects with a potential supervisor and the Director of GEMOC before applying.

Honours Scholarships of up to $2,500 are available for students with exceptional undergraduate track records who are undertaking an Honours Program within the framework of GEMOC's goals. For further information, see the Annual Reports on the GEMOC website for examples of past Honours projects.

Appendix 8: Goldschmidt Advertisement

goldschmidt 2006
geochemistry

16th Annual V.M. Goldschmidt Conference

27 August – 1 September 2006

Melbourne Exhibition & Convention Centre, Australia

Conference themes:

- Techniques
- Mineral Deposits/Ore Geochem
- Solar System Formation
- Convecting Mantle
- Lithosphere Evolution
- Subduction Processes
- Geochemical Constraints on Timescales and Mechanisms of Tectonic Processes
- Biogeochemistry and the Origin and Evolution of Life
- Aquatic Geochemistry and Fluids in the Crust
- Surface Processes, Low Temperature Systems and Landscape Evolution
- Ocean Chemistry and Circulation/Climate and Environment

All submissions of abstracts to be submitted online at: www.goldschmidt2006.org

Deadline for receipt of abstracts: 13 April 2006

For the first time, the Goldschmidt Conference comes to the southern hemisphere, in Melbourne, Australia in 2006. Australia's unique, plate-scale natural laboratory has driven a rich tradition of geochemical, experimental, cosmochemical and isotope research, from the extraordinary archives of past climate of the Great Barrier Reef to the oldest known terrestrial materials of Mount Narryer and Jack Hills. The conference is to be held in the state-of-the-art facilities of the Melbourne Convention Centre. We hope that you will be able to join us Down Under for the Goldschmidt 2006.

Expected delegates will comprise of: Geologists • Geochemists • Cosmochemists • Hydrogeologists • Geochronologists • Biogeochemists

www.goldschmidt2006.org

Contact Details: Goldschmidt 2006 Conference Managers
GPO Box 128 Sydney NSW 2001 Australia
Tel: + 61 2 9265 0700 Fax: + 61 2 9267 5443
Email: goldschmidt2006@tourhosts.com.au

Sponsored by:
European Association for Geochemistry
Geochemical Society
Geological Society of Australia

Appendix 9: Goldschmidt Pre-Meeting Workshop 2006

AUSTRALIA'S INNOVATIVE UNIVERSITY

MACQUARIE UNIVERSITY ~ SYDNEY

16th Goldschmidt 2006 – Pre-Meeting Workshop at GEMOC,

GEMOC

Department of Earth and Planetary Sciences, Macquarie University, Sydney

Geochemical Fingerprinting of Lithosphere and Deep Earth Processes

✱ 1-day session (invited speakers, discussions, demonstrations) on advanced methodologies and techniques for trace-element and isotopic analysis

using:

- LAM ICPMS
- MC-ICPMS (Nu Instruments)
- LAM MC-ICPMS
- TIMS (Triton)

Including:

- ✓ In-situ Re-Os, Hf isotopes, *TerraneChron*™
- ✓ Stable metal isotopes
- ✓ U-series
- ✓ Laser ablation techniques
- ✓ Database mining
- ✓ GLITTER data reduction system for LAM-ICPMS

✱ 1-day of invited and volunteered presentations on applications of geochemical datasets to explore:

- Composition, structure and timing of processes of the Earth's lithosphere
- the nature, evolution and geodynamic consequences of the convecting and deep mantle as revealed through geochemical and geophysical datasets
- insights on geophysical datasets from geochemistry

✱ Harbour Cruise

Ideal base for exploring Sydney (the Harbour City) –
and Blue Mountains (scenery) and Hunter Valley (wine) day-trips before Melbourne

Contact details

http://www.es.mq.edu.au/GEMOC/
gemoc@mq.edu.au

GEMOC
Department of Earth and Planetary Sciences
Macquarie University NSW 2109
AUSTRALIA

Nikki Bohan
Administrator
Phone: 61 2 9850 8953
Fax: 61 2 9850 8943 or 6904
Email: nbohan@els.mq.edu.au

Professor Suzanne Y. O'Reilly
Director
Phone: 61 2 9850 8362
Fax: 61 2 9850 8943
Email: sue.oreilly@mq.edu.au

Professor W.L. Griffin
Program Leader
Phone: 61 2 9850 8954
Fax: 61 2 9850 8943
Email: bill.griffin@mq.edu.au

Dr Norman Pearson
Manager, Geochemical Analysis Unit
Phone: 61 2 9850 8361
Fax: 61 2 9850 8943 or 6904
Email: npearson@laurel.ocs.mq.edu.au

GLOSSARY

ACILP	Australia China Institutional Links Program
AGSO	Australian Geological Survey Organisation (now GA)
AGU	American Geophysical Union
AMASE	Arctic Mars Analogue Svalbard Expedition
AMIRA	Australian Mineral Industry Research Association
ANU	Australian National University
APA (I)	Australian Postgraduate Award (Industry)
ARC	Australian Research Council
ARC LIEF	Australian Research Council Linkage Infrastructure Equipment and Facilities
ASAC	Antarctic Science Advisory Committee
CNRS	French National Research Foundation
CRC	Co-operative Research Centre
CSIRO (EM)	Commonwealth Scientific Industrial Research Organisation (Exploration and Mining)
DEST (SII)	Department of Education, Science and Training (from 2002) (Strategic Infrastructure Initiative)
DIATREEM	Consulting company within MRL
(D)VC	(Deputy) Vice Chancellor
EMP	Electron Microprobe
(D)EPS	(Department of) Earth and Planetary Sciences
EURODOC	The council for postgraduate students and junior researchers in Europe
GA	Geoscience Australia (formerly AGSO)
GAU	Geochemical Analysis Unit (DEPS, Macquarie University)
GIS	Geographic Information System
GLITTER	GEMOC Laser ICPMS Total Trace Element Reduction software
GPS	Global Positioning System
HIAF	Heavy Ion Analytical Facility
ICPMS	Inductively Coupled Plasma Mass Spectrometer
iMURS	International Macquarie University Research Scheme
IPRS	International Postgraduate Research Scholarship
JCU	James Cook University
LAM-ICPMS	Laser Ablation Microprobe - Inductively Coupled Plasma Mass Spectrometer
MC-ICPMS	Multi-Collector ICPMS
MOUs	Memoranda of Understanding
MRL	Macquarie Research Limited
MUECRG	Macquarie University External Collaborative Research Grants
MUIPRA	Macquarie University International Postgraduate Research Award
MURAACE	Macquarie University Research Award for Areas and Centres of Excellence
MURIF	Macquarie University Research Innovation Fund
MURDG	Macquarie University Research Development Grant
MURF	Macquarie University Research Fellowship
NERC	Natural Environment Research Council
NASA	National Aeronautics and Space Administration
NSWGS	New South Wales Geological Survey
PIRSA	Primary Industries and Resources, South Australia
RAACE	Research Areas and Centres of Excellence Postgraduate Scholarships
RIBG	Research Infrastructure Block Grant
RSES	Research School of Earth Sciences at ANU
UN'cstle	University of Newcastle
UNE	University of New England
USYD	University of Sydney
UW'gong	University of Wollongong
UWS	University of Western Sydney
XRF	X-Ray Fluorescence

ARC National
Key Centre for the
Geochemical Evolution and
Metallogeny of Continents