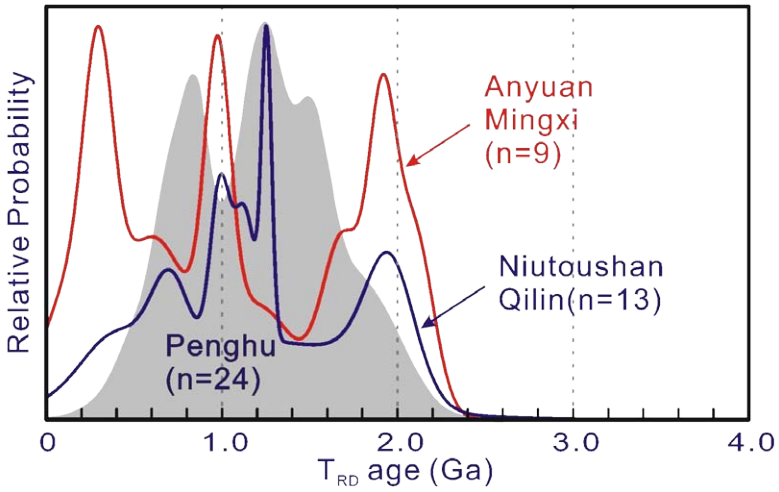


Figure 3. Distribution of model ages for low-Re/Os sulfides in xenoliths from the Cathaysia block. Penghu data are from Wang et al. (2004).

Proterozoic time. This may have affected much of the eastern half of the craton, and coincided with tectonic activity along the major suture (the Taihang Rift Zone) between the eastern and western halves of the craton. The original Archean root of the craton may have survived only in the easternmost part, where kimberlites later intruded. Much work remains to be done, but it already is clear that the lithospheric mantle beneath eastern China has had a very complex history, and is now a mixture of refractory and fertile mantle with different ages.

Contacts: Xisheng Xu, Sue O'Reilly
Funded by: ARC Discovery Project, Linkage International

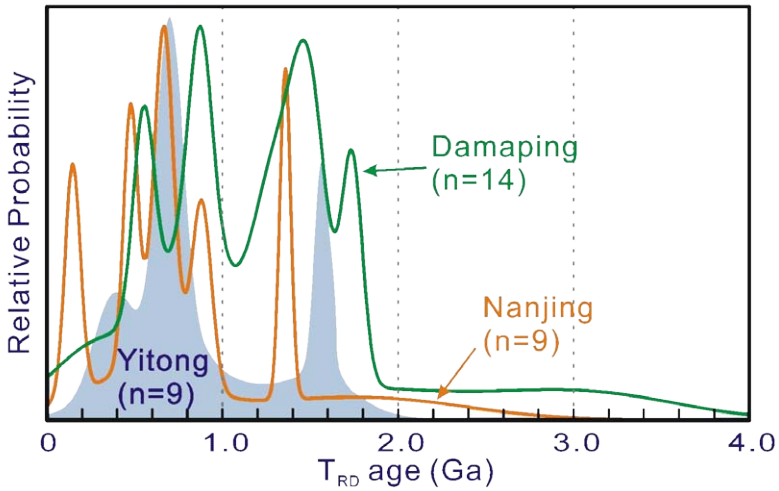


Figure 4. Distribution of model ages for low-Re/Os sulfides in xenoliths from the Cathaysia block.

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 2005

Curriculum Development

- Once again our tailored problem-based learning (TPBL) units GEOS116 Marine Geoscience and GEOS115 Earth Dynamics, Materials and the Environment were well received by students. This format, which includes lectures, problem-based workshops and traditional skill-based practicals is designed to encourage the students to become more active learners and to develop a range of generic skills. The workshops are completed as group work projects and the students are required to produce scientific reports based on the results of their investigations. Generic skills developed include teamwork, problem-solving, critical thinking and written and verbal communication.

GEOS314 students and Dr Simon Jackson reflecting on their field trip to the Northparkes Cu-Au mine in October 2005.

- GEOS230 Field and Laboratory Studies in Geoscience was run successfully in 2005, including being offered externally for the

first time. This new 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. One popular component of the unit is a forensic science murder mystery where an academic staff member has been murdered and three other staff are the key suspects! Many arguments ensue amongst the students over who did it. This type of project increases the student engagement with the unit content and leads to better retention of the key concepts. Once again the unit included a field trip to the historic gold mining town of Hill End.

- GEOS307 Field Geology and Mapping was run by Dr David Durney in 2005 for last time before he retires, bringing the end of an era. Field studies near Eugowra in the Forbes region of NSW allowed students to gain experience mapping deformed and varied geological units. The unit will return to the Broken Hill region in 2006.

- A number of students attended the GEOS381 Special Interest Seminar field trip to New Caledonia in 2005 run jointly with The School of Geosciences at The University of Sydney. They enjoyed great weather. The highlight of the trip was the spectacular exposures of blueschist and eclogite in the NE of New Caledonia.

- Our portable computer lab was upgraded in 2005 with the purchase of new laptop computers. This facility allows students access to up-to-date computer software for use in both the classroom and field. 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.

GEOS224 field trip to Lake Keepit, December.

Geophysics teaching progress 2005

- The named degree, Bachelor of Geophysics, continued in 2005 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, SeisImager 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

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 enrolment levels. 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.

Hands-on experience on the GEOS230 field trip to Hill End, September.

Teaching and training program

GEMOC honours

THE FOLLOWING honours projects in GEMOC were completed 2005:

Martyn Allen: An investigation of the subsurface structure of the Mole Granite using geophysical techniques

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

Zoe Demidjuk: U-Series insights into melting processes and magma evolution beneath the Newer Volcanics Province, South Australia

Glenn Gooch: An investigation of the gravity signature of the Hunter Thrust, Singleton, N.S.W.

Kirsty Liddicoat: Geology and geochemistry of the Lightning Ridge black opal deposits

Penelope Littlewood: The mineralogy and geochemistry of the Phoenix tungsten deposit, near Frogmore NSW

Dania Perez: An EMP and LAM-ICPMS study of the Carboniferous glassy volcanic rocks of the Tamworth Belt

Alice Plioplis: Facies analysis, geochemistry and tectonic setting of the Frampton Volcanics

Heather Skeen: Applying geophysical techniques in grave detection

Natalie Staib: The geophysical expression of Tertiary igneous activity at Mt Tabor, South-Central Queensland

The following Honours projects are relevant to GEMOC in 2006:

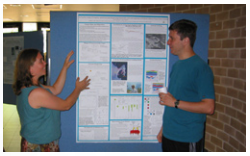
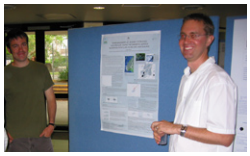
Cara Danis: The 3D upper crustal structure of the Wongwibinda Complex, New England Fold Belt: a tilted block?

Nicole Harb: Facies analysis, fragmentation processes and depositional mechanisms of hyaloclastite breccias, Macquarie Island

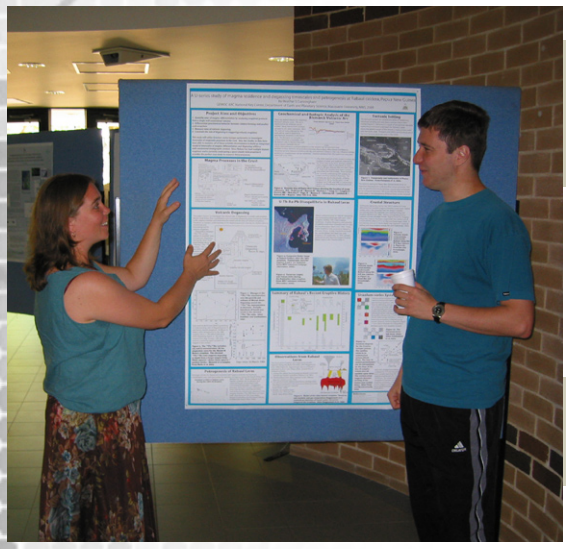
Peter Caffi: Fabric development and finite strain patterns in a metamorphic dome bounding shear zone, Dayman-Suckling Dome, Papuan Peninsula, Eastern PNG

Teaching and training program

GEMOC postgraduate

GEMOC'S ACTIVE INTERNATIONAL EXCHANGE PROGRAM continued, including the program with the University of Jean Monnet, St Etienne. Stéphanie Touron's successful thesis defence was held in August and June Chevet commenced a new co-tutelle PhD project.



The postgraduate seminar series gives important training in public presentation of results.

completed

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

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)

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

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) (see *Research Highlights*)

Jacques Batumike (PhD): The origin of kimberlites from the Kundelungu region (D.R. Congo) and the nature of the underlying lithospheric mantle (commenced 2005)

Stephanie Carroll (PhD): The mechanisms and deep-crustal controls on continental rifting (commenced 2005)

June Chevet (PhD): Gabbroic rocks from the Kerguelen Islands (Indian Ocean): a petrologic, geochemical and isotopic investigation of their origin (commenced 2004)

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

Heather Cunningham (PhD): A U-series isotope study of magma residence times, degassing and petrogenesis of Rabaul Caldera, Papua New Guinea (commenced 2005)

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

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

See advertisement for GEMOC postgraduate opportunities, *Appendix 7*.

Jacques Batumike... D.R. Congo fieldwork 2005.

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

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, submitted 2005)

Sonal Rege (PhD): Trace-element geochemistry of diamonds; *IPRS with iMURS scholarship* (commenced 2002, submitted 2005) (see *Research Highlights*)

Stéphanie Touron (PhD): Geochemical fingerprints of the mantle beneath the Massif Central; *IPRS with MURAACE scholarship* (commenced 2001, submitted 2005)

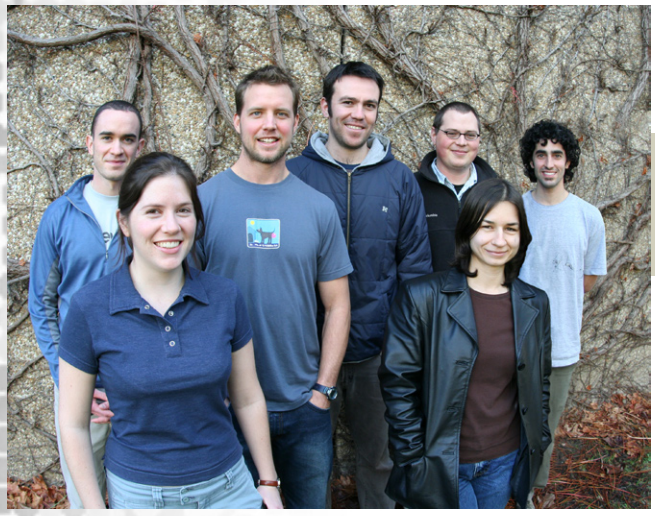
Some of GEMOC's 2005/6 postgraduate students. Above: Nenad Nikolic, Heather Cunningham, June Chevet, Weiqiang Li, and Jacques Batumike; Below: John Caulfield, Kathleen McMahon, Brad Bailey, Luke Milan, Alan Kobussen, Valeria Murgulov, and Ryan Portner.

commencing 2006

John Caulfield (PhD): Tofua volcano- Tonga Arc, Eruption history and timescales of Magma Chamber Processes

David Clark (PhD): Application of magnetic methods to a range of problems in Earth Sciences

Abhijit Deonath (PhD): The early Palaeozoic tectonic evolution of the northern Lachlan Orogen (part-time)



Weiqiang Li (PhD): Stable metal isotope geochemistry of the Cadia and Northparkes porphyry Cu-Au deposits

Alan Kobussen (PhD): Composition, structure, and evolution of the lithospheric mantle beneath Southern Africa

Ryan Portner (PhD): Spreading ridge sedimentation processes: a novel approach using Macquarie Island as a natural laboratory




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 was enhanced by installation of the Thermo Finnigan Triton (TIMS) and the purchase of a New Wave MicroMill.

- 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 Thermo Finnigan Triton TIMS (installed March 2005)
  - a Spectro XLAB2000 energy-dispersive XRF with rocker-furnace sample preparation equipment
  - a LECO RC412 H_2O-CO_2 analyser (delivered September 2003)
  - an Ortec Alpha Particle counter
  - a New Wave MicroMill
  - clean labs and sampling facilities provide infrastructure for ICPMS, XRF and isotopic analyses of small and/or low-level samples

Installing the new Triton: Simon Turner, Bruce Schaefer (Monash) and Chuck Lee (Finnigan).

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

Alex Corgne at the multi-anvil press.

- Experimental petrology laboratories include 4 piston-cylinder presses (pressure to 4 GPa), hydrothermal apparatus, controlled atmosphere furnaces and a multi-anvil apparatus for pressures to 27 GPa.
- The Centre for Isotope Studies has provided access to extraction lines and gas-source mass-spectrometers for stable-isotope analysis of fluids and minerals; it is planned that these facilities will be moved to GEMOC Macquarie.

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 were 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

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.

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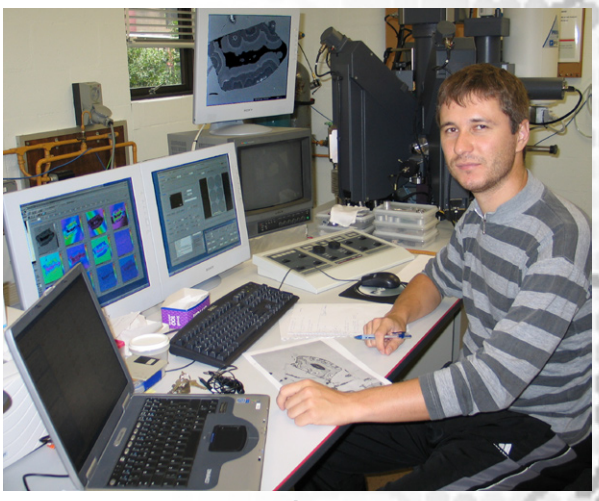


PhD student Nenad Nicolic on the SX100.

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. A further upgrade in 2004 involved the replacement of the Sun-based operating system with the PC-based SAMx software. 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. The CAMECA SX100 carries the workload of the routine major and minor element analyses for the majority of GEMOC's research projects. It is fitted with large-area diffracting crystals for improved sensitivity and lower limits of detection.

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 ELAN 5100 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 the year. 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 New Wave UP-266nm system, and a New Wave UP-213 nm system. In November 2005 the New Wave UP-193 nm system (based on a Lambda Physik OPTex excimer laser) was moved from the Nu Plasma to provide an additional option for *in-situ* analysis of transparent minerals on the 7500CS. 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): The Facility has two Nu Plasma MC-ICPMS. The first was installed in November 1998 and the other in November 2003. The second Nu Plasma instrument has high-resolution capabilities and a retardation filter to enable U-series work. The instruments combine a laser ablation micro-sampler, 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 instruments use either a New Wave 193 nm system based on an Lambda Physik OPTex excimer laser, a New Wave UP-266 nm Nd:YAG laser, or a New Wave UP-213 nm Nd:YAG laser depending on the application. 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.

Heather Cunningham and John Caulfield holding down the Triton.

A Triton thermal ionization mass spectrometer (TIMS): The Triton was purchased in 2004 following a successful ARC LIEF application led by Professor Simon Turner and Dr Bruce Schaefer (Monash University), and was installed in March 2005. Following an intensive period of testing the Triton quickly became the primary source of Sr, Nd and Os isotope analyses in the Facility, relieving the MC-ICPMS of this aspect of the analytical workload. The instrument represents the state-of-the-art in thermal ionisation mass spectrometry and its capabilities have contributed to the developments in Ra isotope analysis.

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 and rutile 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

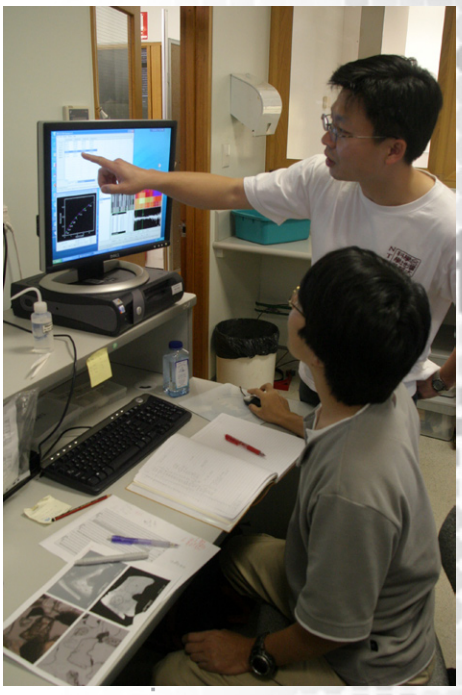
- Re-Os — determination of mantle depletion ages and isochron ages in whole rocks, ilmenites and chromites; dating of sulfide assemblages in ore bodies
- Lu-Hf — crustal genesis, mantle metasomatism; Lu-Hf dating of garnet peridotites, eclogites, granulites; basalt genesis
- Rb-Sr, Sm-Nd, U-Pb, Pb-Pb — MC-ICPMS and TIMS
- 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 2005

1. Facility for Integrated Microanalysis

a. Electron Microprobe: During 2005 the SX50 continued to meet the imaging and analytical demands of the *TerraneChron*® projects and other zircon-related applications. The SX100 serviced all other projects.

b. Laser-ablation ICPMS microprobe (LAM): During 2005, 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 Antarctica, New Zealand, Scandinavia, Chile, Tibet, 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*).



Kuo-Lung Wang explains the GLITTER software to a LAM-ICPMS user.

U-Pb dating of zircons was carried out on the Agilent 7500S, while the two new Agilent 7500CS instruments came into full service with one instrument dedicated permanently to laser-probe applications, and the other set up for solution analysis. The addition of a third ICP-MS allowed uninterrupted periods of time for method development without disrupting the productivity of the laboratory.

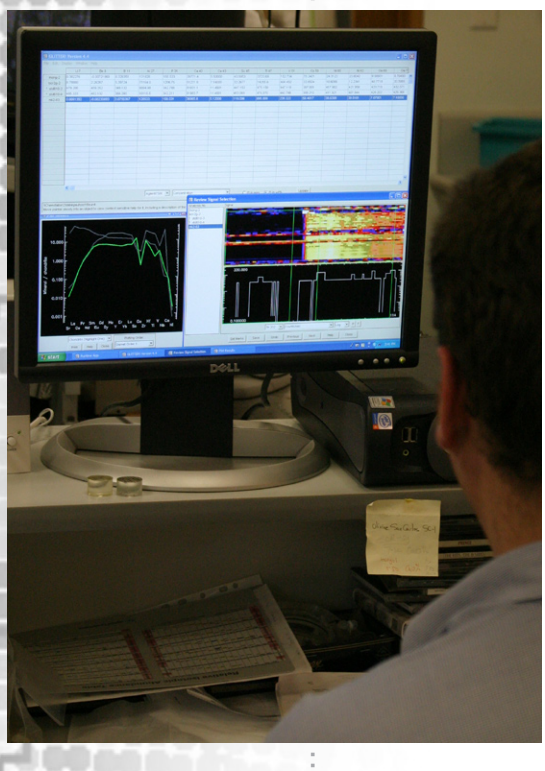
c. MC-ICPMS: The rapid growth in the use of the *TerraneChron*® application (see *Research Highlights*), coupled with the demand for *in situ* Re-Os analysis and stable isotope analysis, led to severe competition for instrument time on the MC-ICPMS. An order was placed early in 2003 for a second instrument, funded by the DEST infrastructure grant, and this instrument (Nu034) was installed in November 2003. Nu034 is equipped with a retardation filter and high-resolution capability, specifically for U-series analysis. In 2004-2005 methods for the analysis of other isotopic systems (Re-Os, Sm-Nd, Lu-Hf, Pb) were transferred to Nu034, and considerable time was spent in doing comparisons of the performance of Nu005 and Nu034 with respect to these isotopic systems.

In 2005 significant advances were made in the analysis of 'non-traditional' stable isotopes (see *Research Highlights*) and included the development of separation techniques and analytical protocols for Tl, Fe and Ni isotopes. A major project continued on the isotopic composition of Cu and Ni in sulfides and whole rocks from major ore bodies, in a collaboration with Anglo American. Major applications during 2005 continued to centre on the high-precision analysis of Hf in zircons to trace lithosphere evolution and magma-mixing histories in granitic rocks and Re-Os dating of single grains of Fe-Ni sulfides in mantle-derived rocks. In-situ Hf isotopes were measured in zircons from Antarctica, New Zealand, Scandinavia, Chile, Tibet, China, Italy, southern Africa and Australia. We carried out Re-Os studies on xenoliths from western USA, South Africa, Vietnam, eastern China and Taiwan, Ethiopia, Siberia and Sicily.

"During 2005, Will Powell, Norm Pearson and Chris Ryan began updating GLITTER to version 4.4"

d. Scanning Nuclear Microprobe: The 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: The new clean-room facility, which is being used primarily for isotope separations, opened in April 2004. It provides an ultra-clean environment within a 3-stage pressurised volume; it contains 6 Class 3500 work areas, three for radioactive isotopes and three for other activities.



The new GLITTER 4.4 in action, trace-element analysis by LAM-ICPMS.

f. Software: GLITTER (GEMOC Laser ICPMS Total Trace Element Reduction) software is our on-line interactive program for quantitative trace element analysis and features dynamically 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 AccessMQ (formerly Macquarie Research Limited). Nineteen copies of GLITTER were sold worldwide in 2005, and the software appears to have achieved industry-standard status; more than 94 copies are in use worldwide, in forensics and materials science, as well as earth science applications. During 2005, Will Powell, Norm Pearson and Chris Ryan began updating GLITTER to version 4.4, and Will Powell took over GLITTER technical support and software development.

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. 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, delivered

in March 2002 was repaired and realigned late in 2005 for use in diamond analysis. Three more New Wave laser systems, acquired during 2004 (a UP-266 nm and two UP-213 nm), represented a major upgrading of the instrument park and giving redundancy to limit downtime. The 213 nm lasers are now used for most of the zircon analytical work including both U-Pb and Hf isotope analyses, especially where small grains are being analysed. The 266 nm systems have proven most useful for analysis of sulfides, and for other stable-isotope applications.

3. Energy dispersive XRF

A Spectro XLAB2000 energy-dispersive X-ray spectrometer, installed in November 2000 in a joint venture with Tasman Resources, continued to produce high-quality major- and trace-element data. During 2005 over 1800 samples were analysed for major and trace elements, providing data to student theses, in-house research projects, and industry collaborators.

A LECO RC412 H_2O-CO_2 analyser, installed in September 2003 to replace an outdated unit, is providing high-quality analyses to complete whole-rock analyses by XRF and solution-ICPMS.

4. Solution analysis

An Agilent 7500CS 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.

During 2005 methods were developed for the separation of Tl and Ni, and improvements were made to the separation procedures for Cu and Fe. The permanent availability of one of the Agilent 7500CS for solution analysis greatly benefited the development of the separation techniques. Advances were also made in the U-series chemistry with the development of separation methods for Ra and ^{210}Pb.

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. 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. A plan is in place for Dr Andrew to 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 AccessMQ 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 both through New Wave Research and directly from GEMOC (http://www.es.mq.edu.au/GEMOC/)
- collaborative relationships with technology manufacturers (more detail in the section on *Technology Development*)
    - GEMOC (Macquarie) is the Australian demonstration site for Agilent Technologies LAM-ICPMS applications
    - GEMOC (Macquarie) is an international test site for New Wave Research Lasers

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 2005

Ten Industry Reports were completed for collaborative industry 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 titled "Global Lithosphere Architecture Mapping" (GLAM) changed partners in late 2005 following the takeover of WMC Resources by BHP-Billiton. Planning and workshop sessions at Macquarie with participants from BHP-Billiton and GEMOC, and visits by Macquarie researchers to Perth, were key activities in 2005. The project has continued with full support following the takeover of WMC by BHP-Billiton. Dr Graham Begg spent significant research time at GEMOC through 2005 as part of the close collaborative working pattern for this project.

GEMOC's development of a method to analyse trace elements in diamond through the PhD project of Sonal Rege (see *Research Highlights*) has opened up potential further developments and applications relevant to industry, ranging from diamond fingerprinting for a range of purposes to improving the knowledge framework for diamond exploration. Rio Tinto funded a pilot project on diamond fingerprinting.

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

A pilot study on detrital zircons from Paleozoic sediments carried out with the New South Wales Geological Survey has evolved into a continuing collaborative research relationship to apply *TerraneChron*® to investigations of the provenance of the Paleozoic sedimentary rocks of the western Lachlan Fold Belt and related areas.

A very successful project with WMC on Continental Flood Basalts related to Ni and PGE deposits was finalised within the original scope envisaged and resulted in a new project with BHP-Billiton commencing in 2005, exploring a novel framework for the origin of magmatic Ni-deposits.

The GLAM team.

The alliance with PIRSA (Primary Industries and Resources, South Australia) that commenced in 2004 for *TerraneChron*® collaborative projects continued.

GEMOC researchers presented invited and keynote addresses at the SGA Meeting on "Mineral Deposit Research: Meeting the Global Challenge" in Beijing in August. This conference had a large industry attendance and the GEMOC work generated much discussion and interest.

Industry visitors spent varying periods at GEMOC in 2005 to discuss our research and technology development (see *visitor list, Appendix 3*). This face-to-face interaction has proved highly effective both for GEMOC researchers and industry colleagues.

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

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.

Sue O'Reilly and Ming Zhang presented papers on GEMOC's industry-related work at the SGA meeting, Beijing 2005.

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 provide more information for integration with 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

Industry Collaborator: BHP-Billiton

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.

Lithosphere Evolution Across a Craton Margin, Southern Africa

Supported by Industry and a matching Macquarie University Collaborative Grant

Industry Collaborator: De Beers

Summary: The margins of cratonic blocks extend to 150-300 km depth, and exert a strong control on crustal tectonics. Kimberlite magmas intruded across the southern margin of the Kaapvaal Craton (S. Africa) provide detailed sampling of the lithospheric mantle. We will use these samples to map the composition and structure of the mantle in two time slices (120 Ma, 90 Ma), providing new information on how the craton margins channel fluids. Linkages between crustal tectonics and mantle events will be constrained by comparing *TerraneChron*® analysis of zircons from modern streams, and the kimberlites themselves, with existing Re-Os ages for mantle rocks.

Trace-element Analysis of Diamonds

Supported by Industry and a matching Macquarie University Collaborative Grant

Industry Collaborator: Rio Tinto

Summary: Diamonds contain minute amounts of trapped fluids, representing the medium from which the diamonds grew; these fluids are a unique source of information on processes in Earth's mantle. New techniques for the trace-element analysis of these fluids, developed recently in GEMOC will be further developed, and applied to the analysis of selected populations of diamonds from the Argyle mine (WA). The data will provide new insights into the genesis of diamond, with applications both to exploration models and to test the feasibility of "fingerprinting" of diamonds for exploration and forensic purposes (tracing illegal diamond sources).

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

Supported by industry and a matching Macquarie University Collaborative grant
Industry Collaborator: BHP-Billiton
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.

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.

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 2005. 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, Thailand and the former USSR.

Sue, Bill and Ming visiting the MC-ICPMS lab of Dr Fuyuan Wu at the Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing.

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)

FUNDED COLLABORATIVE PROJECTS COMMENCED OR ONGOING IN 2005 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, and have expanded to include collaboration with Nanjing University.

- 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 the Hoggar region of Algeria.
- The age of the Earth's core as estimated from ^{182}Hf-^{182}W and $^{238,235}U$-$^{206,207}Pb$ chronometers, a collaborative project with Professsor A. Halliday (University of Oxford).

Sue O'Reilly, Jean-Yves Cottin (St Etienne) and Else-Ragnhild Neumann examining xenoliths from Algeria.

- 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 visited GEMOC in early 2005, supported by a European Union Grant.
- 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 and sponsored visits to GEMOC by Professors Xisheng Xu and planned visit by Dr Hu Xiumian in 2006.
- 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 the East Central Asia Orogenic Belt, with Dr V. Malkovets, Novosibirsk.

***The French Connection** - GEMOC's PhDs and postdocs Guillaume Delpech, Michel Grégoire, Stéphanie Touron, Olivier Alard and Bertrand Moine with Sue O'Reilly at Stéphanie's thesis defense.*

- *TerraneChron*® analysis of Proterozoic terrains in Africa, North America and Europe, with WMC Resources and BHP-Billiton.
- Tectonic domains in southern Norway and Mozambique using *TerraneChron*®, with Professor T. Andersen (University of Oslo) and Dr B. Bingen (Norwegian Geological Survey).
- Age and magma sources of Chilean Cu-porphyries, with Codelco (Chile) and the CSIRO Division of Exploration and Mining (Perth)

GEMOC's international links

Professors Xisheng Xu in Nanjing.

• A new MOUs was negotiated with the United Arab Emirates University and it is anticipated that this will be be signed off in early 2006, opening the way for funded collaborative projects.

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 and evolve 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
- Commercialisation of GLITTER software through AccessMQ
- Independent Research Fellowships to support Postdoctoral Fellows
- LIEF successes for infrastructure with co-investment by industry and other universities
- Success in Macquarie University competitive funding schemes for research, postgraduate studies, and teaching development for undergraduate studies
- 3 new academic staff members (Drs Kelsie Dadd, Simon Jackson and Nathan Daczko) appointed to GEMOC in 1995, 1996 and 2003 have continuing appointments
- Postgraduate funding strategy exceeded goals
- Strategy for equipment and analytical funding exceeded goals

Macquarie University support has been supportive 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. A new initiative in 2006 by the new Vice-Chancellor has recognised GEMOC as one of five CORES (Concentrations Of Research Excellence) and strategies are being planned for significant support and expansion.

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

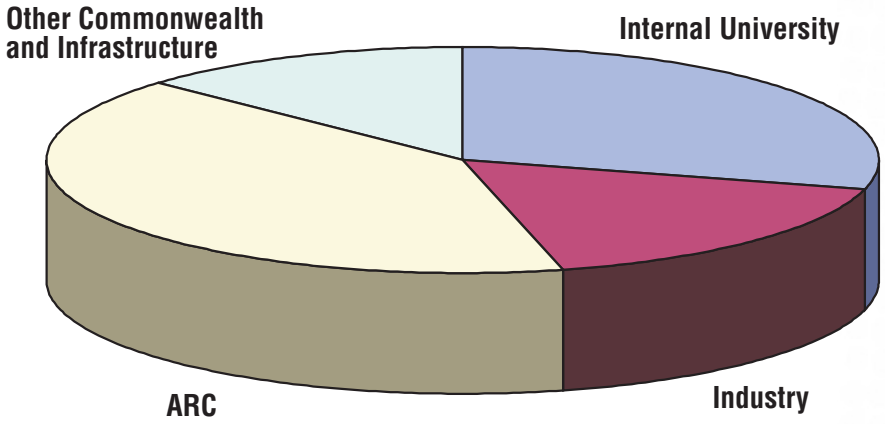
- Annual contribution from the Department of Earth and Planetary Sciences
- Macquarie University's guarantee of a strategic plan to ensure the integrity, maintenance and appropriate staffing of the Geochemical Analysis Unit
- Collaborative project building with industry partners
- Delivery of new exploration 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 2005

This is a summary of 2005 income. A full audited statement of detailed expenditure and income is prepared by Macquarie University. *No in-kind support is included here.*

	$K
ARC	
Discovery (including Fellowships), Linkage (Project and International), Federation Fellowships	1602.0
OTHER COMMONWEALTH	
Postgraduate awards	18.8
ARC LIEF	495.0
INDUSTRY	
Collaborative Research grants (MUECRG industry components and direct industry)	281.0
Collaborative and commercial (GLITTER) through MRL	383.0
INTERNAL UNIVERSITY	
GAU maintenance (Department)	30.0
Internal competitive schemes	
Macquarie Fellowships	72.7
Matching to ARC schemes	477.2
Research grants	178.8
Postgraduate awards	272.5
Postgraduate research grants	8.0
Infrastructure (RIBG)	113.1
Capital Equipment	25.0
TOTAL	**3957.1**

PIE-CHART OF INCOME SOURCES 2005



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)

- Enhanced international links
- Excellence in training of our future generation of geoscientists
- Enhanced industry links nationally and internationally
- Improved exploration tools and strategies for Australian mineral exploration companies both on- and off-shore
- Technological innovation (scientific advances, intellectual property, commercialisation, value-added consulting services)

Appendix 1: Participants

GEMOC PARTICIPANTS 2005/2006

MACQUARIE UNIVERSITY

Department of Earth and Planetary Sciences

Academic and GEMOC Managerial 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)

Dr Norman Pearson (Manager GAU)

Professor Simon Turner (Isotopic Geochemistry)

Professor Bernard Wood (Experimental Petrology

Research Staff

Dr John Adam

Dr Olivier Alard

Dr Debora Araujo

Dr Elena Belousova

Dr Alex Corgne

Ms Tara Deen

Dr Anthony Dosseto

Dr Rhiannon George

Dr Kevin Grant

Emeritus Professor Trevor Green

Dr Oliver Kreuzer

Dr Vladimir Malkovets

Dr Laure Martin

Dr Sune Nielsen

Dr Lev Natapov

Dr Craig O'Neill

Dr Yvette Poudjom Djomani

Emeritus Professor John Veevers

Emeritus Professor Ron Vernon

Dr Kuo-Lung Wang

Dr Helen Williams

Dr Ming Zhang

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 (Geochemist)

Dr Oliver Gaul (Research Officer)

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

Dr John Ketchum (Geochemist)

Ms Carol Lawson (Technical Officer)

Ms Maureen McMahon (Research Officer)

Dr Norman Pearson (Manager, GAU)

Dr William Powell (Research Officer)

Dr Ayesha Saeed (Geochemist)

Dr Kirsty Tomlinson (Geochemist)

Mr Peter Wieland (Geochemist)

Ms Tin Tin Win (Geochemist)

Adjunct Professors

Professor Bruce Chappell (Granite petrogenesis, geochemistry)

Professor Nicholas Fisher

Professor Mike Etheridge

Dr Richard Glen

Professor W.L. Griffin

Dr Jingfeng Guo

Dr John Hronsky (BHP-Billiton)

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

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 Phil Schmidt

Visiting Fellows

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

Honorary Associates

Professor Tom Andersen

Dr Kari Anderson

Dr Anita Andrew

Dr Sonja Aulbach

Dr E.V.S.S.K. Babu

Dr Graham Begg

Ms Kim Berlo

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)

Professor Massimo Coltorti
Professor Kent Condie
Dr Jean-Yves Cottin
Dr Karsten Gohl
Dr Michel Grégoire
Dr Bram Janse
Dr Mel Jones
Dr Felix Kaminsky
Dr Oliver Kreuzer
Dr Bertrand Moine
Dr Geoff Nichols
Dr Boris Panov
Dr Mark C. Pirlo
Dr Peter Robinson
Ms Sonal Rege
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

FORMAL COLLABORATORS

University of Wollongong

Professor Allan Chivas (DEST Systemic Infrastructure partner)

Monash University

Dr Bruce Schaefer (LIEF and Research partner)

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 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)

Australian National University (Research School of Earth Sciences)

Professor Geoff Davies
Professor Brian Kennett
Professor Gordon Lister

GA

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

PIRSA (South Australian Geological Survey)

Dr Anthony Reid
Dr Justin Gum

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-Lin Chung (National Taiwan University)
Professor 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 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)
Dr Csaba Szabo (Eotvos University Budapest)
Professor O.T. Tobisch (University of California, Santa Cruz)
Professor P. F. Williams (University of New Brunswick)
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/

Reid, A.J., Wilson, C.J.L., Belousova, E. and Pearson, N.J. 2006. Mesozoic plutons of the Yidun Arc, SW China: U/Pb geochronology and Hf isotopic signature. *Ore Geology Reviews.* (in press).

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, 266-271.*

Veevers, J.J., Saeed, A., Belousova, E.A. and Griffin, W.L. 2005. U-Pb ages and source composition by Hf-isotope and trace-element analysis 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.*

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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, 221, 243-259.*

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.*

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.*

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.*

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.*

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

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.*

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.*

Smith, D. and Griffin, W.L. 2005. Garnetite xenoliths and mantle-water interactions below the Colorado Plateau, southwestern United States. *Journal of Petrology, 46, 1901-1924.*

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Griffin, W.L., Belousova, E.A., Walters, S.G and O'Reilly, S.Y. 2006. 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), 53, 125-149.*

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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.*

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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.*

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, 50, 2080-2089.*

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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, 139, 42-100.*

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, V1, 27-42.*

Belousova, E.A., Griffin, W.L. and O'Reilly, S.Y. 2006. Zircon crystal morphology, trace-element signatures and Hf-isotope composition as a tool for petrogenetic modelling: examples from eastern Australian granitoids. *Journal of Petrology, 47, 329 - 353.*

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, 601-611.*

Pearson, N.J., Griffin, W.L., Alard, O. O'Reilly, S.Y. 2006. The isotopic composition of magnesium in mantle olivine: Records of depletion and metasomatism. *Chemical Geology, 226, 115-133.*

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Kaminsky, F.V., Zakharchenko, O.D., Khachatryan, G.K., Griffin, W.L. and Der Channer, D.M. 2006. Diamond from the Los Coquitos area, Bolivar State, Venezuela. *The Canadian Mineralogist.* (in press; corr proof online)

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 bridge the "isotopic gap" between MORB and their source mantle. *Nature, 436, 1005-1008.*

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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, 6, Q10006, doi 10.1029/2005GC000978.*

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Klein, E.L., Moura, C.A.V., Krymsky, R.S. and Griffin, W.L. 2005. The Gurupi Belt, northern Brazil: lithostratigraphy, geochronology and geodynamic evolution. *Precambrian Research, 141, 83-105.*

Appendix 2: Publications

Veevers, J.J, Belousova, E.A., Saeed, A., Sircombe, K., Cooper, A.F. and Read, S.E. 2006. Pan-Gondwanaland detrital zircons from Australia analysed for Hf-isotopes and trace elements reflect an ice-covered Antarctic provenance of 700-500 Ma age, T_{DM} of 2.0-1.0 Ga, and alkaline affinity. *Earth-Science Reviews, 76, 135-174.*

Veevers J.J. 2006. Updated Gondwana (Permian–Cretaceous) earth history of Australia. *Gondwana Research, 9, 231-260.*

Powell, W. and O'Reilly, S. Y. 2006. Metasomatism and sulfide mobility in lithospheric mantle beneath eastern Australia: implications for mantle Re-Os chronology. *Lithos.* (in press)

Nielsen, S.G., Rehkämper, M., Norman, M.D. and Halliday, A.N. 2005. Thallium isotopic evidence for ferromanganese sediments in the mantle source of Hawaiian basalts. *Nature, 439, 314-317.*

Zheng, J., Griffin, W.L., O'Reilly, S.Y., Zhang, M. and Pearson, N.J. 2006. Granulite xenoliths and their zircons, Tuoyun, NW China: Insights into southwestern Tianshan lower crust. *Precambrian Research, 145, 159-181.*

Zheng, J., Griffin, W.L., O'Reilly, S.Y., Zhang, M., Pearson, N.J. and Pan, Y 2006. Widespread Archean basement beneath the Yangtze craton. *Geology, 34, 417-420.*

Deen, T., Griffin, W.L., Begg, G., O'Reilly, S.Y. and Natapov, L.M. 2006. Thermal and compositional structure of the subcontinental lithospheric mantle: Derivation from shear-wave seismic tomography. *Geochemistry, Geophysics and Geosystems,* 7, Q07003, doi:10.1029/2005GC001120.

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Nielsen, S.G., Rehkämper, M. and Halliday, A.N. 2006. Large thallium isotopic variations in iron meteorites and evidence for lead-205 in the early solar system. *Geochimica et Cosmochimica Acta, 70, 2643-2657.*

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Griffin, W.L., Pearson, N.J., Belousova, E.A. and Saeed, A. 2006. Comment: Hf-isotope heterogeneity in zircon 91500. *Chemical Geology* (in press; corr proof online)

Adam, J. and Green, T. 2006. Trace element partitioning between mica- and amphibole-bearing garnet lherzolite and hydrous basanitic melt: 1. Experimental results and the investigation of controls on partitioning behaviour. *Contributions to Mineralogy and Petrology, 152, 1-17.*

Lackie, M.A. and McMahon, K.L. 2006. Seismic Reflection Studies of the Amery Ice Shelf, East Antarctica. *Geophysical Journal International, 166, 757.*

Zheng, J., Griffin, W.L., O'Reilly, S.Y., Yang, J.S. and Zhang, R.Y. 2006. A refractory mantle protolith in younger continental crust, east-central China: Age and composition of zircon in the Sulu UHP peridotite. *Geology.* (in press)

Paterson, S.R., Vernon, R.H. and Zak, J. 2005. Mechanical instabilities and physical accumulation of K-feldspar megacrysts in granitic magma, Tuolumne Batholith, California, USA. *Journal of the Virtual Explorer, 18, 1-20.*

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Zheng, J., Griffin, W.L., O'Reilly, S.Y., Zhang, M. and Pearson, N. 2006. Zircons in mantle xenoliths record the Triassic Yangtze-North China continental collision. *Earth and Planetary Sciences, 247, 130-142*

Andersen, T., Griffin, W.L. and Sylvester, A.G. 2006. Sveconorwegian underplating in southwestern Fennoscandia: LAM-ICPMS Hf isotope evidence from granites and gneisses in Telemark, southern Norway. *Lithos.* (in press)

Dosseto, A., Turner, S.P. and Douglas, G.B. 2006. Uranium-series isotopes in colloids and suspended sediments: Timescale for sediment production and transport in the Murray-Darling River System. *Earth and Planetary Science Letters.* (in press)

Zheng, J., Griffin, W.L., O'Reilly, S.Y., Yang, J., Li, T., Zhang, R.Y. and Liou, G.J. 2006. Mineral Chemistry of Garnet Peridotites from Paleozoic, Mesozoic and Cenozoic Lithosphere: Constraints on Mantle Evolution beneath Eastern China. *Journal of Petrology.* (in press).

Appendix 3: Visitors/ GAU users

GEMOC VISITORS 2005
(Excluding Participants in Conferences and Workshops)
Macquarie

Dr Chris Adams (Institute of Geological & Nuclear Sciences, Lower Hutt NZ)

Dr Olivier Alard

Mr Phil Baker (WMC Resources)

Dr Graham Begg (BHP-Billiton)

Dr Steve Beresford (BHP-Billiton)

Ms Kim Berlo (Dept of Earth Sciences, University of Bristol, UK)

Ms Mai-Fei Chu (Taiwan National University)

Professor Sun-Lin Chung (Taiwan National University)

Professor Massimo Coltorti (University of Ferrara)

Dr Craig Cook (Waikato University, Hamilton, NZ)

Professor Jon Davidson (Durham University, UK)

Andy Du Frane (University of New Mexico)

Professor Jim Gill (Santa Cruz University, California)

Dr Alan Goode (AMIRA International)

Mr Rabea Haredy (School of Earth and Environmental Sciences, University of Wollongong)

Dr Jeff Harris (Department of Geographical and Earth Sciences, University of Glasgow and De Beers)

Dr Chris Hatton (DeBeers Johannesburg)

Ms Adriana Heimann (Dept of Geological and Atmospheric Sciences, Iowa State University)

Mr Jim Hill (RSI, Colorado, USA)

Dr Jon Hronsky (BHP-Billiton)

Dr Martin van Kranendonk (Geological Survey of Western Australia)

Ms Yu-Hsuan Liang (Taiwan National University)

Dr Geordie Mark (Dept of Geological Sciences, Monash University)

Mr Paul Montague (Kennelec Scientific P/L)

Dr Michael Palin (Department of Geology, Otago University, NZ)

Dr Chris Ryan (CSIRO)

Professor Mike Sandiford (University of Melbourne)

Dr Simon Shee (DeBeers Australia)

Dr Keith Sircombe (Geoscience Australia)

Mr Darren Stephens (BHP Billiton)

Mr Fraser Tabeart (WMC Resources)

Dr Tadashi Usuki (Institute of Earth Science, Academia Sinica, Taipei)

Dr Esmé van Achterbergh (Rio Tinto)

Professor Bernard Wood (Dept of Earth Sciences, University of Bristol, UK)

Professor Jianping Zheng (China University of Geosciences, Wuhan)

EXTERNAL USERS OF THE GEOCHEMICAL ANALYSIS UNIT FACILITIES IN 2005

(Note: this does not include commercial or contract work through AccessMQ)

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

Dr Manish Arora (Faculty of Dentistry, University of Sydney)

Dr Dioni Cendon (School of Geosciences, University of Wollongong)

Professor Alan Chivas (School of Geosciences, University of Wollongong)

Professor Massimo Coltorti (Università di Ferrara, Italy)

Dr Craig Cook (University of Waikato)

Mr Andy Du Frane (University of New Mexico)

Dr Marco Fiorentini (University of Western Australia)

Professor Jim Gill (University of California, Santa Cruz, USA)

Dr Peter Grave (School of Human and Environmental Studies, Archaeology and Palaeoanthropology, University of New England)

Mr Rabea Haredy (School of Geosciences, University of Wollongong)

Ms Adriana Heimann (Dept of Geological and Atmospheric Sciences, Iowa State University, USA)

Dr Brian Jones (School of Geosciences, University of Wollongong)

Dr Florence Le Hebel (School of Geosciences, University of Sydney)

Dr Geordie Mark (School of Geosciences, Monash University)

Dr Terry Mernagh (Geoscience Australia)

Ms Marianne Sandstrom (University of Adelaide)

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

Dr Bruce Schaefer (School of Geosciences, Monash University)

Dr Qiang Wang (School of Geosciences, University of Sydney)

Dr Derek Wyman (School of Geosciences, University of Sydney)

Dr Oskar Thalhammer (University of Leoben)

Appendix 4: Abstract titles

TITLES OF ABSTRACTS FOR CONFERENCE PRESENTATIONS IN 2005

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

COLLOQUIUM AND ANNUAL GENERAL MEETING OF THE ATLANTIC GEOSCIENCE SOCIETY (AGS), SAINT JOHNS, NEW BRUNSWICK, CANADA, FEBRUARY 4-6 2005

Phreatomagmatism of the Silurian Passamaquoddy Bay Subbelt, Maine and New Brunswick
R.W.D. Lodge[1], N. Van Wagoner[1] and K. Dadd[2]
1. Acadia University, Geology Department, Wolfville, Nova Scotia, Canada, 2. GEMOC, Macquarie

JOINT MEETING OF THE GEOLOGICAL ASSOCIATION OF CANADA, THE MINERALOGICAL ASSOCIATION OF CANADA, THE CANADIAN SOCIETY OF PETROLEUM GEOLOGISTS AND THE CANADIAN SOCIETY OF SOIL SCIENCES (GAC/MAC), HALIFAX, NOVA SCOTIA, CANADA, MAY 15-18 2005

Origin and Evolution of the Lithospheric Mantle beneath the Central 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 Inc., Thunder Bay, ONT., Canada

Evolution of the Makkovik Province, Labrador, Canada: tectonic processes during 200 Ma at a Paleoproterozoic active margin
N. Culshaw[1], J. Ketchum[2], and S.M. Ball
1. Department of Earth Sciences, Dalhousie University, Halifax, Canada, 2. GEMOC, Macquarie

Restite in S-Type Granites of the Lachlan Fold Belt, SE Australia
R.H. Vernon
GEMOC, Macquarie

Late Ordovician to Silurian arc and back-arc sequences: southwestern New Brunswick and eastern Maine
N. Van Wagoner[1], M. McLeod[2], K. Dadd[3] and M. Leybourne[4]
1. Acadia University, Geology Department, Wolfville, Nova Scotia, Canada, 2. New Brunswick Department of Natural Resources, Geological Surveys Branch, Sussex, New Brunswick, 3. GEMOC, Macquarie, 4. Department of Geology, Department of Geosciences, University of Texas at Dallas, Richardson, Texas, US

Comparative volcanology of the Silurian Passamaquoddy Bay Subbelt, Maine and New Brunswick: Implications for correlation and Volcanic Setting
N. Van Wagoner[1], K. Dadd[2]
1. Acadia University, Geology Department, Wolfville, Nova Scotia, Canada, 2. GEMOC, Macquarie

15TH ANNUAL V. M. GOLDSCHMIDT CONFERENCE, UNIVERSITY OF IDAHO, MOSCOW, IDAHO USA, MAY 20-25 2005

The eclogite mantle reservoir: $^{176}Hf/^{177}Hf$, Nb/Ta and Zr/Hf of rutile
S. Aulbach[1], W.L. Griffin[1,2], N.J. Pearson[1] and S.Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia

Os-Hf-Nd Isotope Constraints on Subcontinental Lithospheric Mantle Evolution, Slave Craton (Canada)
S. Aulbach[1], W.L. Griffin[1,2], N.J. Pearson[1], S.Y. O'Reilly[1] and K. Kivi[3]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia, 3. Kennecott Canada Expl. Inc., Thunder Bay, ONT, Canada

The isotopic composition of subduction fluid: High-, low-, or normal $\delta^{18}O$?
I. Bindeman[1,2], S. Turner[3], J.Eiler[2] and M.Portnyagin[4]
1. Geological Science, University of Oregon, Eugene, OR, USA, 2. GPS, Caltech, Pasadena, CA, USA, 3. GEMOC, Macquarie, 4. GEOMAR, Kiel, Germany

Mantle and crustal metasomatism of garnet-bearing peridotite in the Western Gneiss Region of the Norwegian Caledonides
H. Brueckner[1,2], D.A. Carswell[3], W.L.Griffin[4], L.G. Medaris Jr. and E. Beyer[4]
1. Queens College and The Graduate Center of CUNY, USA, 2. Lamont-Doherty Earth Observatory of Columbia University, USA, 3. Department of Geography, University of Sheffield, UK, 4. GEMOC, Macquarie, 5. Department of Geology and Geophysics, University of Wisconsin-Madison, Wisconsin, USA

Rapid response of erosion to recent climatic changes: New insights from uranium-series
A. Dosseto[1], B. Bourdon[2], J. Gaillardet[2], C.J. Allegre[2], and N. Filizola[3]
1. GEMOC, Macquarie, 2. Laboratoire de Geochimie et Cosmochimie, IPGP, Paris, France, 3. IRD-LMTG, Universite Paul Sabatier, Toulouse, France

Understanding radioactive disequilibrium in river-borne material: dependence on colloid/ particle size
A. Dosseto[1], G.B. Douglas[2] and S. Turner[1]
1. GEMOC, Macquarie, 2. CSIRO Land and Water, Wembley, WA, Australia

Magma differentiation and storage at Katmai-Novarupta 1912: comparing U-series time scales with thermal models
R.M. George[1], S. Turner[1], M. Reagan[2], M. Sandiford[3], C. Hawkesworth[4] and W. Hildreth[5]
1. GEMOC, Macquarie, 2. Department of Geoscience, University of Iowa, Iowa City, USA, 3. School of Earth Sciences, University of Melbourne, Victoria, Australia, 4. Department of Earth Sciences, Bristol University, Bristol, UK, 5. US Geological Survey, CA, USA

Appendix 4: Abstract titles

***In-situ* U-Pb geochronology and Hf isotope analyses of the Rayner Complex, east Antarctica**
J.A. Halpin[1], C.L. Gerakiteys[1], G.L. Clarke[1], E.A. Belousova[2] and W.L Griffin[2,3]
1. School of Geosciences, University of Sydney, Sydney, Australia, 2. GEMOC, Macquarie, 3. CSIRO Exploration and Mining, North Ryde, Australia

Laser ablation MC-ICP-MS: shedding new light on *in-situ* isotope ratio measurement
N. Pearson, W.L. Griffin and S.Y. O'Reilly
GEMOC, Macquarie

^{210}Pb-^{226}Ra-^{230}Th implications for timescales of island arc magma degassing
S. Turner[1] and K. Berlo[2]
1. GEMOC, Macquarie, 2. Department of Earth Sciences, University of Bristol, UK

Proterozoic mantle lithosphere beneath the East African Rift (Southern Ethiopia): In situ Re-Os evidence
K.L. Wang[1,2], S.Y. O'Reilly[1], W.L. Griffin[1], N. Pearson[1], R. Matsumura[3] and R. Shinjo[3]
1. GEMOC, Macquarie, 2. Department of Geosciences, National Taiwan University, Taipei, Taiwan, 3. Department of Physics and Earth Sciences, University of the Ryukyus, Nishihara, Okinawa, Japan

Early J2 basalts in SE China: The incipience of large-scale late Mesozoic magmatism
X. Xie[1], X. Xu[1], H Zou[2], S. Jiang[1], M. Zhang[3] and J. Qiu[1]
1. State Key Laboratory of Mineral Deposit Research, Department of Earth Sciences, Nanjing University, Nanjing, China, 2. Department of Earth and Space Sciences, University of California, Los Angeles, USA, 3. GEMOC, Macquarie

EUROPEAN GEOSCIENCES UNION GENERAL ASSEMBLY 2005 VIENNA, AUSTRIA, APRIL 24-29 2005

***In-situ* Os isotopic compositions in sulfides from Kerguelen mantle xenoliths (Indian Ocean): Proterozoic subcontinental mantle fragments under the Kerguelen Archipelago?**
G. Delpech[1,2], M. Grégoire[2,3], J.P. Lorand[4], S.Y. O'Reilly[2] and J.Y. Cottin[1,2]
1. University of Jean Monnet, Saint-Etienne, France, 2. GEMOC, Macquarie, 3. Observatoire Midi-Pyrenees, Toulouse, France, 4. Museum d'Histoire Natrelle, Paris, France

The age of Os isotope reason in the sub-continental lithospheric mantle
N.J. Pearson[1], W.L. Griffin[1], O. Alard[1,2] and S.Y. O'Reilly[1],
1. GEMOC, Macquarie, 2. CNRS, Université de Montpellier, Montpellier, France

AGU 2005 JOINT ASSEMBLY, NEW ORLEANS, LA, USA, MAY 23-27 2005

A sharp continent-ocean transition in the area of the Canary Islands: Evidence from upper mantle and lower crustal xenoliths
E.-R. Neumann[1], R. Vannucci[2,3], M. Tiepolo[3], W.L. Griffin[4], N.J. Pearson[4] and S.Y. O'Reilly[4]
1. Physics of Geological Processes, University of Oslo, Oslo, Norway, 2. Dipartimento di Scienze della Terra, Università di Pavia, Pavia, Italy, 3. CNR - Istituto di Geoscienze e Georsisorse, sezione di Pavia, Pavia, Italy, 4. GEMOC, Macquarie

AOGS, ASIA OCEANIA GEOSCIENCES SOCIETY 2ND ANNUAL MEETING, SINGAPORE, JUNE 20-24 2005

Magma differentiation and storage at Katmai-Novarupta 1912: comparing U-series time scales with thermal models
R.M. George[1], S. Turner[1], M. Reagan[2], M. Sandiford[3], C. Hawkesworth[4]
1. GEMOC, Macquarie, 2. Department of Geoscience, University of Iowa, Iowa City, USA, 3. School of Earth Sciences, University of Melbourne, Victoria, Australia, 4. Department of Earth Sciences, Bristol University, Bristol, UK

Consequences of U-series disequilibria for thermal maturation models for silicic magma production and the time scales involved
S. Turner[1], A. Dosseto[1], R. George[1], K. Berlo[2]
1. GEMOC, Macquarie, 2. Department of Earth Sciences, Bristol University, Bristol, UK

IUGS-SECE, THE ORIGIN, EVOLUTION AND PRESENT STATE OF SUBCONTINENTAL LITHOSPHERE CONFERENCE, CHINA, JUNE 25-30 2005

Mapping the Lithospheric Mantle: Tomography meets Geochemistry and Geothermics
W.L. Griffin[1,2], S.Y. O'Reilly[1], T. Deen[1], G. Begg[3] and Y. Poudjom Djomani[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia, 3. WMC Resources Ltd., Belmont, WA, Australia

Persistence of ancient lithospheric mantle: consequences for geodynamics and basalt geochemistry
S.Y. O'Reilly[1], W.L. Griffin[1,2], M. Zhang[1] and Y. Poudjom Djomani[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia

Re-Os isotopes in mantle xenoliths from SE China: age constraints and evolution of lithospheric mantle
X. Xu[1,2], W.L. Griffin[2], S.Y. O'Reilly[2], and N.J. Pearson[2]
1. State Key Laboratory for Mineral Deposits Research, Department of Earth Sciences, Nanjing University, Nanjing, China, 2. GEMOC, Macquarie

Secular (136 to 0 Ma) chemical variation of mantle-derived mafic magmas in the Sino-Korean Craton: constraints on mantle evolution
M. Zhang[1], W. Fan[1,2], S.Y. O'Reilly[1], J. Zheng[1,3] and W.L. Griffin[1,4]
1. GEMOC, Macquarie, 2. Lab of Lithospheric Tectonic Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, 3. Faculty of Earth Sciences, China University of Geosciences, Wuhan, China, 4. CSIRO Exploration and Mining, North Ryde, NSW, Australia

Late Mesozoic-Eocene mantle replacement beneath the eastern North China Craton: evidence from the Paleozoic and Cenozoic peridotite xenoliths
J. Zheng[1], W.L. Griffin[2,3], S.Y. O'Reilly[2] and F. Lu[1]
1. State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Sciences, China University of Geosciences, Wuhan, China, 2. GEMOC, Macquarie, 3. CSIRO Exploration and Mining, North Ryde, NSW, Australia

Mineral chemistry of garnet peridotites from Paleozoic and Cenozoic lithosphere and Mesozoic UHP terrain: constraints on lithospheric evolution, east China
J. Zheng[1], W.L. Griffin[2,3], R.Y. Zhang[4], S.Y. O'Reilly[2] and J.G. Liou[4]
1. State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Sciences, China University of Geosciences, Wuhan, China, 2. GEMOC, Macquarie, 3. CSIRO Exploration and Mining, North Ryde, NSW, Australia, 4. Department of Geological and Environmental Sciences, Stanford University, CA, USA

GEOLOGICAL SOCIETY OF SOUTH AFRICA, DURBAN, SOUTH AFRICA, JULY 4-7 2005

Structural aspects of igneous cumulates (invited lecture)
R.H. Vernon
GEMOC Macquarie

SPECIALIST GROUP IN GEOCHEMISTRY, MINERALOGY AND PETROLOGY (SGGMP) GEOLOGICAL SOCIETY OF AUSTRALIA FIRST BIENNIAL CONFERENCE, PORT MACQUARIE, JULY 13-15 2005

Plutonism and metamorphism at the root of a Cretaceous magmatic arc
S.A. Carroll and N.R. Daczko
GEMOC, Macquarie

High-pressure mafic migmatites, Fiordland, New Zealand: does migmatisation promote recrystallisation to garnet granulite?
N.R. Daczko[1] and G.L. Clarke[2]
1. GEMOC, Macquarie, 2. School of Geosciences, University of Sydney, Sydney, Australia

Tracking crustal differentiation and assimilation processes at arc volcanoes: a Uranium series isotope perspective
R.M. George[1], S.P. Turner[1] R. Price[2], C. Cook[2] and B. Finney[3]
1. GEMOC, Macquarie, 2. School of Science and Technology, University of Waikato, Hamilton, New Zealand, 3. Department of Earth Sciences, University of Bristol, Bristol, UK

Insights into magma generation and evolution at White Island, New Zealand
Z. Hayworth[1], R.M. George[2], B.F. Schaefer[1] and S.P. Turner[2]
1. School of Geosciences, Monash University, ACT, Australia, 2. GEMOC, Macquarie

Thermobarometry of Early Cretaceous high-pressure contact metamorphic aureole near Resolution Island, Fiordland, New Zealand
L.A. Milan[1], N.R. Daczko[1], I. Turnbull[2], and A. Allibone[2]
1. GEMOC, Macquarie, 2. Institute of Geological and Nuclear Sciences, Dunedin, New Zealand

Thallium isotopic evidence for ferromanganese sediments in the mantle source of Hawaiian basalts
S.G. Nielsen[1,2], M. Rehkamper[1,3], M. Norman[4] and A. Halliday[1,5]
1. Department of Earth Sciences, ETH Zurich, Zurich, Switzerland, 2. GEMOC, Macquarie, 3. Imperial College, London, United Kingdom, 4. Research School of Earth Sciences, Australian National University, Canberra, ACT, Australia, 5. Department of Earth Sciences, University of Oxford, Oxford, United Kingdom

Facies analysis, geochemistry and tectonic setting of the Frampton Volcanics, southeastern New South Wales
A.C. Plioplis and K.A. Dadd
GEMOC, Macquarie

Systematics in two phase REE and Y partitioning coefficients in mafic granulites
F.C. Schroter[1], G.L. Clarke[1], R.W. White[2] and N.J. Pearson[3]
1. School of Earth Sciences, University of Sydney, NSW, Australia, 2. School of Earth Sciences, University of Melbourne, Victoria, Australia, 3. GEMOC, Macquarie

Tectonic significance of low-grade mineralization of seafloor spreading-related faults, Macquarie Island
J-Y. Talbot and N.R. Daczko
GEMOC, Macquarie

Time scales of magmatic processes: a review of recent U-series results
S. Turner
GEMOC, Macquarie

Appendix 4: Abstract titles

Iron Isotopes as a potential new tool in igneous geochemistry and cosmochemistry
H.M. Williams[1,2], A.N. Halliday[3], C.A. McCammon[4], A.H. Peslier[5], N. Teutsch[1], S. Levasseur[1] and J.-P. Burg[1]
1. Department of Earth Sciences, ETH-Zurich, Switzerland, 2. GEMOC Macquarie, 3. Department of Earth Sciences, University of Oxford, Oxford, UK, 4. Bayerisches Geoinstitut, Universitat Bayreuth, Bayreuth, Germany, 5. Texas Centre for superconductivity and Advanced Materials, University of Houston, Houston, TX, USA

Where do high-level granite magmas come from?
R.H. Vernon
GEMOC, Macquarie

8TH BIENNIAL SGA MEETING, MINERAL DEPOSIT RESEARCH: MEETING THE GLOBAL CHALLENGE, BEIJING, CHINA, AUGUST 18-21 2005

Upper mantle composition: tools for smarter diamond exploration
W.L. Griffin[1,2] and S.Y. O'Reilly[1]
1. GEMOC, Macquarie, 2. CSIRO Exploration and Mining, North Ryde, Australia

The evolution of lithospheric domains: a new framework to enhance mineral exploration targeting
S.Y. O'Reilly[1], J. Hronsky[2], W.L. Griffin[1,3] and G. Begg[2]
1. GEMOC, Macquarie, 2. WMC Resources Ltd., Belmont, WA, Australia, 3. CSIRO Exploration and Mining, North Ryde, NSW

SPECIALIST GROUP IN TECTONICS AND STRUCTURAL GEOLOGY CONFERENCE ("STOMP"), TOWNSVILLE, QUEENSLAND, AUGUST 29 - SEPTEMBER 2 2005

Structural evidence for identifying granite cumulates
R.H. Vernon
GEMOC, Macquarie

WEST ANTARCTICA ICE SHEET INITIATIVE (WAIS) WORKSHOP, STERLING, VIRGINIA, USA, SEPTEMBER 28 - OCTOBER 1 2005

Seismic studies of the Amery Ice Shelf, East Antarctica
K. McMahon
GEMOC, Macquarie

INTERNATIONAL CONFERENCE IN HONOUR OF RON H. VERNON ON "SHEARED MAGMAS IN NATURE AND EXPERIMENT: BRIDGING THE BRITTLE AND DUCTILE FIELDS", KLOSTER SEEON, BAVARIA, GERMANY, OCTOBER 4-7 2005

Problems of extraction and sources of felsic magma
R.H. Vernon[1] and S.R. Paterson[2]
1. GEMOC, Macquarie, 2. Earth Sciences, University of Southern California, Los Angeles, USA.

2005 AGU FALL MEETING, SAN FRANCISCO, CA, USA, DECEMBER 5-9 2005

Campbell Plateau, New Zealand: Seismic Analysis and Models From a Rifted Submarine Plateau of Continental Origin
J. Grobys[1], K. Gohl[1], G. Uenzelmann-Neben[1], B. Davy[2], D. Barker[2] and T. Deen[3]
1. Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, 2. GNS Science, Lower Hutt, New Zealand, 3. GEMOC, Macquarie

Runaway growth of Mars and implications for core formation relative to Earth
A.N. Halliday[1], B.J. Wood[2] and T. Kleine[3]
1. University of Oxford, Earth Sciences, Oxford, United Kingdom, 2. GEMOC, Macquarie, 3. ETH Zentrum, Earth Sciences, Zurich, Switzerland

Deciphering multistage crystal histories in arc magmas
R. George[1], S. Turner[1], K. Berlo[2] and N. Pearson[1]
1. GEMOC, Macquarie,
2. Department of Earth Sciences, University of Bristol Wills Memorial Building, United Kingdom

Transitional melt flow in downwelling arc mantle
N. Petford[1] and S. Turner[2]
1. Kingston University, Centre for Earth and Environmental Science Research, London, United Kingdom, 2. GEMOC, Macquarie

Mass transfer in subduction zones: an elemental and isotopic perspective
S. Turner and R. George
GEMOC, Macquarie

Kelvin revisited: Cooling and core formation after the giant impact
B.J. Wood[1] and A.N. Halliday[2]
1. GEMOC, Macquarie, 2. Oxford University, Department of Earth Sciences, Oxford, United Kingdom

Core formation and the oxidation state of the Earth
B.J. Wood[1], J. Wade[2] and M.J. Walter[3]
1. Department of Earth and Planetary Sciences, Macquarie University, Sydney, Australia, 2. University of Bristol, Department of Earth Sciences, Bristol, United Kingdom, 3. Australian Centre for Astrobiology, Macquarie University

Appendix 5: Funded research projects

GRANTS AND OTHER INCOME FOR 2005

Funding Source	Investigators	Project Title	Amount
ARC Discovery	Alard	Toward the use of metal stable isotopes in geosciences	$115,073
ARC Discovery	Belousova	Crustal evolution in Australia: Ancient and young terrains	$106,348
ARC Discovery	Daczko	A new approach to understanding the mechanisms and deep crustal controls of continental rifting	$51,050
ARC Discovery	Jackson	Isotopic fractionation of the ore minerals (Cu, Fe, Zn): A new window on ore-forming processes	$102,100
ARC Discovery	O'Reilly, Griffin, Gohl, Morgan, Cottin, Neumann, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$279,073
ARC Discovery	Turner, Hawkesworth, Reagan, Kirchner	The time scales of magmatic and erosional cycles	$88,816
ARC Linkage International	O'Reilly, Griffin, Cottin, Grégoire, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$41,796
ARC Linkage Projects	O'Reilly, Griffin, WMC	Global lithosphere architecture mapping (including industry contribution)	$196,734
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 (MU contribution)	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	$175,000
ARC Federation Fellowship	Turner	The time scales of geochemical cycles and Earth processes	$310,325
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	$310,325
ARC Federation Fellowship (MU contribution)	Wood	Origin and evolution of Earth's chemical reservoirs	$180,000

Appendix 5: Funded research projects

Funding Source	Investigators	Project Title	Amount
MU capital equipment	DEPS	Alpha counting system	$25,000
Dept. Earth and Planetary Sciences	O'Reilly, DEPS	GAU Maintenance contribution	$30,000
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	$179,928
MU DEST RIBG	Turner et al	Facility for the study of short-lived isotopes in mid-ocean ridge basalt glasses	$65,064
MU DEST RIBG	Wood et al	New Wave Micromill	$48,059
MUECRG Scheme	Belousova	Developing a geochronological framework for the Gawler Craton, South Australia	$20,000
MUECRG Scheme	Belousova	Developing a geochronological framework for the Gawler Craton, South Australia (Industry contribution)	$20,000
MUECRG	O'Reilly	Links between plume-mantle interaction, mantle sulfides and Ni-PGE endowment in large igneous provinces	$40,000
MUECRG WMC	O'Reilly	Links between plume-mantle interaction, mantle sulfides and Ni-PGE endowment in large igneous provinces (industry contribution)	$40,000
MURDG	Malkovets	Age and evolution of the upper mantle beneath the Siberian Craton and Siberian Platform	$21,920
MURF	Malkovets	Age and evolution of the upper mantle beneath the Siberian Craton and Siberian Platform	$72,695
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	Belousova	Enhancing the use of zircon in crustal studies and mineral exploration: trace-element and statistical approach	$19,208
MU New Staff Scheme	Malkovets	Structure and evolution of the upper mantle beneath the Siberian Craton	$19,906

Funding Source	Investigators	Project Title	Amount
MU New Staff Scheme	Williams	The oxidation state of the early Earth mantle: new clues from iron isotopes	$19,978
PGRF	McMahon	Fracturing and deformation along the Amery Ice Shelf: A Seismic Study	$4,000
PGRF	Murgulov	Crust-mantle evolution and metallogeny, E. Australia	$4,000
APA	Murgulov	Crust-mantle evolution and metallogeny, E. Australia	$18,837
IPRS and iMURS	Chevet	Gabbroic rocks from the Kerguelen Island (Indian Ocean): a petrologic, geochemical and isotopic investigation of their origin	$40,837
IPRS and iMURS	Cunningham	A U-series isotope study of magma residence times, degassing and petrogenesis of Rabaul Caldera, Papua New Guinea	$40,837
IPRS and iMURS	Hartman	Tofua Volcano in Northern Tonga: U-series Isotope and Melt Inclusion Studies Along the Tonga-Kermadec Island Arc	$40,837
IPRS and iMURS	Mwandu	The origin of kimberlites from the Kundelungu region (D.R. Congo) and the nature of the underlying lithospheric mantle	$40,837
IPRS and iMURS	Nikolic	Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway	$40,837
IPRS and iMURS	Rege	Trace elements in diamonds: genetic and forensic implications	$30,627
RAACE	Carroll	The mechanisms and deep-crustal controls on continental rifting	$18,837
RAACE	Milan	The emplacement, pressure-temperature-time path and structural evolution of lower crust gneisses in Fiordland, New Zealand	$18,837

FUNDED RESEARCH PROJECTS FOR 2006

Funding Source	Investigators	Project Title	Amount
ARC Discovery	Alard	Toward the use of metal stable isotopes in geosciences	$121,378
ARC Discovery	Daczko	A new approach to understanding the mechanisms and deep crustal controls of continental rifting	$36,414
ARC Discovery	Daczko	Spreading ridge sedimentation processes: a novel approach using Macquarie Island as a natural laboratory	$61,140
ARC Discovery	Jackson	Isotopic fractionation of the ore minerals (Cu, Fe, Zn): A new window on ore-forming processes	$62,424

Appendix 5: Funded research projects

Funding Source	Investigators	Project Title	Amount
ARC Discovery	O'Reilly, Griffin, Gohl, Morgan, Cottin, Neumann, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$284,375
ARC Discovery	Turner, Hawkesworth, Kirchner	The time scales of magmatic and erosional cycles	$90,503
ARC Discovery	Nielsen	Thallium isotopes: a novel geochemical tracer to map recycling in Earth's mantle	$105,000
ARC Discovery	Wood	The behaviour of geochemical tracers during diferentiation of the Earth	$150,000
ARC Linkage International	O'Reilly, Griffin, Cottin, Grégoire, Xu	How has the continental lithosphere evolved? Processes of assembly, growth, transformation and destruction	$42,590
ARC Linkage Projects	O'Reilly, Griffin, WMC	Global lithosphere architecture mapping (including industry contribution)	$199,711
ARC Federation Fellowship	Wood	Origin and evolution of Earth's chemical reservoirs	$316,222
ARC Federation Fellowship (MU contribution)	Wood	Origin and evolution of Earth's chemical reservoirs	$180,000
ARC Federation Fellowship	Turner	The time scales of geochemical cycles and Earth processes	$316,222
ARC Federation Fellowship (MU contribution)	Turner	The time scales of geochemical cycles and Earth processes	$168,390
Dept. EPS	O'Reilly, DEPS	GAU Maintenance contribution	$30,000
MQERCG	O'Reilly, Griffin	Trace-element analysis of diamonds	$50,000
MQERCG (Rio Tinto)	O'Reilly, Griffin	Trace-element analysis of diamonds	$102,000
MQERCG	Griffin, O'Reilly	Lithosphere evolution across a craton margin, southern Africa	$50,000
MQERCG (de Beers)	Griffin, O'Reilly	Lithosphere evolution across a craton margin, southern Africa	$81,000
MURF	O'Neill	Episodicity in mantle convection: effects on continent formation and metallogenesis	$18,400
MURF	O'Neill	Episodicity in mantle convection: effects on continent formation and metallogenesis	$66,136

Funding Source	Investigators	Project Title	Amount
MU Safety Net	Turner	Mantle melting dynamics and the influence of recycled components	$19,700
Capital equipment	Lackie	Ground penetrating radar system	$64,550
Capital equipment	Flood	Rocklab grinding mill	$19,500
Capital equipment	Flood	Portable computer laboratory upgrade	$23,100
LIEF	Kennett, Heinson and O'Reilly	Instrumentation for combined seismic and electromagnetic Earth sounding	$350,000
PGRF	Milan	The emplacement, presure-temperature-time path and structural evolution of lower crustal gneiss in Fiordland, New Zealand	$4,000
PGRF	Nikolic	Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway	$4,000
APA	Murgulov	Crust-mantle evolution and metallogeny, E. Australia	$19,231
IPRS and iMURS	Caulfield	Tofua volcano- Tonga Arc, Eruption history and timescales of Magma Chamber Processes	$42,231
IPRS and iMURS	Chevet	Gabbroic rocks from the Kerguelen Island (Indian Ocean): a petrologic, geochemical and isotopic investigation of their origin	$42,231
IPRS and iMURS	Cunningham	A U-series isotope study of magma residence times, degassing and petrogenesis of Rabaul Caldera, Papua New Gunea	$42,231
IPRS and iMURS	Kobussen	Composition, structure and evolution of the lithospheric mantle beneath Southern Africa	$42,231
IPRS and iMURS	Li	Stable metal isotope geochemistry of the Cadia and Northparkes porphyry Cu-Au deposits	$42,231
IPRS and iMURS	Mwandu Batumike	The origin of kimberlites from the Kundelungu region (D.R. Congo) and the nature of the underlying lithospheric mantle	$42,231
IPRS and iMURS	Nikolic	Evolution of crust-mantle systems near a young rift: NW Spitsbergen, Norway	$42,231
IPRS and iMURS	Portner	Spreading ridge sedimentation processes: a novel approach using Macquarie Island as a natural laboratory	$42,231
RAACE	Milan	The emplacement, pressure-temperature-time path and structural evolution of lower crust gneisses in Fiordland, New Zealand	$19,231

ARC Research Projects initiated prior to 2005 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.

Earth and Planetary Sciences

Are you interested in:

- ***Earth's Environment***
- ***Contaminated Land Remediation***
- ***Geochemistry***
- ***Groundwater Contamination***

Environmental geology explores the interaction of people and the geologic environment. This 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

Units: 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

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

THIRD YEAR

Units: GEOS315 Environmental and Groundwater Geophysics
GEOS377 Environmental Geology
GEOS399 Soils
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 possible.

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

For more information please contact: The Executive Officer, Earth and Planetary Science
Ph. 61-2-9850 8373 Fax. 61-2-9850 6904
Email: eps@mq.edu.au

MACQUARIE UNIVERSITY SYDNEY

Bachelor of Science or Arts

GEOLOGY MAJOR

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

Earth and Planetary Sciences

Are you 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 Geosciences 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 Geoscience
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
GEOS528 Coral Reef Environment

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 possible.

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

For more information please contact: The Executive Officer, Earth and Planetary Science
Ph. 61-2-9850 8373 Fax. 61-2-9850 6904
Email: eps@mq.edu.au

MACQUARIE UNIVERSITY SYDNEY

Bachelor of Science

GEOPHYSICS MAJOR

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

Earth and Planetary Sciences

Are you interested in:

- ***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" — the study of the Earth's structure and evolution, and "Exploration" — 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)
MATH130, MATH135, MATH136, PHYS140, PHYS143
COMP115 *or* ISYS123 *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 Geoscience
GEOS272 Earth's Evolving Environment
MATH235, MATH236, PHYS201, COMP238

THIRD YEAR

Core: GEOS315 Environmental and Groundwater Geophysics *or*
GEOS316 Exploration Geophysics
GEOS385 Golbal Tectonics
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 possible.

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

For more information please contact: The Executive Officer, Earth and Planetary Science
Ph. 61-2-9850 8373 Fax. 61-2-9850 6904
Email: eps@mq.edu.au

MACQUARIE UNIVERSITY SYDNEY

Earth and Planetary Sciences

Bachelor of Technology
EXPLORATION GEOSCIENCE - Geochemistry Strand

72 Credit points required

Are you 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. Employment can be found in mining exploration and environmental consultancy companies, geoanalytical laboratories, government advisory bodies, research and teaching

FIRST YEAR

Core: GEOS115 Earth Dynamics, Materials and the Environment
GEOS116 Marine Geosciences and
GEOS224 Introduction to Field Geology (vacation unit)
CHEM101

And one of: PHYS140, PHYS143, MATH135, MATH136, COMP115

SECOND YEAR

Core: GEOS260 Marine Depositional Environments
GEOS268 Introduction to Geophysics
GEOS230 Field and Lavoratory Studies in Geoscience
CHEM207

Optional: GEOS266 Earth Surface Processes
GEOS272 Earth's Evolving Environment
GEOS315 Environment and Groundwater Geophysics or
GEOS316 Exploration Geophysics
STAT170 or STAT171

THIRD YEAR

Core: GEOS307 Field Geology Mapping
GEOS314 Magmas, Fluids and Ore Deposits
GEOS377 Environmental Geology
GEOS437 Geochemical Applications and Techniques
MPCE360

Optional: GEOS315 Environmental and Groundwater Geophysics or
GEOS316 Exploration Geophysics
GEOS373 Volcanic Geology Fieldwork
COMP238

FOURTH YEAR (HONOURS)

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.

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

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MACQUARIE UNIVERSITY SYDNEY

Earth and Planetary Sciences

Bachelor of Technology
EXPLORATION GEOSCIENCE - Geophysics Strand

72 Credit points required

Are you 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. Employment can be found in mining, exploration and environmental consultancy companies, geoanalytical laboratories, government advisory bodies and teaching.

FIRST YEAR

Units: GEOS115 Earth Dynamics, Materials and the Environment
GEOS116 Marine Geosciences and
GEOS224 Introduction to Field Geology (vacation unit)
PHYS140, PHYS143, MATH135, MATH136, COMP115
And one of CHEM101,CHEM103

SECOND YEAR

Core: GEOS260 Marine Depositional Environments
GEOS268 Introduction to Geophysics
MATH235, MATH236, ELEC166
GEOS315 Environmental and Groundwater Geophysics or
GEOS316 Exploration Geophysics

Optional: GEOS230 Field and Laboratory Studies in Geoscience
PHYS201, PHYS202

THIRD YEAR

Core: GEOS385 Global Tectonics
GEOS420 Data and Image Processing in Geophysics and Exploration
GEOS315 Environmental and Groundwater Geophysics or
GEOS316 Exploration Geophysics
GEOS460 Solid Earth Geophysics
MPCE360 Technology Management

Optional: GEOS314 Magmas, Fluids and Ore Deposits
GEOS307 Field geology and Mapping
GEOS373 Volcanic Geology Fieldwork
COMP238, ELEC274

FOURTH YEAR (HONOURS)

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.

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

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Email: eps@mq.edu.au

MACQUARIE UNIVERSITY SYDNEY

Earth and Planetary Sciences

Bachelor of Marine Science
MARINE GEOSCIENCE MAJOR

Are you interested in:

- ***Origin and evolution of the ocean basins***
- ***Ocean circulation and global climate***
- ***Evolution of the marine biosphere***
- ***Sediments and laves of the ocean basins***
- ***Marine fossil fuels***
- ***Marine Ore deposits***

Marine geoscientists aim to understand how and when the present ocean basins, the water that fills them and the biota that inhabit them were generated. Oceans are intimately connected with the atmosphere; circulation in each effects the other. The atmosphere and oceans exert a vital influence on global climate. A knowledge of the oceans is vital as the present oceans influence the redistribution of solar energy away from the equator, supply a significant amount of the world's food, act as sinks for carbon dioxide and modern and ancient oceans have produced much of the fossil fuel and mineral resources used by modern societies. The marine realm is still imperfectly understood and even more imperfectly managed in an environmental sense. Scientists who understand this huge part of the Earth's surface are needed to conduct research and to advise the increasing number of private and public groups who use the marine environment.

FIRST YEAR

Core: GEOS115 Earth Dynamics, Materials and the Environment
GEOS116 Marine Geoscience
GEOS117 Biophysical Environments
BIOL114 Evolution and Biodiversity

One from each line: CHEM102 or CHEM103
ATH130 or MATH135 or MATH136
GEOS112, PHYS140, PHYS143, PHYS159, STAT170, STAT171

SECOND YEAR

Core: GEOS216 The Atmospheric Environment
ELS201 Marine Science
GEOS260 Marine Depositional Environments

Plus at least 10 credit points from:
GEOS224 Introduction to field geology
GEOS235 Palaeontology
GEOS264 Geographic Information Systems
GEOS266 Earth Surface Processes
And any 200 level physics, chemistry or mathematics unit

THIRD YEAR

Core: ELS3YY Oceanography
ELS3XX Advanced Marine Science

Plus at least 12 credit points from:
GEOS301 Global Climates
GEOS312 Invertebrate Palaeontology
GEOS371 Geographic Information Systems: technical Issues
GEOS397 Applied Palaeontology and Biogenic Sediments
GEOS428 Coral Reef Dynamics
And any 300 level mathematics unit

These notes are only intended to guide your selection, and you should seek Academic advice and read the Calendar's Unit descriptions and coherencies for details. The offering of Units may change from year to year.

For more information please contact: The Executive Officer, Earth and Planetary Science
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Email: eps@mq.edu.au

MACQUARIE UNIVERSITY SYDNEY

Appendix 7: GEMOC postgraduate opportunities

Postgraduate scholarship information as well as a list of Scholarships currently open for application is available at: www.ro.mq.edu.au/HDRU/scholar.htm

POSTGRADUATE OPPORTUNITIES

GEMOC has a flourishing postgraduate research environment with postgraduate students from many countries (including France, Germany, China, Russia, USA 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 Excellence** (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** (Endeavour Scholarships): available to overseas students to cover tuition fees with a closing date in late August 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
- High-pressure experimental studies

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

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

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

AUSTRALIA'S INNOVATIVE UNIVERSITY

* 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

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Email: npearson@els.mq.edu.au

GLOSSARY

ACILP	Australia China Institutional Links Program
AGU	American Geophysical Union
AMIRA	Australian Mineral Industry Research Association
ANU	Australian National University
APA (I)	Australian Postgraduate Award (Industry)
APD	Australian Postdoctoral Fellowship
ARC	Australian Research Council
ARC LIEF	Australian Research Council Linkage Infrastructure Equipment and Facilities
ASAC	Antarctic Science Advisory Committee
CNRS	French National Research Foundation
CORES	Concentrations of Research Excellence
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 AccessMQ
EMP	Electron Microprobe
(D)EPS	(Department of) Earth and Planetary Sciences
EURODOC	The council for postgraduate students and junior researchers in Europe
FIM	Facility for Integrated Microanalysis
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
ICESAT	Ice, Cloud and land Elevation Satellite
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
MURDG	Macquarie University Research Development Grant
MURF	Macquarie University Research Fellowship
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
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
SGA	Society for Geology Applied to Mineral Deposits
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