



Special thanks to the contributing professors and AAG councilors who assisted with this focus issue of EXPLORE, a summary of those Universities around the world teaching courses in Exploration, Environmental, or Applied Geochemistry.

*If there are Universities which we missed in this issue, please send all the information to the editor
Chris.Benn@bhpbilliton.com for inclusion in a later issue of EXPLORE.*

“Who will deliver the last classical exploration geochemistry course?”

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The General Picture for Science Education in Australia

Over the last 15 years the number of students entering Australian universities (including UNSW) has jumped by over 50 %. These gains have mainly favoured non-scientific fields, apart from medical science. The physical sciences

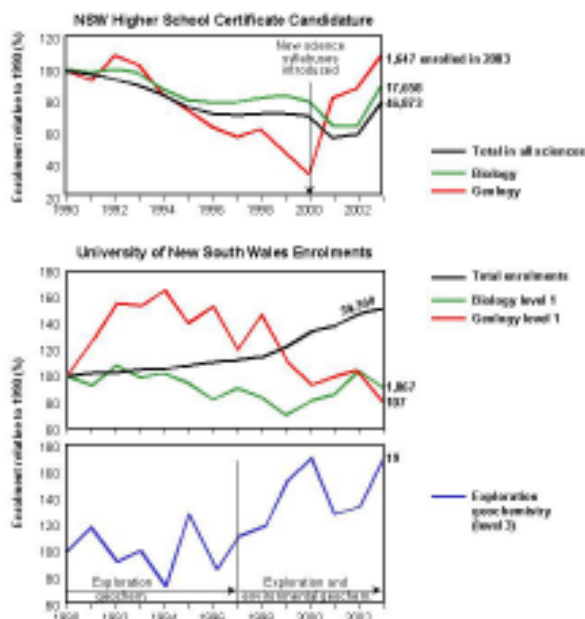


Figure 1 - Comparison of enrollments in science and selected disciplines in the NSW Higher School Certificate and at UNSW for the period 1990-2003, relative to 1990 enrollments. Actual enrollments for 2003 are also indicated.

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have experienced declining or static student enrolments in the face of, or maybe as a result of, a continued reduction in real funding provided to teach those disciplines. Many attribute declining enrolments to reduced numbers of students undertaking science in the latter years of high school. Whereas this is evident in the NSW Higher School Certificate (HSC) candidature over the period 1990–1999, there have been encouraging gains following the introduction of a new syllabus in science (Figure 1). However, to attract the weaker or numerically challenged students, new syllabuses have reduced the quantitative aspects of science and moved away from the study *of science* to the study *about science*, by exchanging social context for scientific content. NSW is possibly an anomaly in having had geology as a senior high school subject. The new HSC course on Earth and Environmental Science (E&ES), that replaced the moribund Geology course, has been well received by teachers and students and 1,700 were enrolled in 2003. Yet, for every student studying E&ES there are 10 students studying Biology. This proportion is likely to get worse for the geosciences* as few graduates with relevant geoscience background are re-entering the school system as teachers (even during the latest mineral industry recession). I suspect this is a common story in many countries.

At tertiary level, the geosciences face both a lack of general student demand for courses and continuing per capita funding reduction for teaching. The peaks in first

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Note: This EXPLORE article has been extracted from the original EXPLORE Newsletter. Therefore, page numbers may not be continuous and any advertisement has been masked.

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year geoscience enrolments in Australia of ~1,800 a year over the period 1994-1998 were only sufficient to generate ~400 third year and ~200 honours geoscience enrolments across the 27 Australian universities with geoscience programs. Honours enrolments over the last five years declined by 50%. In 2003, first year enrolments in biology at UNSW alone were equal to the total enrolment in *all* first year geoscience across *all* universities in Australia (Foden, 2003). Postgraduate enrolments leapt from 400 to nearly 600 between 1991 and 1994, but have since shown a slow decline (Foden, 2003). Academic staff numbers have also declined – quite rapidly in some Universities. A move towards more part-time and contract staff hides the real extent of staff losses. The decline in membership numbers and rise in the median age is also being felt in professional association and learned societies such as the AAG and Geological Society of Australia. For many geoscience schools the question arises as to whether a serious geoscience degree program (or major) will be deliverable with the resources available in the near future.

University administrators are well aware of the high cost of laboratories, support staff and fieldwork demanded by most of the sciences when planning undergraduate numbers. An honours student in biology or geoscience is usually a financial liability to the school (though an academic benefit) unless they continue on to a higher degree. Geoscience is not viewed as an essential science, and does not receive the partial protection afforded to the “enabling” sciences of physics and chemistry, mathematics as well as biology. A major science faculty without a physics or a chemistry school (or department) would be considered a joke – a science faculty without a geoscience may become the norm. Three universities in Australia have disestablished their geoscience schools – others have merged geosciences with other disciplines, such as geography or even biology. Enrolment trends suggest this contraction is not forcing geoscience students into a more limited number of universities – it is diverting them towards other sciences or out of science altogether. Allocating more research funds to virtual *centres of excellence* owned by a small number of universities may provide some protection for the geosciences, but actual concentration of geoscientists into a few institutions (research ghettos) will accelerate the demise of these disciplines.

Education is being shifted from a position at the centre of social and cultural development in Australia to just another sector of industry. If university enrolments in the geosciences drop then this is viewed as just a product of market forces. How can such a trend exist in a country that obtains over 50% of its export income from mining and for whom major environmental and economic challenges are water supply, groundwater pollution and soil salinity? Industry is acutely aware of the problem but incapable of effective action to preserve the extent of geoscience within the tertiary sector. Universities have been forced by government to become as ruthless in their economic

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rationality as the mining industry has been during the latest recession – they don't mine low-grade deposits and we don't teach small classes.

UNSW has one of the larger science faculties in Australia (350 academics, 300 support staff and nearly 5,000 students). Though comprising only 15% of UNSW academics, the Science Faculty generates over 30% of the annual UNSW research income and publications. Yet the physical sciences face severe staff cutbacks due to lack of undergraduate student numbers. With changing funding models within UNSW, undergraduate classes with less than 30 students or postgraduate classes with less than 25 face close scrutiny (i.e. the chop). This is not a problem for our biologists (more accurately the *molecular biologists*, according to my botany and zoology colleagues) who had nearly 300 students enrolled in a second year genetics course in 2003. No undergraduate geoscience course in Australian universities attracts such numbers, as far as I know. Exploration geochemistry has never exceeded 22 students at undergraduate level in its 25-year history at UNSW.

Science still excites people in the 21st century – TV has at least three channels devoted to it. Dinosaurs, big bangs, earthquakes, Mars exploration and human genome mapping stories all rate front page in newspapers. Students who undertake science generally enjoy the experience and science staff at UNSW receive a disproportionate number of teaching awards. Over 95% of UNSW geology graduates have found immediate employment or obtained postgraduate scholarship, even during the recent recession. What is the problem? The problem is possibly threefold:

- (i) the kudos once attached to being a scientist in the developed world has largely vanished,
- (ii) the job prospects in science are generally viewed as poor (in the long term) compared with medicos, lawyers or screen jockeys at the stock exchange,
- (iii) the quantity and quality of dedicated science teachers in high schools have dropped alarmingly.

Exploration and Environmental Geochemistry

If things are difficult for the geosciences, what of our cherished sub-discipline? *Exploration Geochemistry*, as loosely defined by the contents of Rose, Hawkes and Webb

(1984) or Levinson (1980) is becoming scarce in the university system – both in research and, therefore, in teaching. A Google search using the key words [*Exploration Geochemistry* + *University* + *Course* + .edu ± .ac] scored 300 hits, from which I could count 22 universities that offered (metals) geochemical exploration courses at undergraduate or postgraduate level. I should confess that this list no longer includes UNSW. The same search with [*Environmental Geochemistry* + etc] scored 3,400 hits and included >120 universities offering various environmental geochemistry courses. The answer to the longevity of our sub-discipline already lies in the name change from AEG to AAG – broaden our perspective to attract students to university courses, members to the association, delegates to conferences and experts from other disciplines into our orbit. Does the AAG have a strategic plan to entice students into its ranks?

At UNSW, enrollments in *Geochemical Exploration* hovered around 10 students until 1996 when the course changed to *Exploration and Environmental Geochemistry* after which enrolments increased to an average of 14. From 2004, this course will be entirely replaced by *Environmental and Contaminant Geochemistry*. Quell horreur! The reason for this change partly comes from the new alignment of Geology with Biology and Physical Geography into a new unified school (no departments) and the desire to provide better integration of these disciplines in both research and teaching. We must now address the needs and interests of a more disparate group of students and I have been reflecting on the statement of Einaudi (1994):

“Generalists with a high degree of competence have a longer half-life than specialists in today's unpredictable world (the half-life of an isotope geochemist is about 10 years). Enrolments can increase if you persuade students of the general applicability of studies in economic geology”

In line with this general philosophical approach, the number of courses offered to students at UNSW, across most faculties, has been significantly reduced under the principle of “teach less *better*”. There have also been moves to reduce the level of prescription in programs, hence course pre-requisites (computer control) are being gradually replaced by assumed knowledge (student responsibility). The educational philosophy is swinging towards providing a broad framework of content for each major discipline or cross-discipline, but developing more general *graduate attributes* that include a greater capacity for critical thinking and the ability to acquire knowledge and skills for oneself. In other words, teach key geochemical principals and skills well and let the content sort itself out (to some extent). As such, classical exploration geochemistry and many of the contaminant geochemistry courses that carry an “environmental geochemistry” label, should be viewed as mere extensions of the underlying broader discipline of **applied (low-T) geochemistry** (the purpose of our newly defined association).

The question we have had to consider is “what constitutes the core of applied geochemistry from which specific applications in the exploration or environmental games may be drawn?” This is worthy of much AAG debate

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(hint to webmaster) as part of the process of converting a name change to a true broadening of the association's scope and commitment to the various inhabitants of the applied geochemical world. Some of what I perceive "the core" to be is already well covered in most current exploration geochemistry courses, including low-T aqueous chemistry, sampling media selection and methodologies, analytical techniques, quality control. Where these courses are commonly limited is in the areas of organics (natural and anthropogenic) and the role of biota in geochemical processes (of interest to those working at the plant-soil-water interface). With suitable breadth of content, applied geochemistry will take its place at the centre of programs for students of the natural sciences (at both undergraduate and postgraduate levels), rather than the isolated regions inhabited by just economic geologists, and ensure a steady flow of new AAG members into the future.

I therefore pose the following question to all AAG members: "You have a new course titled '*Applied Geochemistry*', 56 hours of class and lab contact time, a TA and three days for fieldwork – what will you cover?"

Einaudi, M.T., 1994. *Future of Economic Geology in Academia*. Meyer Symposium on Compatibility of Mining and the Environment, GSA, Seattle, October, 1994.

Foden, J., 2003. A survey of the changing enrolment and staffing levels in the geosciences at Australian Universities since 1990. *The Australian Geologist*, 127:21-24.

*Attempts have been made to separate courses and programs with high geology content (geoscience) from courses that are principally physical geography, although the two commonly overlap.



Institution: Colorado School of Mines

Location: Colorado USA

Contributing Professor: Dr. Graham Closs

Course of Study: Exploration Geochemistry, Applied Geochemistry

Web Site: <http://www.mines.edu/academic/geology>

Colorado School of Mines (CSM) is a small, premier technical university located just west of Denver, Colorado at the edge of the Rocky Mountains. It has a focus on engineering and science disciplines related to resource development: exploration, production and environmentally responsible operation. A number of mining, petroleum and environmental firms are based in the area, as are several other universities and the United States Geological Survey. This setting provides access for field-based programs, supported by outstanding laboratory facilities, and an active geosciences community.

Research and courses in Exploration Geochemistry were initiated in 1955 by Professor Harold Bloom. He developed the colorimetric Cold Extractable Heavy Metals Test (CXHM), referred to as the "Bloom Test", for immediate, onsite analysis, thus contributing significantly to exploration effectiveness. These types of tests were the precursors to the current revised interest in selective extraction research.

Currently Graham Closs lcloss@mines.edu, has responsibilities for exploration geochemistry at CSM. He came to CSM after completing the program in Exploration Geochemistry at Queen's, followed by 5½ years experience as geologist/geochemist with the Ontario Government. His work in Ontario focused on problems of applying exploration geochemistry to the glaciated terrain of Northern Ontario. His interests include design and planning of surveys, applications of exploration/applied geochemistry to baseline studies and resource assessment problems, and geological data analysis. Specific topics are selected to meet industry's needs as their target commodities and exploration environments change over time.

In addition, Professor Sam Romberger sromberg@mines.edu is active in the field of hydrothermal geochemistry and acid rock drainage, and Professor Ron Klusman, rklusman@mines.edu focuses on gas geochemistry applications and has conducted baseline geochemical studies. Exploration Geochemistry has been a part of the economic geology program at the Colorado School of Mines for almost a half century.

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Recent and current exploration-related research topics include: laterite geochemistry in support of gold exploration in Venezuela, geochemical and fluid inclusion zoning in epithermal deposit systems, soil gas geochemistry related to volcanogenic massive sulfide and porphyry copper exploration, assessment of field portable X-ray Fluorescence instruments for exploration and environmental surveys, and geological data analysis techniques applied to data management, presentation and interpretation.

Exploration geochemistry is but one component of an interdisciplinary graduate Geochemistry Program that emphasizes the energy, minerals, and materials fields and their complex interaction with the environment. Faculty are drawn from the Geology and Geological Engineering and the Chemistry and Geochemistry Departments, and the Division of Environmental Sciences and Engineering. Specialties include both fundamental and applied research areas of geochemistry. Masters and PhD degrees, and non-thesis Masters degrees are offered. Project support has been provided by mining companies, government agencies and the individuals.

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Institution: Federal University of Rio de Janeiro

Location: Rio de Janeiro, Brazil



Contributing Professor: Dr. Claudio Gerheim Porto
Course of Study: Mineral and Petroleum Exploration, Environmental studies.
Web Site: <http://www.geologia.ufrj.br>

The teaching activities of the Geology Department of the Federal University of Rio de Janeiro are related to applied geochemistry and aim to provide knowledge to students at undergraduate and graduate levels that can be used in the areas of Mineral and Petroleum Exploration, and Environmental Studies. The following disciplines are offered:

1. Undergraduate level (BSc): Geochemistry, Organic Geochemistry, Geochemical Prospecting, Introduction to GIS.
2. Graduate levels (MSc and PhD): Regolith Geology in Tropical Terrains, Advanced Geochemistry, Petroleum Geochemistry, Introduction to Hydrogeochemistry, Isotope Geology, GIS Applied to Geological Resources

Research in the Geology Department has recently been granted US\$150,000 for a two-year project aiming to develop geochemical exploration strategies adapted to the regolith environments of the Amazon region. The grant has been

issued by the Mineral Fund from the Ministry of Mines & Energy and originates from mining taxes.

Partners include the Federal University of Pará (UFPA), State University of São Paulo (USP), State University of Campinas (Unicamp), the Geological Survey (CPRM), as well as a number of mining and exploration companies, including CVRD and Wheaton River.

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Institution: International Institute for Geo-information and Earth Observation



Location: Enschede in the Netherlands

Contributing Professor: Dr. Boudewijn de Smeth
Course of Study: Mineral Resource Exploration, Applied Geochemistry
Web Site: <http://www.itc.nl/education>

ITC, the International Institute for Geo-information and Earth Observation in Enschede in the Netherlands provides regular training courses, ranging from short courses to 18 month MSc. courses in a wide number of disciplines, to several hundreds of mid-career professionals every year. The students are mainly from developing countries. Entry requirements are at least a BSc. relevant for the opted course. ITC, which started in 1952, has over 15,000 alumni spread all over the world. Besides education, the Institute is involved in research (currently 50 PhD candidates) and consulting activities world wide.

All ITC courses are organized in modules of three weeks. These consist of core modules on GIS and RS, programme modules, specialization modules, and elective modules. Most course participants come for the 18 months MSc programme or the 12 months professional masters programme but also for a short course of a few modules or just a single module. Full information on courses, course content, timing, costs etc. can be found on the ITC web site: <http://www.itc.nl/education>

The six educational programmes cover a wide range of topics in which applications of GIS and Remote Sensing methods form the common factor. Within two educational programmes, Applied Geochemistry is a topic in the Water Resources and Environmental Monitoring programme (WREM) and in the Earth Resources and Environmental Geoscience programme (EREG). Each programme has several specialisation courses. The objective of teaching applied geochemistry in these courses is to create understanding of how to use it appropriately and correctly when solving problems in hydro-geochemistry, exploration geochemistry and environmental geochemistry. Specialisation courses which have most components of applied geochemistry are the Mineral Resource Exploration (EREG) course and the WREM specialisation courses.

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Teaching geochemical topics in class is combined with several weeks of practical training in the field in Spain, Portugal, Kenya or elsewhere and chemical or physical analysis at the ITC Geochemical, Water and Soil Laboratory. Field training involves sampling methods at various scales, determination of major water quality parameters in the field or field-lab., mineral determination with portable infrared equipment, gamma-ray spectrometry, digital field data capture, ground checking multi- and hyper-spectral remote sensed data as well as excursions to organisations, mines and industry. The ITC laboratory is adequately equipped with sample preparation equipment and spectrometers (AAS and ICP-AES) for the purpose of training and research support but not for massive data production. Quality control is an important aspect in the student training. During the elective module periods, students from all different programmes can choose from a wide array of topics among which there is one module specifically in Applied Geochemistry and one on Hydro Geochemistry.

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Institution: Queen's University

Location: Ontario, Canada



Contributing Professor: Dr. Graham Closs, Kurt Kyser
Course of Study: Mineral Exploration, Applied Geochemistry

Web Site: <http://www.queensu.ca>

Exploration Geochemistry was initiated at Queen's University in 1969 by Professor Ian Nichol following recognition that research and trained geochemists familiar with problems associated specifically with Canadian conditions were needed. Nichol had previously been associated with Professor John Webb's program at Imperial College, London. Thirty-five post-graduate research programs were completed under his direction between 1969 and 1998. Support was provided by individual mining companies, consortia of companies, commercial laboratories and government agencies. Topics addressed were initially focused on Canadian problems: glacial geology/drift prospecting, lake sediment geochemistry, lithogeochemistry applied to volcanogenic massive sulfide exploration, uranium exploration geochemistry, gold exploration geochemistry and associated sampling issues, selective extraction, and data analysis and interpretation. As the Canadian mining industry adopted more global focus, so too did the topics addressed by this group. Projects were completed in Australia, Thailand, the USA, Chile and China. Graduates have gone on to senior positions in industry, government, private practice, and universities.

Exploration Geochemistry has been an integral component of the non-thesis QMINEX Masters mineral exploration program since its inception in 1975. To date, over 120 students have completed this program.

Professor Kurt Kyser kyser@geol.queensu.ca joined the

Queen's faculty in 1995 and is carrying on responsibilities for exploration geochemistry. Kyser was previously associated with the USGS and the University of Saskatchewan. In 1997 he established the Stable Isotope and ICP-MS Laboratory at Queen's. It has continually evolved as a state-of-the-art research facility housing some of the most technologically advanced equipment in Canada, including the recently acquired High Resolution ICP-MS. From this base he has been involved in a broad range of problems spanning the earth, biological and environmental sciences.

In the natural resources area, his collaborative and multidisciplinary research interests range from property scale evaluation to issues of regional area selection. Examples of recent exploration research projects include: (1) development of continuous leach (CL)-ICP-MS analysis to identify specific sites and mineral phases from which elements are being released, and hence anomaly screening, (2) evaluation of N and S isotopes in soils as a guide for regional exploration in northern Chile, (3) determination of metal content and stable isotopes in tree rings for both exploration and environmental application, and (4) use of Pb-isotope ratios in sandstones near areas of unconformity-related uranium deposits in Australia as guides for exploration. He and his team are demonstrating the value of these *recently* available and powerful isotope geochemistry tools to the future of mineral exploration.

In addition, two other faculty members have interests in applied geochemistry. Professor Heather Jamieson's jamieson@geol.queensu.ca research is in the area of environmental geochemistry, focusing on the impact of mining on the environment. Professor Victoria Remenda's remenda@geol.queensu.ca research in hydrogeology employ groundwater tracers including stable isotopes of water and major, minor and trace gases.

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Institution: Seoul National University

Location: Seoul, Korea

Contributing Professor: Prof. Hyo T. Chon, Professor of Applied Geochemistry

Course of Study: Exploration and Environmental Geochemistry.

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Institution: Technische Universität Bergakademie Freiberg

Location: Freiberg, Germany

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Course of Study: Applied and Environmental Geochemistry
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Freiberg is still one of the strongest universities of Germany in the Earth Sciences. Geochemistry is offered for students of all directions in the Earth sciences. We currently have three professors (chair plus 2 associate) for Applied and Environmental Geochemistry, Analytical Geochemistry and Isotope Geochemistry. Our labs feature the whole range of facilities except for detailed organic analysis. Respective techniques are taught in collaboration with the chemical department. Our research is also strongly focused on applied and environmental geochemistry, well reflected by our publications.

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Institution: University of Michigan

Location: Michigan, USA

Contributing Professor: Dr. Stephen Kesler
Course of Study: Exploration and Environmental Geochemistry
Web Site: <http://www.geo.lsa.umich.edu/>



The Department of Geological Sciences at the University of Michigan has an active program in all aspects of geochemistry. Ongoing research relevant to exploration

and environmental geochemistry includes work on:

- 1) fractionation of heavy stable isotopes, especially mercury, in ore deposits, sedimentary rocks, and biological materials,
- 2) the oxidation state of magmas related to porphyry copper mineralization and their role as a guide to fertile intrusions,
- 3) the setting of gold in arsenian pyrite and its role in formation of epithermal deposits,
- 4) base and precious metal geochemistry of igneous minerals as an indicator of concentration processes during magmatic differentiation, and
- 5) geochronologic constraints on unroofing of base and precious metal deposits in convergent margin terranes.

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Institution: University of Nevada, Reno

Location: Nevada, USA



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Course of Study: Geochemistry
Web Site: www.mines.unr.edu/geology/

The Geochemistry program at the University of Nevada, Reno at present has four full-time faculty plus a number of research, affiliated and adjunct faculty with offices in the Mackay School of Earth Sciences and Engineering. Our course offerings range from theoretical (e.g., Isotope Geochemistry; Geochemical Modeling) to applied (e.g., Environmental Geochemistry, Hydrothermal Geochemistry). Ongoing research includes application of a wide variety of techniques to the understanding of earth and ocean processes. We have active research projects in environments ranging from high-temperature geochemistry (e.g., volcanic and hydrothermal processes) to low-temperature and environmental geochemistry (e.g., contaminant fate and transport). The Nevada Bureau of Mines and Geology and the US Geological Survey Reno Field Office are housed within the same building complex and there is significant interaction among the groups. The Desert Research Institute (a research branch of the University and Community College System of Nevada) is located just north of main campus and provides additional opportunities for interdisciplinary geochemical research.

Examples of some recent and ongoing research projects include:

- ❖ Stable isotope geochemistry of hazardous organic contaminants: sources and behavior in ground water
- ❖ Geothermal system geochemistry & hydrology
- ❖ Carbonate vein geochemistry in and around Carlin-type hydrothermal systems

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- ❖ Trace metals in geothermal systems as a discriminator between magmatic and extensional systems
- ❖ Fluxes of trace gases (mercury and volatile organics) in the environment and global mercury cycles
- ❖ Surface chemistry and dissolution rates of minerals
- ❖ Elemental and isotope geochemistry of hydrothermal carbonates and implications for fluid flow in the crust
- ❖ Oxidation rates of arsenic sulfides
- ❖ Paleoclimate on a long-term timescale using stable isotopes of geothermal and fossil geothermal systems
- ❖ Tephrochronology of Tertiary Great Basin rocks
- ❖ Thermochemical profiling of fossil hydrothermal systems using low-temperature geochronology and stable isotope geochemistry
- ❖ Crustal architecture of the Great Basin elucidated from stable isotope geochemistry of plutons
- ❖ Experimental studies of gold bisulfide reaction with activated carbon
- ❖ Aqueous geochemistry of pit lakes forming at active and abandoned mine sites
- ❖ Sediment diagenesis, marine and lake sediment geochemistry and paleoceanography

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Institution: University of New South Wales **Location: New South Wales, Australia**

Contributing Professor: Dr. David Cohen
Course of Study: Applied Geochemistry
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Institution: University of Pretoria **Location: South Africa**

Contributing Professor:
Prof. H. F. J. Theart, Department of Geology
Course of Study: Environmental Geochemistry
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Applied geochemistry is alive and well at the University of Pretoria, South Africa.

We teach a course in Environmental Geochemistry, as a module required for the degree BSc Environmental and Engineering Geology, in addition to the standard chemistry

courses these students need to do. The general objective of this four-week module is to create an understanding of the interactions between the pollutants produced by Man and the geological environment, especially groundwater. The course comprises formal lectures to give the students a sound background of low temperature geochemistry, solute transport in groundwater, sampling methods, experimental techniques and statistical analysis of gathered data. In addition, the students are given individual assignments emphasizing the dynamic student-centered and co-operative learning approach of this module — creating creative thinking, communication, and interpersonal skills as well as group dynamics.

At the end of this module the students should have

- Knowledge and understanding of different pollutants, their origin, characteristics and properties,
- The ability to describe the interaction amongst pollutants, the subsurface and groundwater,
- Knowledge and understanding of different site investigation techniques,
- The ability to design and implement a monitoring programme for a contaminated site,
- The ability to evaluate possible remediation options and to select the best option.

During the fourth year training programme for BSc Hons Geology, Exploration Geophysics, and Environmental and Engineering Geology students, Exploration geochemistry is taught as an important component of a module on exploration techniques. Here the students are introduced to the fundamental principles governing geochemical dispersion in the primary and secondary environments as applied to litho-, stream-, and soil-geochemical surveys. Quality control, data processing and anomaly detection are also addressed. In addition, the students are given individual assignments to develop their ability to apply the concepts taught.

Mineral and rock chemistry, including major and trace elements as well as isotope geochemistry, as applied in igneous and metamorphic petrology and mineral beneficiation for the mining industry, is taught in various courses throughout the BSc Geology programme and in courses designed for metallurgical and mining engineering students. Advanced training in this regard is provided in the course work for the MSc Applied Mineralogy.

Current research in the department on related topics includes a study on the geochemical detection of base-metal sulphide deposits covered by calcrete and sand in arid environments. A main area of focus within the Centre for Research on Magmatic Ore Deposits (CERMOD) is the research on the geochemical behaviour of the PGE's related to base metal sulphides and their host rocks. Also, the use of mineral and whole rock chemistry to detect areas associated with low PGM flotation recovery within the UG2 chromitite layer of the Bushveld Complex is being investigated. The Department of Geology maintains well-equipped laboratories for graduate teaching and, in combination with this, it also runs more sophisticated research equipment. It hosts XRF, XRD (including a

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precession single crystal camera) and EMP equipment, a modern heat flow calorimeter for cement development studies, and a high temperature experimental laboratory for sulphide research. These facilities are augmented by local collaboration with sister departments in the University of Pretoria, the Council for Scientific and Industrial Research's Water Research Unit, the Nuclear Energy Cooperation of South Africa, and the South African Police's forensic laboratory. In this way researchers and students have access to a wide range of equipment including micro-Raman spectroscopy; scanning, emission and transmission electron microscopy; single crystal XRD; atomic absorption spectroscopy; atomic force microscopy; and image analyses microscopy.

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Institution: University of the Western Cape Location: Bellville, South Africa



Contributing Professor: Professor Charles Okujeni
Course of Study: Applied Geochemistry
Web Site: www.uwc.ac.za

The applied geochemistry programme in the Department of Earth Sciences, University of the Western Cape was initiated in 1997 and funded through the Anglo American Chairman's funds, AngloGold and the Mineral Education Trust Funds (METF). The programme is being coordinated by Prof. Charles Okujeni.

Introductory courses to geochemistry and exploration geochemistry are taught at 2nd and 3rd year respectively and cover basic principles including lithogeochemistry, hydrogeochemistry, surficial equilibria and isotope geochemistry etc. Further post graduate lectures on geochemical concepts and exploration geochemistry cover various aspects of methodology, application of geochemical techniques as well as case studies.

Research has mainly focussed on regolith and lithogeochemistry. The main project area is the Kraaipan Greenstone Belt in the Northern Province of South Africa. There are currently 2 Ph.D, 4 M.Sc and 2 Honors student currently enrolled in the programme; other Ph.D and M.Sc students are also being co-supervised with the chemistry department on various environmental geochemistry projects.

Research activities have been constrained by limited infrastructure of research. A marked change is anticipated when our XRF and a GFAAS will be commissioned in 2004.

Contact: Charles Okujeni
Email: cokujeni@uwc.ac.za

Institution: Acadia University Location: Wolfville, Canada



Contributing Professor: Professor Cliff Stanley
Course of Study: Applied Geochemistry
Web Site: www.acadiau.ca

Acadia University, located in Wolfville, Nova Scotia, Canada, offers both B.Sc. and M.Sc. programs in Geology and Environmental Geoscience. The university has approximately 4000 students, is regarded as one of the top liberal arts universities in Canada, and possesses a very strong geology program. The Dept. of Geology consists of 6 professors and graduates, 12-15 undergrads, and 2-4 graduate students per year. Amongst the courses offered are a range of applied geochemistry, economic geology, and related courses:

Undergraduate Courses

Introduction to Geochemistry
Exploration and
Environmental Geochemistry
Mineral Deposits
Mineral Exploration
Exploration Geophysics

Graduate Courses

Geochemical Material Transfer
Advanced Economic Geology
Advanced Exploration and
Environmental Geochemistry

Applied geochemistry research at Acadia is undertaken through B.Sc. Honours and M.Sc. thesis projects. These are largely under the direction of Dr. Cliff Stanley, although Dr. Ian Spooner (glacial geology) and Dr. Sandra Barr (igneous petrology) have collaborated in supervising applied geochemistry thesis projects.

Dr. Stanley's research interests include lithogeochemistry, numerical applications in geochemistry, till geochemistry and biogeochemistry. Recent, ongoing and future research projects involving geology honours and masters students at Acadia University include:

Heavy metal uptake in *Salix* as a potential phyto-remediation agent (*B.Sc. honours environmental science student Sandi MacPherson*)

Speciation of Zn in stream sediments of the Antigonish Highlands, Nova Scotia (*B.Sc. honours geology student Charlie Moore*)

Au uptake in *Eucalyptus salmophloia* (*B.Sc. honours environmental science student Rebecca Schaefer*)

Au precipitation mechanisms at the Callie Gold Mine, Northern Territory, Australia (*B.Sc. honours geology student Jeffery Bigelow*)

Lithogeochemistry of the Fimiston Lode, Kalgoorlie, Western Australia (*M.Sc. geology student Tansy O'Conner-Parsons*)

Glacial dispersion of Li from a spodumene pegmatite, Yarmouth Country, Nova Scotia (*M.Sc. geology student Andrea Locke*)

Igneous petrology and lithogeochemistry of the Mechanic Settlement layered intrusion, Sussex, New Brunswick (*M.Sc. geology student Russel Heibert*)

Focus on: Academic Institutions... continued from page 25



Institution: Jilin University Location: China

The Department of Geochemistry of Jilin University was established in 1995, based on the original Geochemical Staff Room founded in 1961 and Geochemical Expecting Staff Room founded in 1964. At present, the Department includes Geochemical Research and Teaching Center, Resource and Environment Research and Teaching Center and attached laboratory. The Department has 1 undergraduate program offering BSc degree, 2 MSc graduate programs and 1 PhD graduate program. They are listed as follows.

Undergraduate program: Exploration and Engineering: Applied Geochemistry

MSc program: Geo-Exploration and its Information Technology: Applied Geochemistry

Nuclear Technology and Application

PhD program: Geo-Exploration and its Information Technology: Applied Geochemistry

Currently there are 17 academic staff members in the Department, among which 6 are professors, 4 are associate professors, and 2 laboratory assistants in the Department. Professor Hao Libo is the department head.

At present the research works we are carrying out include regional geochemistry and environmental geochemistry funded by the Ministry of Land and Resources and Ministry of Science and Technology. Tel: 86-0431-8502441 Fax: 86-0431-8524544

Major and Main Courses

Undergraduate

Introduction to Exploration and Engineering: Applied Geochemistry. The characteristic of the major is that the students who study Exploration and Engineering: Applied Geochemistry not only master the theories of applied

geochemistry and environmental science, but also have the power to solve the problems with the geochemical theory.
Main Courses: Introduction to Earth Science • Introduction to Environmental Science • Theory of Geochemistry • Theory of Geophysics • Applied Geochemistry • Environmental Geochemistry • Instrument Analysis Technology • Processing and Explanation of Geochemical Data • Applied Geophysics • Multivariate Statistical Analysis • Analytical Chemistry Experiment.

MSc Graduate: Geo-Exploration and its Information Technology: Applied Geochemistry

Main Courses: Applied Geochemistry • Special Subject of Applied Geochemistry • Trace Element and Isotope Geochemistry • Geochemical Data Processing • Modern Geochemical Sample Analysis

Nuclear Technology and Application

Main Courses: Isotope Geochemistry

PhD Graduate: Major Geo-Exploration and its Information Technology: Applied Geochemistry

Main Courses: Existing Status Theory of Element • Theory and Methods of Survey Geochemistry • Special Subject of Applied Geochemistry • Regional Geochemical Survey and Evaluation.

Professor Hao Libo

Survey Geochemistry/Environmental Geochemistry

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Professor Ji Hongjin, Survey Geochemistry

AddressE_mail: jih_j@sina.com.cn Tel: 86-431-8502441

Professor Zhou Yongchang, Survey Geochemistry

College of GeoExploration Science and Technology

Jilin University, Xi Min Zhu Street, Changchun 130026 China

Professor Zhong Chongxue, Survey Geochemistry

College of GeoExploration Science and Technology

Jilin University, Xi Min Zhu Street, Changchun 130026 China



University	Country	Professor	Field of Study	Web Site
University of New South Wales	Australia	Dr. D. Cohen	Applied Geochemistry	http://www.unsw.edu.au
Federal University of Rio de Janeiro	Brasil	Dr. Claudio Porto	studies	http://www.geologia.ufri.br
Acadia University	Canada	Dr. C. Stanley	Geology	http://www.acadiau.ca
Queen's University	Canada	Dr. Kyser	QMINEX mineral exploration, Applied Geochemistry	http://www.queensu.ca
Jilin University	China	Dr. Xueqiu Wang	Exploration Geochemistry	
Freiberg	Germany	Dr. Jörg Matschullat	Applied and Environmental Geochemistry	http://www.ioez.tu-freiberg.de
Seoul National University	Korea	Prof. Hyo T. Chon	Exploration and Environmental Geochemistry	http://gong.snu.ac.kr/~envilab
International Institute for Geo-information and Earth Observation	Netherlands	Dr. Boudewijn de Smeth	Mineral Resource Exploration, Applied Geochemistry	http://www.itc.nl/education
University of Pretoria	South Africa	Prof. H. F. J. Theart	Exploration and Environmental Geochemistry	http://www.up.ac.za/academic/geol/Welcome.html
University of the Western Cape	South Africa	Pro. C. Okujeni	Applied Geochemistry	http://www.uwc.ac.za
University of Barcelona	Spain	Dr. M. Viladevall	Exploration and Environmental Geochemistry	http://www.ub.edu/gpgp/
Abersytwth University	UK	Dr. R. Fuge	Applied and Environmental Geochemistry	
Bristol University	UK	Prof. Wood	Organic and Experimental Geochemistry	
Cardiff University	UK	Prof. D. Rickards	Applied and Environmental Geochemistry	
Imperial College	UK	Prof. I. Thornton	Applied and Environmental Geochemistry	
Leeds University	UK	Prof. R. Raiswell	Applied and Environmental Geochemistry	
Leicester University	UK	Dr. C. Moon	Environmental and Exploration Geochemistry	
Manchester University	UK	Prof. C. Curtis	Pure and Applied Geochemistry	
Newcastle University	UK		Organic Geochemistry	
Reading University	UK	Dr. A. Parker	Environmental Geochemistry	
Royal Holloway College	UK	Prof. Mather	Environmental Geochemistry	
Sheffield University	UK	Dr. S. Banwart	Environmental Geochemistry	
Southampton University	UK	Dr. I. Croudace	Marine Geochemistry	
Colorado School of Mines	USA	Dr. G. Closs	Exploration Geochemistry	http://www.mines.edu/academic/geology
University of Michigan	USA	Dr. S. Kesler	Exploration and Environmental Geochemistry	http://www.geo.lsa.umich.edu/
University of Nevada, Reno	USA	Dr. Greg B. Arehart	Geochemistry	http://www.mines.unr.edu/geology/