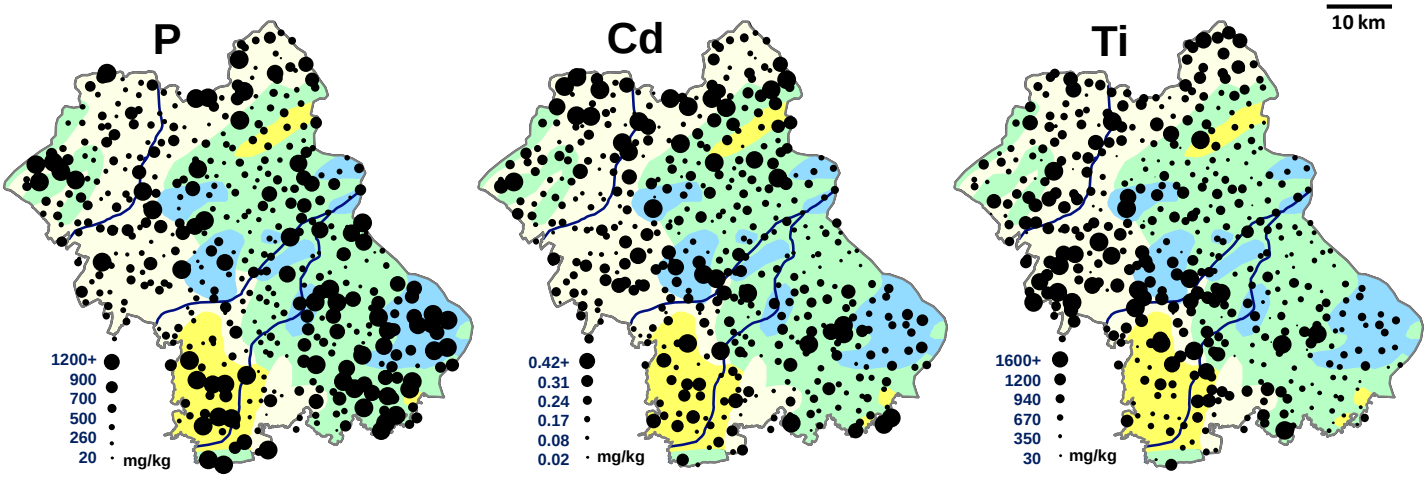
THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE

SCHOOL OF BIOLOGICAL, EARTH and ENVIRONMENTAL SCIENCES



GEOS3281
Applied Geochemistry

Session 1, 2018

Course Manual

A/Prof David Cohen

SCHOOL OF BIOLOGICAL, EARTH and ENVIRONMENTAL SCIENCES

GEOS3281

Applied Geochemistry

Session 1, 2018

6 units of credit

Important Dates

WEEK	DAY	DATE	DETAILS
Wk 5	Friday	30 Mar	Laboratory Assignment #1 (geochemical mapping) due
Wk 6	Friday	13 Apr	Laboratory Assignment #2 (quality control) due
Wk 6	Saturday	14 Apr	Fieldwork – Sunny Corner, near Lithgow (all day)
Wk 8	Friday	27 Apr	Laboratory Assignment #3 (aqueous modelling) due
Wk 9	Friday	4 May	Laboratory Assignment #4 (isotopes) due
Wk 11	Friday	18 May	Sunny Corner fieldwork report due
Wk 12	Friday	25 May	Laboratory Assignment #5 (mineral exploration) due
Wk 13	Monday	29 May	Short essay due

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1 INFORMATION ABOUT THE COURSE

1.1 General

Year of Delivery	2018
Course Code	GEOS3281
Course Name	Applied Geochemistry
Academic Unit	School of Biological, Earth and Environmental Sciences
Level of Course	III (undergraduate)
Units of Credit	6
Session(s) Offered	S1
Assumed Knowledge, Prerequisites or Co-requisites	**Prerequisites:** GEOS1111 or GEOS1211 or GEOS1701 or lvl 1 CHEM **Assumed knowledge:** Geology: Basic mineralogy and lithology; introductory ore deposits. Chemistry: HSC-level knowledge of the periodic table; bonding; pH-Eh, redox and acid-base reactions. Maths: Basic statistics (e.g. MATH1041 or BEES2041).
Hours per Week	4 (including one-day field trip to Sunny Corner)
Number of Weeks	12
Commencement Date	Tuesday, Mar 6

Summary of Course Structure (for details see 'Course Schedule')

Component	HPW	Time	Day	Location
Lecture	2	3 – 5 pm	Tuesday	Matthews C
Laboratory	2	1 – 3 pm	Thursday	BioSci G29
Field trip	1 day	7 am – 6 pm	Tbc	Sunny Corner
Total	4			
Special Details	There is no disabled access or any other facilities at Sunny Corner			

1.2 Staff Involved in the Course

Staff	Role	Name	Contact Details	Consultation Times
Course Convenor		A/Prof David Cohen	Rm 202, Chancellery d.cohen@unsw.edu.au	tba
Additional Teaching Staff	Lecturers	Prof Anita Andrew Dr Mira van der Ley		
	Demonstrators	Lauren Coyle Eric Chen		
	Technical staff			

1.3 Course Details

Course Description[1] (Handbook Entry)	***Overview*** The modern world is highly dependent on mineral resources, with a need to maintain exploration programs for new deposits. A consequence, however, of industrialisation, new technologies and population growth has been the progressive contamination of the environment, especially in urbanised regions. Metals and carbon have been relocated from parent rock to the surface environment and atmosphere, along with a wide variety of natural and synthetic organics. Geochemical surveys and modelling are important components in the discovery and use of resources, sustainable development and controls or remediation of environmental pollution. *Geochemistry* is a broad discipline grouping that integrates the knowledge and skills derived from various areas of science to investigate the source, fate and geochemical behaviour of various materials and the processes involved in geochemical systems operating in natural and human-altered environments. ***Scope*** This course examines the characteristics, source and fate of metals and other chemical species in natural and urban environments. Primary and secondary dispersion of elements and weather processes. Principles of vapour, water, soil, drainage sediments, rocks and vegetation geochemistry as applied to environmental assessments and mineral exploration; aqueous geochemistry and contaminant modelling, with reference to Australian case studies. Introduction to sampling, analytical techniques and design of environmental surveys. *Note: Fieldwork of 1 day duration will involve geochemical surveys at a contaminated site and students may incur some personal costs.*
Course Aims[2]	The course provides students an introduction to the fundamental concepts and processes relating to geochemistry of surface environment with applications in environmental and exploration geochemistry. It provides an introduction to the design, implementation and interpretation of results from geochemical surveys and their use in fields ranging from environmental management to mineral exploration.
Student Learning Outcomes[3]	**Domains:** Fundamental principles → Survey design and implementation → Data modelling and interpretation →Environmental policy and management; mineral exploration *Acquisition of knowledge* → *Application to theory* → *Application to practice* → *Communication to others* Lab and fieldwork will provide practical skills in a range of geochemical methods. The course also emphasises the development of: • Oral presentational skills, report and essay writing • Project planning and management, including data handling • Group working, co-ordination and delegation The various assignments will test the knowledge and understanding of geochemical processes and effects in the surficial environment, with a focus on geological sources of metals, as well as the urban environment. Practical skills in conducting field surveys, laboratory tests and data analysis will also be developed and tested in the course, as will oral and writing skills at communicating the results. The course will emulate the type of professional activities that students might be expected to undertake on graduation. Specifics are set out in the table below.

[1] UNSW Virtual Handbook: http://www.handbook.unsw.edu.au/2008/index.html
[2] Learning and Teaching Unit: http://www.ltu.unsw.edu.au
[3] Learning and Teaching Unit – Learning Outcomes: http://www.ltu.unsw.edu.au/content/course_prog_support/outcomes.cfm?ss=0

1.4 Knowledge, Understanding and Skills

(based on material from the University of Reading)

Knowledge and Understanding

A. Students will develop knowledge and understanding of:

1. The nature of geochemistry as a discipline
2. Relevant fundamentals of inorganic, organic and aqueous geochemistry
3. Geochemical cycles, transportation of contaminants
4. Data acquisition, data processing methods and geochemical mapping
5. Processes in the surface and near-surface environment, including interactions between the solid Earth, hydrosphere, atmosphere and biological agents, including man.
6. Environmental systems and issues
7. Applications of geochemistry in mineral exploration and environmental sciences
8. Selected case studies provided by staff and other students
9. Fieldwork safety issues and procedures

Teaching and learning methods

The framework will be provided by the lectures and directed readings, together with student seminars and practical exercises. Students will be directed towards appropriate references in the library and on the web and will be expected to undertake their own program of reading and reflection. Students will investigate some topics in depth as preparation for their essay and seminar, and this may be selected in view of future areas of specialization (e.g. honours projects).

Assessment

Knowledge will be tested through the reports and exercises.

Skills and other attributes

B. Students will improve their intellectual skills by:

1. Thinking logically and critically in a scientific manner
2. Undertaking study and investigations in areas of science outside those immediately familiar
3. Analysing and interpret environmental data, recognizing theoretical and practical limitations to the analysis and potential issues and problems
4. Organising tasks ranging from practical work to seminar presentations
5. Appreciating the current state of knowledge of the environment

C. Students will develop further their practical skills by:

1. Accurately observing, recording and interpreting earth materials and geochemical data
2. Acquiring geochemical and other data analysis skills using a variety of techniques
3. Conducting practical geochemical projects
4. Carrying out a risk assessment for fieldwork in a given area.

D. Transferable skills

1. Use of IT, including resource searching
2. Communicate scientific ideas in various formats
3. Work as part of a team

Teaching/learning methods and strategies

Intellectual skill development is embedded throughout the course, but is specifically addressed in a number of the topics and tasks. The ability to integrate and apply concepts and principles from one area of the subject to another are intrinsic to high-level performance in the program.

1.5 Graduate Attributes Developed in this Course[4]

Science Graduate Attributes[5]	Level of Focus *1 = minimal* *2 = minor* *3 = major*	Activities / Assessment
Research, inquiry and analytical thinking abilities	*3*	Literature reviews and critique of papers Design, conduct and interpretation of results of field and laboratory work
Ethical, social and professional understanding	1	Role of geosciences in environmental management and resources
Communication	2	Essay, seminar and two major reports on field and laboratory work
Teamwork, collaborative and management skills	3	Field and laboratory work
Information literacy	2	Use of information resources for essay and seminar

Major Topics (Syllabus Outline)	**See schedule below and Moodle**
Relationship to Other Courses within the Program	The course is an option within earth science plans, with particular relevance to students undertaking environmental science or resource geology. The course is supported by: level 1 courses in GEOS and CHEM GEOS2181 Earth Materials The course is complementary to the following courses: GEOS2291 Earth Interconnections GEOS2721 Aust Surface Environments and Landforms GEOS3141 Mineral and Energy Resources GEOS3911 Environmental Impact Assessment CHEM3041 Analytical Chemistry CHEM3311 Environmental Chemistry

[4] Access the contextualised Science Graduate Attributes and your mapped courses: http://www2.science.unsw.edu.au/guide/slatig/sciga.html (Mapped courses are available at this site)

1.6 Rationale and Strategies Underpinning the Course

Teaching Strategies	The structure of the course is built around the lectures and associated readings indicated by the staff. This content will be supplemented by the student seminars on diverse geochemical topics. The concepts discussed in the lectures are then reinforced through both the laboratories and the fieldwork.	
Rationale for learning and teaching in this course[5],	**Guidelines on teaching:**	***Application to course:***
	1. A climate of enquiry should be developed where students fell challenged	*1. Emphasis of the complexity of geochemical systems – what is known and what is not known*
	2. Activities should be interesting and challenging	*2. Fieldwork involves students in planning. Focus on practical experiences.*
	3. Material must be perceived as relevant to future study or professional practice	*3. Lab and field exercises are based on typical projects that young professionals would undertake.*
	4. There must be dialogue/ interaction between lecturers and students	*4. Some of the teaching (especially labs) will follow a classical Greek dialectic approach*
	5. There should be multiple teaching methods	*5. Lectures, labs, fieldwork, readings*
	6. Goals, outcomes and requirements of the course must be clearly articulated	*6. The relevance of each topic and the purpose and outcomes of the prac work will be discussed*
	7. Students are to be encouraged to take responsibility for own learning	*7. Essays and seminars require students to undertake largely undirected lit. review; students to determine nature of data analysis to be performed on prac data*
	8. Broad graduate attributes must be developed	*8. See above*
	9. Co-operative work with peers assists learning	*9. Much of the work is group-based, though reporting is individual (no exam)*
	10. There must be informative and timely feedback to students on progress.	*10. See how we go with the shortened term.*

[5] LTU – Teaching Philosophy: http://www.ltu.unsw.edu.au/content/teaching_support/teaching_portfolio.cfm?ss=0#putting

1.7 Course Schedule

Wk	Date	Tuesday 3:00 - 5:00 pm	Lecture			Date	Thursday 11:00 am - 1:00 pm	Lab			Assig
		Topic	*Staff*	*Form*	*Rm*		*Topic*	*Staff*	*Form*	*Rm*	*Due*
2	6-Mar	Introduction to the course; Rocks to regolith	**DRC**	Lect	Matt C	8-Mar	*Regolith geochemistry exercise*	**DRC**	Lab	Biosci Teach Lab 5	
3	13-Mar	Soil and stream geochemical processes	**DRC**	Lect	Matt C	15-Mar	*Introduction to ARC-GIS and Geochemical mapping - Assignment #1*	**DRC MvdL LC**	Lab	BioSci G29	
4	20-Mar	Chemical processes in water and contaminants	**DRC**	Lect	Matt C	22-Mar			Lab	BioSci G29	Fri 30 Mar
5	27-Mar	Sampling, Analysis and QC	**DRC**	Lect	Matt C	29-Mar	*Analytical quality control - assignment #2*	**DRC**	Lab	BioSci G29	Fri 13 Apr
	3-Apr	**MID SESSION**				5-Apr	**MID SESSION**				
6	10-Apr	Acid mine drainage and other mining pollutants	**MvdL**	Lect	Matt C	12-Apr	*Aqueous modelling; Minteq or Phreeq- assignment #3*	**DRC**	Lab	BioSci G29	Fri 27 Apr
	14-Apr	**Sunny Corner field excursion (7.30 am - 6.00 pm)**						**DRC MvdL EC**	Field	BioSci G29	
7	17-Apr	The Periodic Table - a tutorial	**MvdL**	Lect	Matt C	19-Apr	*Stats exercise*	**MvdL**	Lab	BioSci G29	
8	24-Apr	Isotope applications	**AA**	Lect	Matt C	26-Apr	*Isotope - assignment #4*	**MvdL**	Lab	BioSci G29	Fri 4 May
9	1-May	Geochemical mapping and urban geochemistry	**DRC**	Lect	Matt C	3-May	*Group work on Sunny Corner dataset + report - assignment #5*	**DRC MvdL**	Lab	BioSci G29	Fri 18 May
10	8-May	Geochemistry in mineral exploration	**DRC**	Lect	Matt C	10-May					
11	15-May					17-May	*Mineral exploration - assignment #6*	**DRC MvdL**	Lab	BioSci G29	Fri 25 May
12	22-May	Student seminars	**DRC MvdL**	Seminar	Matt C	24-May	**No lab**				
13	29-May					31-May	**No lab**				

1.8 Course Evaluation and Development

Student feedback is gathered periodically by various means. Such feedback is considered carefully with a view to acting on it constructively wherever possible.

Mechanisms of Review	Last Review Date	Comments or Changes Resulting from Reviews
Major Course Review	Feb 2011	With the change from 14 to 12 weeks and increased class size, chemical laboratory work has been replaced by field testing techniques and a reduction in the number of case studies. Introduction of additional computer-based labs.
CATEI or myExperience	2012 2015 2017	Students were generally satisfied with all aspects of the course, including general subject content, delivery, field and laboratory work, assignments, assessment methods and implementation. There were no major concerns over the amount of assignment work. Increased use of in-class discussions
Other	2007 2013 2015 2016 2017	The course content was discussed with members of AAG Changes to field-based exercises Swap long essay with lab exercise Extended mineral exploration exercise and new isotopes exercise Change to field exercise to test neutralisation

1.9 Other Administration Matters

Expectations of Students	Attendance at lectures, labs and the field excursions is compulsory. Labs G07 and G11 are available for student use whenever the labs are not being used for teaching. www.bees.unsw.edu.au/current/studentoffice.html and www.bees.unsw.edu.au/current/ugradguidelines.html		
Assessment components	Laboratory assignments (5) 60% Field report 20% Seminar 10% Short essay 10%		
Assignment Submissions	Assignments and reports must be submitted on time. No extensions will be permitted (apart from the normal UNSW provisions). Completed assignments must be submitted via Moodle **by the due date**. Penalties for late submission apply and will be a reduction in the maximum mark of 15% per day.		
Occupational Health and Safety[6]	**See Section 4**		
Field Excursion Travel	Tba		
Assessment Procedures	Normal UNSW rules apply to illness, misadventure or other situations which affect attendance at class or submission of assessment tasks.		
Equity and Diversity	Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss study needs with the course Convenor prior to the course commencing, or with the Equity Officer (Disability) in the Equity and Diversity Unit. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.		
Grievance Policy[7]	**School Contact**	**Faculty Contact**	**University Contact**
	Prof Martin van Kranendonk (HOS) Or A/Prof Jes Sammut (Grievance officer)	A/Prof Janelle Wheat Deputy Dean (Education) j.wheat@unsw.edu.au	University Counselling Services[8] Tel: 9385 5418

[6] UNSW Occupational Health and Safety: www.riskman.unsw.edu.au/ohs/ohs.shtml
[7] UNSW Grievance Policy: http://www.infonet.unsw.edu.au/poldoc/student_grievance_resolution.pdf
[8] Compass – University Counselling Service http://www.counselling.unsw.edu.au/compass_programs/

2 ASSESSMENT

2.1 Assessment Tasks and Feedback

Task	Knowledge & abilities assessed	Assessment Criteria	% of total mark	Date of		Feedback		
				Release	Submission	Who	When	Where
Lab Ex 1	Use of software packages Data manipulation and basic mathematical skills Modelling of simple aqueous systems Interpretation of data	See table below	12	On Moodle	See page 2	Lecturers	On return of assignments, etc	Written comments
Lab Ex 2	Use of software packages Data manipulation and basic mathematical skills Appropriate processing and interpretation of geochemical data		12					
Lab Ex 3			12					
Lab Ex 4			12					
Lab Ex 5			12					
Field report	Applications of geochemistry to acid mine drainage problems Fieldwork skills Synthesis of data Group work Concise technical report writing		20					
Short Essay	Literacy Synthesis of information Presentation in concise and well-written form		10					
Seminar	Literacy Synthesis of information Visual presentation skills Speaking skills		10		Schedule to be advised			

2.2 Marking Criteria

Component	***Pass / Credit***	***Distinction / High Distinction***
Laboratories *(60%)*	Basic processing of data and demonstrated capacity to use software packages. Adequate presentation of results. Basic data interpretation and the drawing of conclusions from results. Use of clear technical English in reports. Correct use of referencing.	Higher level processing, manipulation and modeling of results. Superior skills in presentation of results. Detailed interpretation of results drawing out most of the key features of the data as they relate to the problems posed. Use of clear technical English in reports. Correct use of referencing.
Field Report *(20%)*	Adequate description of work done, in both field and laboratory. Adequate presentation of results. Basic data interpretation and the drawing of key conclusions from results. Use of clear technical English and effective structure	Detailed description of all key aspects of work done in field and laboratory with some explanation of their significance in the study. Superior skills in presentation of results. Detailed interpretation of results drawing out most of the key features of the data and extending beyond the directions of course staff. Reference to key literature to support interpretation. Use of clear technical English and effective structure in reports.
Short essay *(10%)*	Review of a sufficient number of references of direct relevance to the topic selected, but with minimal reference to scientific papers and similar higher level sources. Drawing main geochemical observations, principals, observations and issues from the literature. Basic integration of material from literature and summarizing in essay. Summarizing key conclusions made within the literature reviewed. Use of clear technical English and effective structure.	Review of more than the minimum required amount of literature, including use of scientific papers, books and other high level sources of direct relevance to the topic selected. Comprehensive coverage of geochemical observations, principals, observations and issues from the literature. Advanced level of integration and synthesis of material from literature and summarizing in essay. Critical evaluation and synthesis of the material presented in the literature. Use of clear technical English and effective structure with demonstration of higher level communication skills.
Seminar *(10%)*	Some demonstration of capacity to generate own slides, with necessary clarity and relevance to topic. Capacity to engage audience with the oral presentation. Good technical content. Correcting timing. Ability to answer questions.	Creation of high visual impact slide material. Capacity to enthuse audience with the oral presentation. High levels of technical content. Good balance between components of presentation – introduction, data, and conclusions. Correcting timing. Ability to answer questions.

3 ADDITIONAL RESOURCES AND SUPPORT

3.1 Moodle

Lecture notes, data for laboratories and other references

3.2 Books

Alpers CN and Blowes DW (Eds), 1994, Environmental Geochemistry of Sulfide Oxidation. ACS.

Andrews JE (Ed), 1996, An Introduction to Environmental Chemistry. Blackwell Science.

Appelo CAJ and Postma D, 1996. Geochemistry, Groundwater and Pollution. Balkema.

Brownlow AH, 1996, Geochemistry (2nd Ed). Prentice Hall

Cohen DR, Rutherford NF, Morisseau E & Zissimos A, 2011, Geochemical Atlas of Cyprus, UNSW Press.

Drever JI, 1997. The Geochemistry of Natural Waters; Surface and Groundwater Environments (3rd Ed). Prentice Hall.

Faure G, 1991, Principles and applications of inorganic geochemistry: a comprehensive textbook for geology students. Macmillan.

Govett GJS (series Ed.), Handbook of Geochemistry Series, vols 1–7.

Holland HD and Turekian KK (Eds), 2004, Treatise on Geochemistry. Elsevier Pergamon,

Langmuir D, 1997. Aqueous Environmental Geochemistry. Prentice Hall.

Marshall CP and Fairbridge RW (Eds), 1999, Encyclopedia of geochemistry. Kluwer

Reimann C, 1998. Chemical Elements in the Environment: Factsheets for the Geochemist and Environmental Scientist. Springer.

Rose AW, Hawkes HE and Webb JS, 1984, Geochemistry in Mineral Exploration (2nd ed.) Acad Press.

Salminen, R. (ed) and 30 others, 2005, The Geochemical Atlas of Europe: Geological Survey of Finland.

Siegel FR, 2001, Environmental Geochemistry of Potentially Toxic Metals. Springer.

3.3 Journals

Applied Geochemistry

The official journal of the International Association of Geochemistry and Cosmochemistry. Geochemistry and cosmochemistry which have some practical application to an aspect of human endeavour, such as environmental monitoring, agriculture, health, waste disposal and the search for resources. Topics covered include: environmental geochemistry, hydrogeochemistry, surface water and groundwater, medical geochemistry, agricultural geochemistry, the search for energy and mineral deposits and waste disposal including the specific topic of nuclear waste disposal.

Chemical Geology

The official journal of the European Association for Geochemistry and covers the fields of organic and inorganic geochemistry, and chemical geology, including: low temperature geochemistry, organic/petroleum geochemistry, inorganic geochemistry, analytical techniques, isotope studies, environmental geochemistry, and experimental petrology and geochemistry. Its website provides contents lists and abstracts; access to full text is restricted to subscribers.

Environmental geochemistry and health

Official Journal of the Society for Environmental Geochemistry and Health, examines links between the chemical composition of rocks and minerals and the health of plants, animals and people. Bedrock geochemistry controls on the composition of soil, water and vegetation. Pollution, arising from the extraction and use of mineral resources, geochemical surveys of soil, water and plants, epidemiological studies.

Geochemistry: Exploration , Environment and Analysis

The official journal of the Association of Applied Geochemists. Published quarterly by The Geological Society of London, covers environmental and economic geochemistry. It includes all aspects of the geochemistry of the environment and the application of geochemistry to the exploration and study of mineral resources and related fields. Similar to J. Geochem. Explor. in scope.

Geochimica et Cosmochimica Acta

A journal of the Geochemical Society and the Meteoritical Society, which publishes research subject papers on terrestrial geochemistry, meteoritics, and planetary geochemistry. The main fields covered by the journal are: physical chemistry of gases, aqueous solutions, glasses, and crystalline solids; igneous and metamorphic petrology; chemical processes in the atmosphere, hydrosphere, biosphere, and lithosphere of the Earth; organic geochemistry; isotope geochemistry; meteoritics and meteorite impacts.

Journal of Geochemical Exploration

Published quarterly by Elsevier, covers environmental and economic geochemistry. It includes all aspects of the geochemistry of the environment and the application of geochemistry to the exploration and study of mineral resources and related fields. Its main topics are: geochemical exploration; sampling and analytical techniques and methods of interpretation; processes of geochemical dispersion in rocks, soils, vegetation, water and the atmosphere; and geochemical distributions in and around mineralised environments. Similar to GEEA in scope.

Organic Geochemistry

Official Journal of the European Association of Organic Geochemists and covers research on all phases of geochemistry in which organic compounds play a major role (including molecular and isotopic geochemistry); geology, biogeochemistry, environmental geochemistry, chemical oceanography and hydrology. The scope of the journal includes research involving petroleum (including natural gas) coal, organic matter in the aqueous environment and recent sediments, organic-rich rocks and soils and the role of organics in the geochemical cycling of the elements.

Science of the Total Environment

Papers covering changes in the natural level and distribution of chemical elements and compounds which may affect the well-being of the living world, and ultimately harm man himself. Emphasis is given to applied environmental chemistry. The subjects covered include: (a) application of techniques and methods of chemistry and biochemistry to environmental problems (b) pollution of the air, water, soil and various aspects of human nutrition (c) environmental medicine, when the effect of abnormalities in the level and distribution of chemical elements and compounds are given prominence (d) the use of interdisciplinary methods in studies of the environment (e) environmental planning and policy.

3.4 Web sites

Acid Rock Drainage

This website is part of the InfoMine website, and provides detailed information on the technical aspects of Acid Rock Drainage (ARD) and related reference material. The topics covered by pages on the site are ARD fundamentals (natural acid rock drainage, trace element geochemistry, the role of microorganisms, etc), prediction, treatment and case studies (Britannia mine, Kemess district).
http://technology.infomine.com/enviromine/ard/home.htm

Environmental Geochemistry

Lecture notes provided by Ken Rubin of the University of Hawaii. The course covers the natural and anthropogenically driven aspects of the Earth's hydrosphere and atmosphere and its interaction with surficial rocks, sediments, soils, and the biosphere. The content is based largely on the application of geochemistry to the environment, with supporting content in theoretical geochemistry, organic chemistry, inorganic chemistry, biochemistry, and microbiology.
http://www.soest.hawaii.edu/krubin/gg425.html

Fundamentals of Geochemistry

This comprehensive set of lecture notes accompany a course led by Dr Ken Rubin at the School of Ocean and Earth Science and Technology, University of Hawaii. Material covered by the course includes: aquatic chemistry; biogeochemistry; soil formation; hydrologic cycles; marine sediments; radioactivity; planetary formation and igneous processes. Lists of book chapters for further reading are provided. All notes are presented in PDF format.
http://www.soest.hawaii.edu/krubin/gg325.html

Geochemistry

This online book has been made available in PDF format by W M White of Cornell University. It is a comprehensive introduction to most aspects of geochemistry including the fundamental concepts, aquatic

chemistry, trace elements and radiogenic isotope geochemistry, the geochemistry of the core, mantle and crust and the geochemistry of the oceans, atmosphere and weathering processes. Chapters on organic geochemistry and cosmochemistry are also included.
http://www.geo.cornell.edu/geology/classes/geo455/Chapters.HTML

Geochemistry on the World Wide Web
This site contains a broad set of links to geochemistry-based web sites. Categories include professional societies, journals, geochemical data, geochemical standards, government and university laboratories and cosmochemistry, astronomy and planetology. This site is a useful starting point for identifying web-based geochemistry resources in all geochemical fields, e.g. volcanology, organic, mineralogy, isotope geochemistry and cosmochemistry.
http://www.geo.cornell.edu/geology/classes/Geochemweblinks.HTML

Global Cycles of Biologically Active Elements
This data is part of the website of Dr William S Reeburgh, a professor of marine and terrestrial geobiochemistry from the University of California. It gives information and figures about global cycles of biogeochemically important elements. Data is given for the cycles of carbon, oxygen, nitrogen, phosphorous, sulphur (pre-industrial), sulphur (mid 1980s), silica, water and methane. The size of the reservoirs in different regions of the environment for the particular elements is also given together with the relevant turnover times.
http://www.ess.uci.edu/~reeburgh/figures.html

Isotope Geochemistry Lecture Notes : Geo Sci 656
This site contains a series of isotope geochemistry lecture notes from W M White, Cornell University Department of Geology in PDF format. There are 37 lectures, major headings are geochronology, radiogenic isotope geochemistry and stable isotope geochemistry. The lectures also include case studies, graphs, images, data tables and useful further reading.
http://www.geo.cornell.edu/geology/classes/Geo656/GEO656.html

3.5 Interactive Periodic Tables

http://www.ptable.com/
http://www.webelements.com/
http://www.rsc.org/chemsoc/visualelements/pages/pertable_fla.htm
http://www.appliedgeochemists.org/ChemElements/elements.html

3.6 References

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Anand RR et al, 2012, Australian Journal of Earth Sciences.

Anand RR and Paine M, 2002, Regolith geology of the Yilgarn Craton, Western Australia: Implications for exploration. Australian Journal of Earth Sciences, 49.

Anand RR, 2005, Boddington, Western Australia. In: Butt CRM et al (eds), Regolith Expressions of Australian Ore Deposits. CRC LME, Optima Press. Perth.

Anand RR and Butt CRM, 2010, A Guide for mineral exploration through the regolith in the Yilgarn Craton, Western Australia. Aust J Earth Sci. 57.

Anand RR, Cornelius M and Phang C, 2007, Use of vegetation and soil in mineral exploration in areas of transported overburden, Yilgarn Craton, Western Australia: A contribution towards understanding metal transportation processes. Geochemistry: Exploration Environment Analysis,7, 267– 288.

Andrew AS, Carr GR, Giblin AM and Whitford DJ, 1998, Isotope hydrogeochemistry in exploration for buried and blind mineralization. The State of the Regolith. Geol. Soc. Aust. Spec. Publ. 20, 222–225.

Anna E, Petts AE, Hill SM and Worral L, 2009, Termite species variations and their importance for termitaria biogeochemistry: Towards a robust media approach for mineral exploration. Geochemistry: Exploration Environment Analysis, 9, 257-266.

Averill SA, 2001, The application of heavy indicator mineralogy in mineral exploration, with emphasis on base metal indicators in glaciated metamorphic and plutonic terrain. In: McClenaghan MB et al (eds), Drift Exploration in Glaciated Terrains. Geol. Soc. Lond. Spec. Publ. 185, 69–82.

Bamba O, Parisot JC, Grandin G and Beauvais A, 2002, Ferricrete genesis and supergene behaviour in Burkina Faso, West Africa. Geochemistry: Exploration Environment Analysis, 2, 15–25.

Blain CF and Andrew RL, 1977, Sulfide weathering and the evaluation of gossans in mineral exploration. Minerals Sci. Eng 9, 119–150.

Bølviken B and Logn O, 1975, An electrochemical model for element distribution around sulfide bodies, In: Elliott I and Fletcher WK (eds), Geochemical Exploration 1974. Elsevier, 631–648.

Borovička J, Dunn CE, Gryndler M, et al, 2010, Bioaccumulation of gold in macrofungi and ectomycorrhizae from the vicinity of the Mokrsko gold deposit, Czech Republic. Soil Biology and Biochemistry, 42, 83–91.

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4 OH & S OBLIGATIONS

The School of BEES recognises its obligations to provide a safe working environment for all persons involved in School-related activities. To achieve this goal with regards to teaching and learning, the School adopts the UNSW Occupational Health and Safety Policy (2001) and the UNSW OH&S Responsibility and Accountability Document (2001). These documents stipulate that everyone attending a UNSW workplace must ensure their actions do not adversely affect the health and safety of others. This outcome is achieved through the establishment of a documented chain of responsibility and accountability for all persons in the workplace, extending from the Head of School through to the students undertaking courses offered.

As part of this chain of responsibility and accountability, the Course Authority is responsible for ensuring all activities associated with this course are safe. The Course Authority has undertaken detailed risk assessments of all course activities and identified all associated potential hazards. These hazards have been minimised and appropriate steps taken to ensure your health and safety. For each activity, clear written instructions are given and appropriate hazard warnings or risk minimisation procedures included for your protection.

It is the student's responsibility to prepare for all practical work. Students should be familiar with the written procedures scheduled for the practical class and identify all personal protection requirements needed to complete the exercise in a safe manner. Students must comply with all safety instructions given by the Course Authority and/or Laboratory / Field Demonstrator, and observe the Safety Information located outside or within teaching rooms. If you are unsure of any safe operating procedures or written instruction regarding safety, you should seek further information from the Course Authority and/or Laboratory / Field Demonstrator before attempting the task. Failure to comply with safety instructions may, in the first instance, be considered as a form of academic misconduct. If the outcome of a student's failure to comply with safety instructions results in personal injury, or endangers the health and safety of others, then the matter may be dealt with by WorkCover as a breach of the NSW OH&S Act (2000).

Conditions of Entry to Courses

To abide with Section 17 (1) (Persons in control of workplaces etc, used by non-employees to ensure health and safety) and Section 19 (Employees at work to take care of others and to co-operate with employer) of the **N.S.W. Occupational Health & Safety Act (1983):**

1. (a) All persons entering UNSW property are required to wear sturdy shoes at all times. Thongs, sandals and open toed shoes are not acceptable; porous topped footwear (e.g. canvas joggers) are not safe for wear in chemical laboratories.
   (b) Sturdy footwear is required on all field excursions and boots are strongly recommended.
2. (a) Safety glasses, masks, gloves, helmets and/or ear muffs must be worn when provided by supervising staff. Students must wear laboratory coats and safety glasses in chemical laboratories.
   (b) Students in second and higher years must be in possession of approved safety goggles and must wear them when within 3 metres of anyone hammering rocks.
3. Students with ongoing medical conditions, needing regular medication (e.g. diabetes, asthma, allergies, etc.), are required to inform the field excursion supervisor so that they are aware of your condition, but this information will be strictly confidential to staff members.
4. All students taking field excursions are expected to have had a *Tetanus* injection within the last 10 years. These injections are readily available at the Student Health Centre.
5. (a) The University of New South Wales is a **smoke-free work environment,** which means that smoking is prohibited inside all Buildings in the University.
   (b) Alcohol and smoking are not permitted in University vehicles nor in vehicles hired by the University for field excursions.
6. Students are advised to lodge the name, address, telephone number and Fax number (if available) of next of kin with the School's Administrative Assistant.

ENTRY TO SCHOOL BUILDINGS, AND ATTENDANCE ON FIELD EXCURSIONS, WILL BE DENIED TO STUDENTS WHO DO NOT ABIDE BY THESE CONDITIONS.

Professor M. van Kranendonk, Head of School

5 UNSW ACADEMIC HONESTY AND PLAGIARISM

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.
Examples* include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle. † Adapted with kind permission from the University of Melbourne

6 ASSIGNMENTS

A series of assignments will be complete during the laboratory sessions and outside lab time. Their objective is to provide practical experience with various aspects of geochemistry, including use of various computer packages.

The laboratory sessions set aside to assist with the assignments are designed to be done in pairs or even larger groups, however all assignments except the Sunny Corner reports need to be completed individually.

The assignments are:

6.1 Lab Exercise 1: Mapping geochemical data

Objective: To undertake a practical exercise in mapping geochemical data using ArcGIS.
Submission: Individual students

6.2 Lab Exercise 2: Analytical quality control

Objective: To undertake a practical exercise in determining the analytical quality of geochemical datasets.
Submission: Individual students.

6.3 Lab Exercise 3: MINTEQ aqueous modelling

Objectives: To apply an aqueous speciation modeling package to interpret water geochemical data.
Submission: Individual students.

6.4 Lab Exercise 4: Isotopes

Objective: To use isotope data to understand geochemical processes.
Submission: Individual students.

6.5 Lab Exercise 5: Geochemical exploration

Objective: To apply geochemical data to help detect mineralization.
Submission: Individual students.

6.6 Field Report: Field study at Sunny Corner

Objectives: Investigate the environmental conditions of a former base metal mine, conduct a geochemical survey of the stream system in the vicinity of the mine.
Submission: Small groups.

Itinerary:	**Meet:**	**7.00 am sharp** at UNSW **14 April (date tbc)**
	Coffee stop:	**9.40 – 10.00** at MacDonalds, Lithgow
	Arrive:	**~10.30 am** at Sunny Corner
	Depart:	**~2.30 pm** from Sunny Corner
	Coffee stop:	**3.00 – 3.15 pm** at MacDonalds, Lithgow
	Return:	**~6.00 pm**

Things to Bring: Field clothing; Clip-board or folder; Rain gear; Sunscreen and hat; Lunch; Sturdy footwear; Water.

7 SEMINAR

Topic: You will be presenting solo.

You are free to select a topic from any aspect of environmental or exploration geochemistry. The actual topic selected must be approved by A/Prof Cohen. You must select you topic by Week 9

Task: For the selected topic present synopsis in a format that is informative and entertaining.

Objective: To improve skills at oral presentations.

Time: 12 minutes each (including questions). (Typically 10 to 12 slides max)

Format: Digital presentation.

Date: Presentations to be made in Weeks 12 or 13. Timeslot will be issued randomly.

8 SHORT ESSAY

Task: Using a selection of articles and other resources, summarise key **geochemical** aspects of the nominated element and present in the form of a short essay.

Topic: You will be randomly allocated an element.

Objective: To provide further opportunity to develop skills at condensing information from the literature into a report format, making use of figures and tables to present information and written in suitable technical English.

Length: 800 words, plus figures and tables.

References: The essay must make reference to at least four journal articles or books, as well as other sources.

Format: Scientific essay.

Submission: Submit via Moodle.

Short essay topic:

Element	Student Name
Antimony	
Arsenic	
Barium	
Beryllium	
Bismuth	
Boron	
Bromine	
Cadmium	
Cerium	
Cesium	
Chlorine	
Chromium	
Cobalt	
Europium	
Fluorine	
Gallium	
Germanium	
Gold	
Helium, Neon and Argon	
Indium	
Iodine	
Iridium and Osmium	
Krypton and Xenon	
Lanthanum	
Lithium	
Manganese	
Mercury	
Molybdenum	
Niobium and Tantallum	
Platinum and Palladium	
Plutonium	
Polonium	
Radium	
Radon	
Rhenium	
Rhodium	
Rubidium	
Ruthenium	
Scandium	
Selenium	
Silver	
Strontium	
Tellurium	
Thallium	
Thorium	
Tungsten	
Uranium	
Vanadium	
Zirconium	

AAG APPLICATION FOR STUDENT MEMBERSHIP

To the Association of Applied Geochemists:

STUDENT MEMBER

I, _____, wish to apply for election as a Student Member of the Association of Applied Geochemists. I am presently engaged as a full-time student at **The University of New South Wales**, where I am taking a course in pure or applied science. I have read the Code of Ethics of the Association and in the event of being elected a Student Member agree to honour and abide by them.

_____

(Signature of applicant)

_____

Date

Student status must be verified by a Professor of your institution or a Fellow of the Association of Applied Geochemists. I, **Associate Prof David R. Cohen, Fellow of the AAG,** certify that the applicant is a full-time student at The University of New South Wales, Australia.

_____

(Signature)

NAME AND ADDRESS

Name:

Address:

Telephone:

Email: