UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF GEOSCIENCE
COURSE OUTLINE
WINTER 2016

1. **Course:** Geology 403, Aqueous Geochemistry

   Lecture Sections:

   L01: TuThu, 15:30-16:45, ES 162
   LAB: W, 8:00, 11:00, 14:00, 17:00; F 8:00
   For a listing of all lab sections corresponding with this course, please see the following link:
   http://geoscience.ucalgary.ca/geoscience_info/courses/w16

   Instructor, Dr. Benjamin Cowie, Office: ES 514, Tel: 403-220-6809, e-mail address, cowie@fas.harvard.edu
   Office Hours: Wednesday, by appointment

   Geoscience Department ES 118, 403-220-5841, geoscience.ucalgary.ca, geoscience@ucalgary.ca

2. **Prerequisites:** Geology 323. See section 3.5.C in the Faculty of Science section of the online Calendar (www.ucalgary.ca/pubs/calendar/current/sc-3-5.html)

   **Antirequisites:** Credit for both Geology 403 and 503 will not be allowed.

3. **Grading:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

| | |
|---|---|
| Lab Assignments (10) | 25% |
| Midterm test | 25% |
| Final Examination | 50 % (To be scheduled by the Registrar) |

**A passing grade on the final exam is necessary to pass the course as a whole.**

Each piece of work (assignment, laboratory report, midterm test of final examination) submitted by the student will be assigned a percentage score. The student's average percentage score for the various components listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade, bearing in mind that an F grade will result if the student does not pass the Final Examination. The conversion between course percentage and letter grade is given below.

| Letter Grade | Percent | Letter Grade | Percent |
|---|---|---|---|
| A+ | 95-100 | C+ | 65-69 |
| A | 90-94 | C | 60-64 |
| A- | 85-89 | C- | 56-59 |
| B+ | 80-84 | D+ | 53-55 |
| B | 75-79 | D | 50-52 |
| B- | 70-74 | F | 0-49 |

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in Section 3.6. It is the student's responsibility to familiarize himself/herself with these regulations. See also Section E.6 of the University Calendar.

5. **Scheduled out-of-class activities:** N/A

   **REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY.** If you have a clash with this out-of-class-time-activity, please inform your instructor as soon as possible so that alternative arrangements may be made for you.

6. **Course Materials:** Recommended textbook: Appelo, C.A.J., and Postma, D., *Geochemistry, groundwater and pollution* (2nd ed., 2005, UofC bookstore; Gallagher Library: TD420.A67 2005)
Other useful reference books:
- Langmuir, D., *Aqueous environmental geochemistry*, Prentice Hall, 1997 (GB855.L36 1997).
- Stumm, W., and Morgan, J., *Aquatic chemistry* (3rd ed.), Wiley, 1996 (GB697.S78 1996)
- Drever, J.I., *The geochemistry of natural waters* (2nd ed.), Prentice Hall, 1988 (GB855.D73 1988)

The course D2L site contains the lecture material and the lab assignments, as well as other resource material that you might find useful. Students are advised that reading the course page is not a substitute for attendance at lectures. The lectures provide an interactive environment that embellishes on, and provides a context for, the material in the textbook, whereas blackboard is a live site that allows for tailoring and updating of the course material during the term.

7. **Examination Policy**: No electronic or written aids (eg. cell phones, tablets, computers, PDAs, notes, textbooks) will be allowed during writing of any exams. Non-programmable calculators will be permitted to answer quantitative questions on exams, if applicable, and permission to do this will be clearly indicated on the examination paper. Students should also read the Calendar, Section G, on Examinations.

8. **Writing across the curriculum statement:** In this course, the quality of the student's writing in laboratory reports will be a factor in the evaluation of those reports. See also Section E.2 of the University Calendar.

9. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

**(a) Academic Misconduct:** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties

**(b) Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on assembly points.

**(c) Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf. Students needing an Accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of Geoscience, Dr. E.S. Krebes by email krebes@ucalgary.ca or phone 403-220-5850.

**(d) Safewalk:** Campus Security will escort individuals day or night (http://www.ucalgary.ca/security/safewalk/). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

**(e) Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also http://www.ucalgary.ca/secretariat/privacy.

**(f) Student Union Information:** VP Academic Phone: 403 220-3911 Email: suvpaca@ucalgary.ca
SU Faculty Rep. Phone: 403 220-3913 Email: science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca;
Student Ombuds Office: 403-220-6420 Email: ombuds@ucalgary.ca; http://ucalgary.ca/provost/students/ombuds

**(g) Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

**(h) U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses (www.ucalgary.ca/usri). Your responses make a difference – please participate in USRI Surveys.

Department Approval: ORIGINAL SIGNED Date: January 8, 2016

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   Lecture Sections:

   L01: TuTh, 15:30-16:45, ES 162; Instructor: Dr. Ben Cowie Office: ES 514 e-mail address: cowie@fas.harvard.edu, Office Hours: Wednesday, by appointment

   The course website can be found on D2L (tbd).
   Departmental Office: ES118, 403-220-5184, geosci@ucalgary.ca

2. **Prerequisites:** Geology 323 (see http://www.ucalgary.ca/pubs/calendar/current/geology.html#9734)

3. **Syllabus:** The aim of this course is to provide a comprehensive introduction to aqueous geochemistry. The students will learn the processes that determine the quality (chemical constituents) of surface water and groundwater to understand interactions between anthropogenic activities and the natural environment. The first part of the course will focus on hydrology, measurements and sampling techniques. Applications of environmental tracers (e.g. isotopes) will be presented, followed by chemical principles used in aqueous geochemistry, including acid/base equilibria, salts and solutions. The next part will focus on mineral dissolution and chemical weathering, including silica and carbonate systems. Chemical weathering and redox reactions, acid mine drainage and other case studies will complete aqueous geochemistry concepts.

   This course is accompanied by weekly lab sessions that will help the students to conduct geochemical calculations and visualisation of geochemical data. The lab also includes geochemical modelling, providing hands-on computer experience. Isotope applications and case studies will emphasize the understanding of geochemical concepts.

   The topics covered in the course are given in the table below. This is intended as a general guideline and the schedule of topics may change slightly as the course progresses.

| Week | Dates | Lecture topic(s) | Lab |
|---|---|---|---|
| 1 | January 12/14 | Introduction, Groundwater Quality | No lab |
| 2 | January 19/21 | Hydrology – Rainwater, Groundwater, Isotopes | Lab 1: Water Chemistry and Analytical Results |
| 3 | January 26/28 | Water Chemistry Controls, GW Dating, Mineral Solubility | Lab 2: Balancing geochemical reactions |
| 4 | February 2/4 | Acitvity/SI/Kinetics | Lab 3: Measuring field parameters |
| 5 | February 9/11 | Carbonates | Lab 4: Measuring alkalinity |
| **Reading break, no classes February 16/18** | | | |
| 6 | February 23/25 | **Midterm Examination: Feb. 23** Carbonate Systems/CO2 | Lab 5: Ionic strength/ Activity coefficients part 1 |
| 7 | March 1/3 | Carbonate System | Lab 6: Ionic strength/Activity coefficients part 2, GWB |
| 8 | March 8/10 | Carbon Dioxide Dissolution | Lab 7: Geochemist's Workbench |
| 9 | March 15/17 | Ion Exchange and Sorption | Lab 8: Geochemist's Workbench |
| 10 | March 22/24 | Adsorption & Chemical Weathering | Lab 9: Silicate Weathering |
| 11 | March 29/31 | Silicate Weathering | Lab 10: Redox Diagrams |
| 12 | April 5/7 | Redox Reactions | Lab 11: Redox with Geochemist's Workbench |
| 13 | April 12 | Exam review | No lab |
| | **April 16-27** | **Final Examination, scheduled by registrar** | |