EAS 368 Outline Winter 2013

EAS 368: ORE DEPOSITS GEOLOGY
Winter 2013

LECTURES: EAS 368-B1, MWF, 9:00–9:50 am, ESB 2-35
PROFESSOR: Dr. Jeremy Richards (ESB 3-02; Jeremy.Richards@UAlberta.ca)
OFFICE HOURS: Mondays 13:00–14:00 or any time by appointment
LECTURE NOTES: Basic lecture notes are posted on e-Class the week prior to each class.

LAB INSTRUCTORS: TBA

LAB COORDINATOR: Marilyn Huff ESB 3-04A e-mail: huff@ualberta.ca

CALENDAR DESCRIPTION:
Mineralogy and petrography of ore and gangue minerals under the reflected and transmitted light microscope and in hand specimen. Interpretation of ore textures and paragenetic sequences. Geological characteristics and distribution of ore deposits, including deposits of base and precious metals, diamonds, and industrial minerals. Prerequisite: EAS 331. Not available to students with credit in EAS 433.

COURSE OBJECTIVES:
To gain an awareness and appreciation of:
• The minerals industry, its economic basis, and impacts.
• The variety, form, and global distribution of a range of important metalliferous mineral deposit types;
• Their regional geological and tectonic context;
• Their geochemical and geophysical signatures, as applicable to mineral exploration;
• A basic understanding of mineral exploration practices.

To gain a practical knowledge of:
• Common ore and alteration minerals in hand specimen and polished section, and the interpretation and description of their textures;
• Suites of ore and alteration minerals associated with different mineral deposit types.

COURSE PHILOSOPHY:
Despite current popular beliefs, the maintenance of modern civilization is dependent on the affordable and plentiful supply of raw materials and energy. Banning mining is not a realistic option for the modern world. Nonetheless, many of the concerns of environmentalists are valid, and must not be ignored. Thus, one of the challenges facing the extractive minerals industry today is how to find and recover these raw materials with the least environmental and social impact. We will approach the subject of the origin of and exploration for mineral deposits with this challenge in mind.

The study of mineral deposits is a particularly satisfying one for the geologist because it draws upon all aspects of the geological sciences, and often other sciences too. Thus, you will find aspects of mineralogy and geochemistry particularly applicable, but also paleontology and sedimentology (in dealing with sediment-hosted mineral deposits), igneous and metamorphic petrology (intrusive-hosted and metamorphic deposits), and even remote sensing and physical geology (field exploration). A key characteristic of the successful exploration geologist is a lively but realistic imagination, and the ability to extrapolate useful information and make accurate predictions from limited available data. This expertise will come with experience, but the basic principles and current theories required for making informed judgments will be reviewed here.

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**Course Timetable and Content:**

Lectures are from 9.00 to 9.50 a.m., Monday, Wednesday, and Friday, ESB 2-35. Labs will be held in ESB 3-07 in several sections.

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Lecture (ESB 2-35)</th>
<th>Lab (ESB 3-07)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>7 Jan</td>
<td>Course introduction</td>
<td>No lab</td>
</tr>
<tr>
<td>Wed</td>
<td>9</td>
<td>Role of minerals in society</td>
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<tr>
<td>Fri</td>
<td>11</td>
<td>The minerals industry</td>
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<tr>
<td>Mon</td>
<td>14</td>
<td>Mine life cycle</td>
<td>Introduction to ore microscopy</td>
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<tr>
<td>Wed</td>
<td>16</td>
<td>Distribution of elements</td>
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<tr>
<td>Fri</td>
<td>18</td>
<td>Reflected light microscopy</td>
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<tr>
<td>Mon</td>
<td>21</td>
<td>Oxides and native metals</td>
<td>Oxides and native metals</td>
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<tr>
<td>Wed</td>
<td>23</td>
<td>Oxides and native metals cont.</td>
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<tr>
<td>Fri</td>
<td>25</td>
<td>Sulfides</td>
<td></td>
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<tr>
<td>Mon</td>
<td>28</td>
<td>Sulfides cont.</td>
<td>Sulfide minerals I</td>
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<tr>
<td>Wed</td>
<td>30</td>
<td>Arsenides, antimonides, sulfosalts, tellurides</td>
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<tr>
<td>Fri</td>
<td>1 Feb</td>
<td>Arsenides, antimonides, sulfosalts, tellurides cont.</td>
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<tr>
<td>Mon</td>
<td>4</td>
<td>Ore textures</td>
<td>Sulfide minerals II</td>
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<tr>
<td>Wed</td>
<td>6</td>
<td>Ore textures cont.</td>
<td></td>
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<tr>
<td>Fri</td>
<td>8</td>
<td>Alteration mineralogy</td>
<td>Ore textures and paragenesis</td>
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<tr>
<td>Mon</td>
<td>11</td>
<td>Alteration mineralogy cont.</td>
<td>Alteration minerals</td>
</tr>
<tr>
<td>Wed</td>
<td>13</td>
<td>Alteration mineralogy cont.</td>
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<tr>
<td>Fri</td>
<td>15</td>
<td><strong>LECTURE MID-TERM EXAM</strong></td>
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<td></td>
<td>18–22</td>
<td><strong>READING WEEK</strong></td>
<td></td>
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<tr>
<td>Mon</td>
<td>25</td>
<td>Orthomagmatic oxide/sulfide deposits</td>
<td><strong>LAB MID-TERM EXAM</strong></td>
</tr>
<tr>
<td>Wed</td>
<td>27</td>
<td>Orthomagmatic oxide/sulfide deposits cont.</td>
<td>(in your normal lab period)</td>
</tr>
<tr>
<td>Fri</td>
<td>1 Mar</td>
<td>Pegmatite, greisen, skarn deposits</td>
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<tr>
<td>Mon</td>
<td>4</td>
<td>Pegmatite, greisen, skarn deposits cont.</td>
<td>Orthomagmatic deposits</td>
</tr>
<tr>
<td>Wed</td>
<td>6</td>
<td>Diamonds and the diamond industry</td>
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<tr>
<td>Fri</td>
<td>8</td>
<td>Diamonds and the diamond industry cont.</td>
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<tr>
<td>Mon</td>
<td>11</td>
<td>Porphyry deposits</td>
<td>Magmatic-hydrothermal deposits</td>
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<tr>
<td>Wed</td>
<td>13</td>
<td>Porphyry deposits cont.</td>
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<tr>
<td>Fri</td>
<td>15</td>
<td>Porphyry deposits cont.</td>
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<tr>
<td>Mon</td>
<td>18</td>
<td>Epithermal deposits</td>
<td>Epithermal deposits</td>
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<tr>
<td>Wed</td>
<td>20</td>
<td>Epithermal deposits cont.</td>
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<tr>
<td>Fri</td>
<td>22</td>
<td>Epithermal deposits cont.</td>
<td></td>
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<tr>
<td>Mon</td>
<td>25</td>
<td>Mesothermal deposits</td>
<td>Mesothermal deposits and VHMS</td>
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<tr>
<td>Wed</td>
<td>27</td>
<td>Mesothermal deposits cont.</td>
<td></td>
</tr>
<tr>
<td>Fri</td>
<td>29</td>
<td><strong>GOOD FRIDAY</strong></td>
<td></td>
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<tr>
<td>Mon</td>
<td>1 Apr</td>
<td><strong>EASTER MONDAY</strong></td>
<td>Sediment-hosted deposits</td>
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<tr>
<td>Wed</td>
<td>3</td>
<td>Stratiform &amp; stratabound deposits: VHMS</td>
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<tr>
<td>Fri</td>
<td>5</td>
<td>SEDEX Pb-Zn deposits</td>
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<tr>
<td>Mon</td>
<td>8</td>
<td>MVT Pb-Zn deposits</td>
<td><strong>LAB FINAL EXAM</strong></td>
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<tr>
<td>Wed</td>
<td>10</td>
<td>Sediment-hosted Cu deposits</td>
<td>(in your normal lab period)</td>
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<tr>
<td>Fri</td>
<td>12</td>
<td>Placer deposits, residual deposits and weathering</td>
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<tr>
<td>Wed</td>
<td>18 Apr</td>
<td><strong>LECTURE FINAL EXAM</strong></td>
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* Provisional: It is the student’s responsibility to verify this date on BearTracks when the Final Exam Schedule is posted.

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EXAMINATION TIMES
Lecture Midterm Exam is in-class on Friday 15 February, 2013.
Lab Midterm Exams are in normal lab periods in the week of 25 February–1 March, 2013.
Final Exam is provisionally scheduled for Wednesday 18 April, 2013, from 09:00–11:00, in ESB 2-35.
Note: Students must verify this date on BearTracks when the Final Exam Schedule is posted.

Deferred Exams
• Deferred Lecture Midterm: Students who are granted permission to sit a deferred mid-term must do that exam on:
  Friday 1 March, 2013, from 10:00–10:50, in ESB 3-02.
• Deferred Lecture Final: Students who are granted permission to sit a deferred final exam must do that exam on:
  Wednesday 1 May, 2013, from 09:00–11:00, in ESB 3-02.

DEFERRED EXAM POLICY (See Calendar §23.3 and §23.5.6 for details)
Term Exams:
A student who cannot write a term examination due to incapacitating illness, severe domestic affliction, or other compelling reasons (which exclude simple inconvenience) can apply in writing to the Instructor for an excused absence. Such an application must be made “to the instructor within two working days following the scheduled date of the term work or term exam missed, or as soon as the student is able, having regard to the circumstances underlying the absence” and must be supported by a Statutory Declaration (in lieu of a medical statement form) or other appropriate documentation (Calendar §23.3.1). The Instructor may decide either to allow the student to sit a deferred exam (on dates shown below), or to waive the exam and adjust the weighting of the remaining work to 100%.

Final Exams:
A student who cannot write a final examination due to incapacitating illness, severe domestic affliction, or other compelling reasons (which exclude simple inconvenience) can apply in writing to sit a deferred exam on dates shown below. Such an application must be made to the student’s Faculty office “within two working days following the scheduled date of the exam missed, or as soon as the student is able, having regard to the circumstances underlying the absence” and must be supported by a Statutory Declaration (in lieu of a medical statement form) or other appropriate documentation (Calendar §23.3.2).

D e f e r r a l of final exams is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of facts to gain a deferral is a serious breach of the Code of Student Behaviour.

COURSE MARK-WEIGHT DISTRIBUTION AND GRADING:
Lecture Midterm Exam .................................................................20%
Laboratory Midterm Exam ..........................................................20%
Laboratory Exercises .................................................................10%
Laboratory Final Exam ...............................................................20%
Lecture Final Exam ....................................................................30%

• Lecture Midterm (50 minutes) will consist of a limited choice of short-answer questions relating to topics covered in the lectures.
• Laboratory Midterm (2 hours) will consist of hand samples and polished sections for identification and description.
• Laboratory Exercises will consist of the preparation and submission of mineral, rock, and ore suite descriptions (in hand specimen and polished section). A nominal mark of 1% (course total) per lab will be given for attendance and submission of work, and feedback will be provided.
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- **Laboratory Final Exam** will consist of hand samples, polished sections, and sample suites for identification, description, and genetic interpretation.
- **Lecture Final Exam** (2 hours) will consist of short-answer questions and an essay question with a choice of topics. Questions in the Final may be asked relating to all aspects of the course, including laboratories. Information gained from suggested readings may enhance your grade.

**Distribution of Grades and Grade Assignment:** A letter grade will be assigned for your efforts and achievement in the course. Grades will be based upon your earned percentage of cumulative marks and the overall grade distribution. Your final grade will thus reflect a combination of absolute achievement and relative standing in the class. Historically recommended grade distributions are used as a guideline only, and the actual grade distribution will vary from year to year depending on cohort performance.

NB: Grades are unofficial until approved by the Department and/or Faculty offering the course.

**PAST (OR REPRESENTATIVE) EVALUATIVE MATERIAL**
Example questions for the midterm and final exams will be posted on the course eClass site and will be reviewed in class in the week before the exams.

**ABOUT YOUR INSTRUCTOR:**

**Jeremy Richards**  (Jeremy.Richards@UAlberta.CA)
My office is at the west end of the 3rd floor of the Earth Sciences Building (room ESB 3-02) — if my door is open, feel free to stop by with any questions you may have, in or out of “office hours”; or you can make a specific appointment by phone (780-492-3430) or e-mail (Jeremy.Richards@UAlberta.ca).

Please note that I do not respond to e-mails that do not address me by name (“Dear Dr. Richards” is a customary salutation) or end with your signature (i.e., provide your name), or do not respect common norms of politeness and civility.

My research interests focus on the origin of mineral deposits, especially of metals such as copper and gold, and sustainable development of mineral resources. These interests take me and my graduate students all over the world, including various parts of Canada (Canada is one of the world’s top suppliers of minerals). On the way we see some spectacular geology and mineral deposits, and I hope to be able to impart some of the excitement of the geological and mining world to you during this course.
FORMAL NOTICES

GFC POLICY ON COURSE OUTLINES
“Policy about course outlines can be found in Section 23.4(2) of the University Calendar” (GFC 29 SEP 2003). The General Faculties Council, in approving these guidelines, expects a common sense approach to their application and understands that circumstances might develop, during a term, where a change to the course outline as set out in Section 61.6(a) of the GFC Policy Manual, makes sense to all concerned. Such changes shall only occur with fair warning or general class consent.

ACADEMIC STANDARDS
“The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour, online at: http://www.governance.ualberta.ca/en/CodesofConductandResidenceCommunityStandards/CodeofStudentBehaviour.aspx and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.” (Section 23.4(2) of the University Calendar; GFC 29 SEP 2003.)

All forms of dishonesty are unacceptable at the University. Any offence will be reported to the Senior Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offences. Anyone who engages in these practices will receive at minimum a grade of zero for the exam or paper in question and no opportunity will be given to replace the grade or redistribute the weights. As well, in the Faculty of Science the sanction for cheating on any examination will include a disciplinary failing grade (no exceptions) and senior students should expect a period of suspension or expulsion from the University of Alberta.

See www.ualberta.ca/tie for more information on Academic Standards. Remember that it is the student’s responsibility to be aware of the contents of the Code of Student Behaviour. Ask the Instructor or Lab Coordinator if you have questions about acceptable collaborations, cheating, etc.

COLLABORATION
Lab work commonly involves working in small teams. Be sure that you understand University policies on collaboration (see brochure at: http://www.tie.ualberta.ca/~media/tie/Documents/Collaborating.pdf), and specific expectations for each lab. If in doubt, ask your TA or the Laboratory Coordinator.

EXAMS
Your student photo I.D. is required at exams to verify your identity. Students will not be allowed to begin an examination after it has been in progress for 30 minutes. Students must remain in the exam room until at least 30 minutes has elapsed. No electronic equipment of any kind can be brought into examination rooms, and hats should not be worn.

CELL PHONES
Cell phones are to be turned off during lectures, labs, and seminars. Cell phones are not to be brought to exams.

RECORDING
Recording is not permitted except as part of an approved accommodation plan, which requires the prior written consent of the Instructor.

SPECIALIZED SUPPORT AND DISABILITY SERVICES
Students who require accommodations in this course due to a disability affecting mobility, vision, hearing, learning, or mental or physical health are advised to discuss their needs with Specialized Support and Disability Services, 2-800 Students’ Union Building, 492-3381 (phone) or 492-7269 (TTY).

Remember to provide the Instructor and Lab Coordinator with copies of your Letter of Introduction early in the term, and completed Exam Instructions & Authorization sheets at least 1 week in advance of exams, so that your exam needs can be met come exam time.

ACADEMIC SUPPORT CENTRE
Students who require additional help in developing strategies for better time management, study skills or examination skills should contact the Academic Support Centre (2-300 Students’ Union Building).
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EAS 368: Bibliography

Course Texts
Required:

Recommended:
Taylor, R., 2009, Ore textures: recognition and interpretation: Springer. Download from http://www.springerlink.com/content/v13117/-section=679213&page=1

Web Sites
General Mineralogy: http://webmineral.com/
Mineral and Gemstone Kingdom: http://www.minerals.net/
INFOMINE: http://www.info-mine.com/
Society of Economic Geologists: http://www.segweb.org/

Additional Ore Microscopy and Alteration References

General References
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Geol. Mon. 6, 667 p. [QE 390.2 G65 G346]
Canada, 194 p. [QE 364.2 S7 O662]
Assoc. Canada, 154 p. [TN 263 O3]
Vaughan, D.J., ed., 2006, Sulfide mineralogy and geochemistry: Mineralogical Society of America, Reviews in Mineralogy,
v. 61, 714 p.

Journals
Economic Geology [QE 1 E19] [Online]
Exploration and Mining Geology [TN 26 E96] [Online]
Mineralium Deposita [QE 351 M664] [Online]
Mining Magazine [TN 1 M66]
Northern Miner [Shelved by title in Cameron]
Ore Geology Reviews [QE 390 O67] [Online]

DISCLAIMER
Any typographical errors in this Course Outline are subject to change, and changes will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported in this syllabus.

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