EAS 368: ORE DEPOSITS GEOLOGY

Winter 2010

Course Instructor:

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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 facts and current theories required for making informed judgements will be reviewed here.

Course Texts

Required:

Evans, A.M., 1993, Ore geology and industrial minerals, an introduction, 3rd edn: Blackwell Scientific, 390 p. [QE 390 E92]

Recommended:

Marshall, D., Anglin, C.D., and Mumin, H., 2004, Ore mineral atlas: GAC, Mineral Deposits Division, 112 p.

Spry, P.G., and Gedlinske, B.L., 1997, Tables for the determination of common opaque minerals: Economic Geology Special Publication, 52 p. [QE 369 O6 S7715]

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; the groupings and timings will be arranged in the first week of term.

Day	Date	Lecture (ESB 2-35)	Lab (ESB 3-07)
Wed	6	Role of minerals in society	
Fri	8	**No class**: WIUGC	
Mon	11	The minerals industry	Introduction to ore microscopy
Wed	13	Mine life cycle	
Fri	15	Distribution of elements	
Mon	18	Oxides and native metals	Oxides and native metals
Wed	20	Oxides and native metals cont.	
Fri	22	Sulfides	
Mon	25	Sulfides cont.	Sulfide minerals I
Wed	27	Arsenides, antimonides, sulfosalts, tellurides	
Fri	29	Arsenides, antimonides, sulfosalts, tellurides cont.	
Mon	1 Feb	Ore textures	Sulfide minerals II
Wed	3	Ore textures cont.	
Fri	5	Alteration mineralogy	
Mon	8	Alteration mineralogy cont.	Ore textures and paragenesis Alteration minerals
Wed	10	Alteration mineralogy cont.	
Fri	12	**LECTURE MID-TERM EXAM**	
	15–19	**READING WEEK**	
Mon	22	Orthomagmatic oxide/sulfide deposits	**LAB MID-TERM EXAM** (in your normal lab period)
Wed	24	Orthomagmatic oxide/sulfide deposits cont.	
Fri	26	Pegmatite, greisen, skarn deposits	
Mon	1 Mar	Pegmatite, greisen, skarn deposits cont.	Orthomagmatic deposits
Wed	3	Diamonds and the diamond industry	
Fri	5	Diamonds and the diamond industry cont.	
Mon	8	Porphyry deposits	Magmatic-hydrothermal deposits
Wed	10	Porphyry deposits cont.	
Fri	12	Porphyry deposits cont.	
Mon	15	Epithermal deposits	Epithermal deposits
Wed	17	Epithermal deposits cont.	
Fri	19	Epithermal deposits cont.	
Mon	22	Mesothermal deposits	Mesothermal deposits and VHMS
Wed	24	Mesothermal deposits cont.	
Fri	26	Stratiform & stratabound deposits: VHMS	
Mon	29	SEDEX Pb-Zn deposits	Sediment-hosted deposits
Wed	31	MVT Pb-Zn deposits	
Fri	2 April	Sediment-hosted Cu deposits	
Mon	5	**EASTER MONDAY**	**LAB FINAL EXAM** (in your normal lab period)
Wed	7	Uranium deposits	
Fri	9	Placer deposits, residual deposits and weathering	
Mon	12	Residual deposits and weathering cont.	

Examination Times

Final Exam is scheduled for **Monday 26 April, 2010, from 09:00–11:00, in ESB 2-35.**

Deferred Exams

- **Deferred Lecture Midterm**: Students who are granted permission to sit a deferred mid-term must do that exam on: **Wednesday February 24, 2010, 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: **Monday May 3, 2010, from 09:00–11:00, in ESB 3-02.**

Assessment

Marks and Grading:

Lecture Midterm Exam 20%
Laboratory Midterm Exam..... 20%
Laboratory Exercises..... 10%
Laboratory Final Exam 20%
Lecture Final Exam 30%

Note that a letter grading scheme will be used for the final evaluation of course performance, but individual pieces of work will each be marked out of 100%. Because the relationship of marks to grades is not fixed, histograms of class performance will be provided periodically so that individuals can measure their relative successes.

- **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.
- **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.

Example questions for the midterm and final exams will be reviewed in class in the week before the exams.

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)

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* www.ualberta.ca/secretariat/appeals.htm*) 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.*" (GFC 29 SEP 2003)

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). Web site: www.ualberta.ca/ssds

EAS 368: Bibliography

Web Sites

Rob Ixer's Virtual Atlas of Opaque and Ore Minerals: **http://www.smenet.org/opaque-ore/**
General Mineralogy: **http://web.wt.net/~daba/Mineral/**
INFOMINE: **http://www.info-mine.com/**
Society of Economic Geologists: **http://www.segweb.org/**
Society for Geology Applied to Mineral Deposits (SGA): **http://e-sga.org/**
Geological Assoc. Canada, Mineral Deposits Division: **http://www.sfu.ca/mdd/**

Course Texts

Evans, A.M., 1993, Ore geology and industrial minerals, an introduction, 3rd ed: Blackwell Scientific, 390 p.
Marshall, D., Anglin, C.D., and Mumin, H., 2004, Ore mineral atlas: Geological Association of Canada, 112 p.
Spry, P.G., and Gedlinske, B.L., 1997, Tables for the determination of common opaque minerals: Economic Geology Special Publication, 52 p. [QE 369 O6 S7715]

Additional Ore Microscopy and Alteration References

Craig, J.R., and Vaughan, D.J., 1994, Ore Microscopy and Ore Petrography: J. Wiley Intersci., 434 p. [QE 390 C886]
Thompson, A.J.B., and Thompson, J.F.H., 1996, Atlas of alteration: Geol. Assoc. Canada. [QE 390.5 A65]

General References

Berger, B.R., and Bethke, P.M., eds., 1995, Geology and Geochemistry of Epithermal Systems: Soc. Econ. Geol., Reviews in Economic Geology, v. 2. [QE 390.5 G345]
Boyle, R.W., ed., 1999, Sediment-hosted stratiform copper deposits: Geol. Assoc. Canada, Spec. Paper 36, 710 p. [TN 441 S448]
Crowson, P., 2008, Mining Unearthed: The definitive book on how economic and political influences shape the global mining industry: Aspermont UK, London, 423 p.
Eckstrand, O.R., Sinclair, W.D., and Thorpe, R.I., eds., 1995, Geology of Canadian mineral deposit types: Geological Survey of Canada, Geology of Canada no. 8, 640 p.
Evans, A.M., ed., 1995, Introduction to mineral exploration: Blackwell Scientific, 396 p. [TN 270 I58]
Guilbert, J.M., and Park, C.F., 1996, The geology of ore deposits: Freeman & Co. [QE 390 G95]
Hedenquist, J.W., Thompson, J.F.H., Goldfarb, R.J., and Richards, J.P., editors, 2005, Economic Geology 100th Anniversary Volume: Society of Economic Geologists, 1136 p.
Keays, R.R., Ramsay, W.R.H., and Groves, D.I., eds., 1989, The Geology of Gold Deposits: The Perspective in 1998: Econ. Geol. Mon. 6, 667 p. [QE 390.2 G65 G346]
Kerrich, R., and Cassidy, K.F., 1994, Temporal relationships of lode gold mineralization to accretion, magmatism, metamorphism and deformation—Archean to present: Ore Geology Reviews, v. 9, p. 263–310.
Kirkham, R.V., et al., (eds.), 1993, Mineral deposit modeling: GAC Special Paper 40, 770 p. [TN 263 M55]
Marjoribanks, R., 1997, Geological methods in mineral exploration and mining: Chapman & Hall, 115 p.
Mitchell, A.H.G., and Garson, M.S., 1991, Mineral deposits and global tectonic settings: Academic Press, 405 p. [QE 601 M68]
Naldrett, A.J., 1999, Magmatic sulfide deposits: Oxford University Press, Oxford Monographs on Geology and Geophysics No. 14, 186 p. [QE 389.2 N168]
Peters, W.C., 1997, Exploration and mining geology, 2nd edition: John Wiley & Sons, 685 p. [TN 260 P48]
Roberts, R.G., and Sheahan, P.A., eds., 1998, Ore deposit models: Geoscience Canada Reprint Series 3, Geol. Assoc. Canada. 194 p. [QE 364.2 S7 O662]
Sawkins, F.J., 1994, Metal deposits in relation to plate tectonics: Berlin, Springer-Verlag, 325 p. [TN 263 S27]
Sheahan, P.A., and Cherry, M.E., eds., 1993, Ore deposit models, Volume II: Geoscience Canada Reprint Series 6, Geol. Assoc. Canada, 154 p. [TN 263 O3]
Skinner, B.J., ed., 1991, Econ. Geol. 75th Anniversary Volume. [QE 1 E1912]

Journals

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

Ore Geology Reviews [QE 390 O67] [Online]