Geochemistry GEOS 316

This introduction to the chemical Earth helps students understand fundamental geological interactions and the occurrence of geoscientific phenomena. We will study the structures and activities of atoms and matter; the formation of planets, rocks, and minerals; the nature of Earth's core, mantle, crust, and skin; and the impact of surface conditions on Earth materials. This course emphasizes the manner in which our experience of Earth materials and environments is shaped by the chemical and physical tendencies of the universe. Class discussions incorporate primary literature extensively. Laboratory analyses stress the nature of human-environment interactions and incorporate the instructor's research. Coursework emphasizes the importance of and skills necessary for scientific writing through journalling and constructive report- and paper-writing. Prerequisite: GEOS 201 or 211

Course Goals

- to add to the students' scientific literacy a qualitative and quantitative understanding of geochemical processes,
- to promote student facility in understanding and analyzing geoscientific literature,
- to provide students with the tools necessary to understand and communicate the functioning of Earth systems and interactions,
- to emphasize the importance and interconnectedness of the fields of Geochemistry and encourage the application of geochemical principles and techniques in problem-solving and sustaining Earth.

Course meets for

lecture	laboratory
T R 10:30-11:50 in Dennis 324	R 13-15:50 in Dennis 324/333

Professor: Cynthia Fadem
Email: fademcy@earlham.edu
Phone: 765.983.1231

Office: Dennis 329
Office Hours: TBD
& by appointment/drop-in

Required text:

Walther, J. (2008). *Essentials of Geochemistry.* 2nd edition. Jones & Bartlett Publishers, Boston. (ISBN: 0-763-75922-8)

Assessment

40% Laboratories (9)

25% Written Examinations (3)

15% Papers (3)

10% Class participation (11)

10% Journal entries (10)

Grades

90-92 – A-	≥93 – A	
80-82 – B-	83-85 – B	86-89 – B+
70-72 – C-	73-75 – C	76-79 – C+
60-62 – D-	63-65 – D	66-69 – D+

≤59 – F

Policies

Open door: Students should feel free to write/talk to the instructor at any time regarding course material or life in general.

Academic integrity: Students are expected to abide by Earlham's policy on academic integrity (http://www.earlham.edu/curriculumguide/academics/integrity.html).

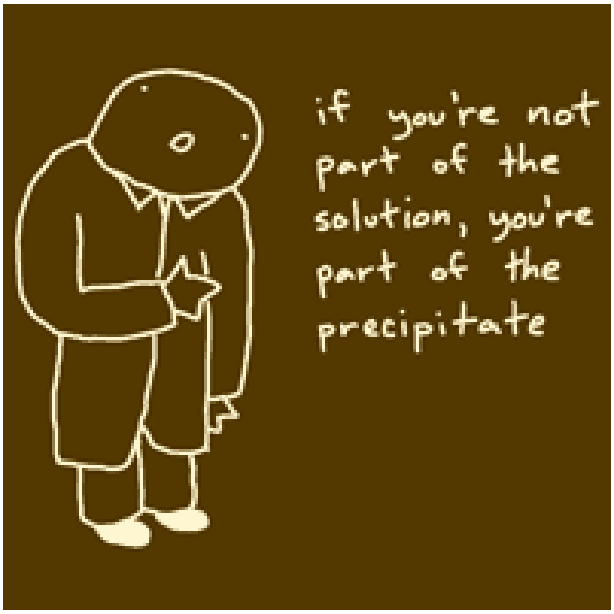
Accommodation: For information on disabilities legislation compliance or to discuss academic accommodation, contact the Academic Enrichment Center (http://www.earlham.edu/~sas/support/, 765.983.1341). Students with college-accommodated disabilities not facilitated by the AEC are encouraged to meet with the instructor as soon as possible so appropriate arrangements may be made.

Attendance: Students are expected to attend all class meetings. Should a student miss a lecture, it is the student's responsibility to obtain notes from a fellow student. Students are never excused from assignments; however, there are cases in which a make-up or alternative assignment/exam would be provided:

- In the case of regularly-scheduled laboratories, absence will be accepted for illness with a doctor's note ONLY.
- In the case of a field trip, absence will be accepted for illness with a doctor's note or religious obligations. *If the student will be missing a field trip for a religious obligation, s/he MUST notify the instructor at least one week prior to the scheduled field trip.*

Due dates: All assignments are issued with a due date and all due dates are listed in the syllabus schedule. Students may always turn in assignments early. Late assignments will incur a *10% per day penalty*.

Curves: The exams will be curved by a quantity sufficient to make the mean 75% if necessary.



Discussion Readings

Alfé, D., Gillan, M.J, and. Price, G.D. (2003). Thermodynamics from first principles: temperature and composition of the Earth's core. *Mineralogical Magazine* 67: 113–123.

Bade, D.L., Carpenter, S.R., Cole, J.J., Hanson, P.C., and Hesslein, R.H.(2004). Controls of δ^{13}C-DIC in lakes: Geochemistry, lake metabolism, and morphometry. *Limnology and Oceanography* 49:1160-1172.

Chorover, J., Kretzschmar, R., Garcia-Pichel, F., and Sparks, D.L. (2007). Soil Biogeochemical Processes within the Critical Zone. *Elements* 3:321–326.

Connelly, J.N. (2010). Adjusting the Solar System's absolute clock. *Science* 327:422-423.

De Yoreo, J.J., Wierzbicki, A., and Dove, P.M. (2007). New insights into mechanisms of biomolecular control on growth of inorganic crystals. *Crystal Engineering Communications* 9:1144–1152.

Dove, P.M., Han, N., and De Yoreo, J.J. (2005). Mechanisms of classical crystal growth theory explain quartz and silicate dissolution behavior. *Proceedings of the National Academy of Sciences* 102:15357–15362.

Ganguly, J., Freed, A.M., Saxena, S.K. (2008). Density profiles of oceanic slabs and surrounding mantle: Integrated thermodynamic and thermal modeling, and implications for the fate of slabs at the 660 km discontinuity. *Physics of the Earth and Planetary Interiors* 172:257-267.

Greenwood, R.C., Franchi, I.A., Jambon, A., and Buchanan, P.C. (2005). Widespread magma oceans on asteroidal bodies in the early Solar System. *Nature* 453:916-918.

Hirose, K. (2010). The Earth's missing ingredient. *Scientific American* 302:58-64.

Jaisi, D.P., Ji, S., Dong, H., Blake, R.E., Eberl, D.D., and Kim, J. (2008). Role of microbial Fe(III) reduction and solution chemistry in aggregation and settling of suspended particles in the Mississippi River Delta Plain, Louisiana, USA. *Clays and Clay Minerals* 56:416–428.

Lakshmanan, E., Kannan, R., and Kumar, M. S. (2003). Major ion chemistry and identification of hydrogeochemical processes of ground water in a part of Kancheepuram district, Tamil Nadu, India. *Environmental Geosciences* 10:157–166.

Li, Y., Massonne, H.-J., Willner, A., Tang, H.-F. and Liu, C.-Q. (2008). Dehydration of clastic sediments in subduction zones: Theoretical study using thermodynamic data of minerals. *Island Arc* 17:577–590.

Mourier, B., Poulenard, J., Chauvel, C., Faivre, P., and Carcaillet, C. (2008). Distinguishing subalpine soil types using extractible Al and Fe fractions and REE geochemistry. *Geoderma* 145:107–120.

Poage, M.A., Barrett, J.E., Virginia, R.A., and Wall, D.H. (2008). The influence of soil geochemistry on nematode distribution, Mcmurdo dry valleys, Antarctica. *Arctic, Antarctic, and Alpine Research* 40:119-128.

Sánchez-Navas, A., Martín-Algarra, A., Rivadeneyra, M.A., Melchor, S., and Martín-Ramos, J.D. (2009). Crystal-growth behavior in Ca-Mg carbonate bacterial spherulites.

Trail, D., Watson, E.B., and Tailby, N.D. (2011). The oxidation state of Hadean magmas and implications for early Earth's atmosphere. *Nature* 480:79-82.

Turley, C. (2008). Impacts of changing ocean chemistry in a high-CO_2 world. *Mineralogical Magazine*. 72:359–362.

Zahnle, K.J. (2006). Earth's earliest atmosphere. *Elements* 2:217-222.

Schedule

Date			Unit	Type	Reading	Assignment	Due Date
JAN	17	R	The Universe & Everything	Lecture		Paper 1	31 Jan
				Lab		Safety training	24 Jan
	22	T		Lecture	Walther Ch. 1, 2		
	24	R		Discussion	Connelly, 2010; Turley, 2008	Discussion 1, Journal 1	
				Lab		Lab 1	31 Jan
	29	T		Discussion	Trail et al., 2011; Zahnle, 2006	Discussion 2	
	31	R		Lecture	Walther Ch. 3	Journal 2	
				Lab		Lab 2	14 Feb
FEB	5	T	**Review**				
	7	R	**Exam 1**				
	12	T	Rocks & Minerals	Discussion	Alfé et al., 2003; Hirose, 2010	Discussion 3	
	14	R		Lecture	Walther Ch. 12, 13	Journal 3, Paper 2	7 Mar
				Lab		Lab 3	28 Feb
	19	T		Lecture	Walther Ch.4, 5	Journal 4	
	21	R	**Early Semester Break - no class**				
	26	T		Discussion	Greenwood et al., 2005; Dove et al., 2005	Discussion 4	
	28	R		Lecture	Walther Ch. 8, 9 (metamorphics)	Journal 5	
				Lab		Lab 4	7 Mar
MAR	5	T		Discussion	Ganguly et al., 2008; Li et al., 2008	Discussion 5	
	7	R		Lecture	Walther Ch. 10, 11	Journal 6	
				Lab		Lab 5	28 Mar
	12	T	**Review**				
	14	R	**Exam 2**				
	19	T	**Spring Break - no class**				
	21	R					
	26	T	Waters & Living Things	Lecture	Walther Ch. 6	Journal 7, Paper 3	25 Apr
	28	R		Lecture	Walther Ch. 7		
				Lab		Lab 6	11 Apr
APR	2	T		Discussion	Bade et al., 2004; Lakshmanan et al., 2003	Discussion 6	
	4	R	**SAA Conference - no class**				
	9	T		Discussion	Sánchez-Navas et al., 2009; De Yoreo et al., 2007	Discussion 7	
	11	R		Lecture	Walther Ch. 9 (soils), 14	Journal 8	
				Lab		Lab 7	18 Apr
	16	T		Discussion	Jaisi et al., 2008; Poage et al., 2008	Discussion 8	
	18	R		Lecture	Walther Ch. 15	Journal 9	
				Lab		Lab 8	25 Apr
	23	T		Discussion	Chorover et al., 2007; Mourier et al., 2008	Discussion 9	
	25	R		Lecture	Walther Ch. 16	Journal 10	
				Lab		Lab 9	2 May
	30	T	**Review**				
MAY	2	R	**GSA Regional Conference - no class**				
	8	W	**Exam 3 @ 16:30**				