

GEOLOGY 250: MINERALOGY

Fall 2009

Lecture: MWF, Mudd 65, 9:40 AM- 11:00 AM

Laboratory: Mudd 65 Monday 1:00 PM -5:00 PM

Instructor: Bereket Haileab

Office Mudd 162, telephone 222-5746

Office hours: Wednesday 11:00-12:00 AM, Thursday 10:00AM -12:00 PM or during lab time (or anytime by appointment)

Laboratory assistants: Nicholas (Nick) Holschuh

[Outline of Major Topics to be covered in this course lecture.](#)

I. Crystallography (chapter 5)

Symmetry operations, combinations of operations
 Point group symmetry, and crystal classes; Hermann-Mauguin symbols
 Miller indices
 Stereographic plotting of symmetry elements, faces and forms
 Crystal systems: and their recognition and definition

II. X-ray crystallography (chapter 7)

Generation of x-rays, x-ray tubes
 Characteristic and white (continuous) radiation
 Diffraction and the Bragg equation
 Why powder diffraction works

III. Crystal chemistry (chapter 3)

Bonding, coordination, and coordination polyhedra, radius ratios
 Polymorphism (types of transformations), solid solution, exsolution
 Color in minerals; ligand field theory
 Nucleation and growth of minerals

IV. Phase equilibria (chapter 4)

The phase rule
 Reading phase diagrams; one, two and three component systems
 Free energy and phase diagrams

V. Optical crystallography (chapter 7 and few chapters from Bloss)

Index of refraction, refraction of light, Snell's law
 Becke lines and dispersion colors
 Indicatrix theory and the geometry of isotropic, uniaxial, and biaxial minerals
 The relationship between crystallography and optical behavior
 Origin of interference colors; birefringence; path difference
 Addition and subtraction with accessory plates
 Interference figures; their origin and interoperation
 Determination of optic sign
 Optics of many common rock forming minerals

****** [Click here to link to all Lecture Notes and](#) ******

[Powerpoint presentations for this course](#)

Syllabus:

September 14	M	Introduction
September 16	W	Crystallography, Lattice, Lattice point, Lattice line, Lattice plane
September 18	F	Crystallography, Lattice, Lattice point, Lattice line, Lattice plane
September 21	M	Symmetry operations, combination of operations, Point group symmetry & crystal classes;
September 23	W	Symmetry operations, combination of operations, Point group symmetry & crystal classes;
September 25	F	Symmetry operations, combination of operations, Point group symmetry & crystal classes;
September 28	M	Hermann-Maugui symbols, Miller Indices, Stereographic plotting of symmetry elements, faces, and forms, crystal systems their recognition and definitions.
September 30	W	Crystal chemistry: Bonding, coordination & coordination polyhedral, radius ratios,
October 2	F	Crystal chemistry: Bonding, coordination & coordination polyhedral, radius ratios,
October 5	M	Structures: Major types of silicate minerals, structural groups, variation of silica from group to group, recognition of group base on the Si/O
October 7	W	X-ray crystallography, Characteristic & continuous radiation.
October 9	F	Diffraction and Bragg equation. How powder diffraction works.
October 12	M	Phase equilibria and thermodynamics; The phase rule, reading phase diagrams, one, two, three component systems;
October 14	W	Free energy and phase diagrams (Remember also there will Mineral Id exam on October 26)
October 16	F	Time to catch up
October 19	M	Midterm Break
October 21	W	Optical mineralogy, Light, refractive index; polarized light, isotropic media, Becke lines, Dispersion, relation between crystallography and optical behavior of minerals.
October 23	F	Isotropic minerals; uniaxial optics, optic sign, birefringence, & origin of interference colors

October 26	M	The indicatrix; interference figures.
October 28	W	Uniaxial minerals
October 30	F	Biaxial minerals, the biaxial indicatrix, Biaxial optics, optic angle, sign, orientation
November 2	M	Dispersion, its effects, observation and use
November 4	W	General description of alkali feldspars optics Plagioclase feldspar optics, determinative methods
November 6	F	Optics of Olivines and pyroxenes
November 9	M	Take home exam, Optics of Olivines and pyroxenes conti.
November 11	W	Optics of Amphiboles
November 13	F	Optics of Micas Aluminosilicates
November 16	M	Time to catch up.
November 18	W	Take home exam due

Grading:

Midterm	25 %
Mineral Id	20 %
Take Home exam	25%
Laboratory	15 %
Quizzes and Homework	15 %

Readings:

All from Klein 2002 unless otherwise noted

September 14	W	Chapter 5, p 214-239
September 16	F	Chapter 5, p175-188
September 18	M	Chapter 5, p. 192-194, Mineralogy Tutorial CD
September 21	W	Chapter 3, p. 38-103
September 23	F	Chapter 3, p. 38-103
September 25	M	Time to catch up
September 28	W	Chapter 7, p. 309-321
September 30	F	Chapter 7, p. 309-321
October 2	M	Chapter 3, p. 80-90 and Chapter11, p441-490
October 5	W	Chapter11, p441-490
October 7	F	Chapter 4, p.115-136
October 9	M	Chapter 4, p.115-136
October 12	W	Chapter 4, p.115-136
October 14	F	Chapter 7. p. 290-309
October 16	M	Midterm exam
October 19	W	Midterm Break
October 21	F	All reading for the remaining part of the course are from Bloss, see lab syllabus (page 5) for detailed reading
October 23	M	Bloss and handouts
October 26	W	Bloss and handouts
October 28	F	Bloss and handouts
October 30	M	Bloss and handouts
November 2	W	Bloss and handouts
November 4	F	Bloss and handouts
November 6	M	Bloss and handouts
November 9	W	Take home exam
November 11	W	Bloss and handouts
November 13	F	Bloss and handouts
November 16	M	Bloss and handouts
November 18	W	Bloss and handouts
November 18	F	Bloss and handouts (Take home exam due)

Exams and quizzes:

Midterm	October 16, 2009	60 minutes
Mineral Id	October 26	60 minutes during lab time
Take Home Exam	November 9	Week and half long

Take Home exam November 18 @ 5:00 PM
 Quizzes At the end of each Chapter 10 minutes long

[Click here for Minerals to know for the Mineral Quiz](#)

Required Books and Materials:

Book: Klein, C., 2000, **Mineral Science, (23rd Edition), Wiley & Sons, 675 pages**

Useful References (* indicates book(s) on General Reserve)

Berry, L.G., Mason, B. and Dietrich, R.B., 1983, Mineralogy(*) (2nd Edition), W.H. Freeman & Co., 561 p.
 Deer, W.A., Howie, R.A. and Zussman, J., 1966, An Introduction to the Rock-forming Minerals(*), Longman, 528 p.
 Zoltai, T. and Stout, J.H., 1984, Mineralogy Concepts and Principles(*), Burgess Publishing Co., 505 p.

Dana's System of Mineralogy, John Wiley and Sons.

Vol. 1. Elements, Sulfides, Sulfosalts and Oxides, Palache, C., Berman, H. and Frondel, C., 1944.
 Vol. 2. Halides, Nitrates, Borates, Carbonates, Sulfates, Phosphates, Arsenates, Tungstates, Molybdates, etc., Palache, C., Berman, H. and Frondel, C., 1951.
 Vol. 3. Silica Minerals, Frondel, C., 1962.

Deer, W.A., Howie, R.A. and Zussman, J., John Wiley and Sons.

Vol. 1. Ortho and Ring Silicates, 1962.
 Vol. 2. Chain Silicates, 1963.
 Vol. 3. Sheet Silicates, 1962.
 Vol. 4. Framework Silicates, 1963.
 Vol. 5. Non Silicates, 1962.

Reviews in Mineralogy, Mineralogical Society of America

Vol. 1. Sulfide Mineralogy, Ribbe, P.H., Ed., 1974, 284 p.
 Vol. 2. Feldspar Mineralogy, Ribbe, P.H., Ed., 1982, 350 p.
 Vol. 3. Oxide Minerals, Rumble, D., III, Ed., 1976, 502 p.
 Vol. 4. Mineralogy and Geology of Natural Zeolites, Mumpton, F.A., Ed., 1977, 232 p.
 Vol. 5. Orthosilicates, Ribbe, P.H., Ed., 1982, 410 p.
 Vol. 6. Marine Minerals, Burns, R.G. Ed., 1979, 380 p.
 Vol. 7. Pyroxenes, Prewitt, C.T., Ed., 1980, 525 p.
 Vol. 9a. Amphiboles and other Hydrous Pyriboles- Mineralogy, Veblen, D.R., Ed., 1981, 372 p.
 Vol. 11. Carbonates: Mineralogy and Chemistry, Reeder, R.J., Ed., 1983, 394 p.
 Vol. 13. Micas, Bailey, S.W., Ed., 1984, 584 p.
 Vol. 19. Hydrous Phyllosilicates (Exclusive of Micas), Bailey, S.W., Ed., 1988, 725 p.
 Vol. 21. Geochem. and mineralogy of Rare Earth Elements, Lipin, B.R. and McKay, G.A., Eds., 1989, 348 p.

Handbook of Mineralogy, Anthony, J.W., Bideaux, R.A., Bladh, K.W. & Nichols, M.C., Mineral Data Publ., Tucson, AZ.

Laboratory syllabus:

<u>Lab</u>	<u>Date</u>	<u>Topic</u>	<u>Reading</u>
Lab 1	September 14	Physical properties of minerals	Chapter 2, page 17-37
Lab 2	September 21	Crystallography	Chapter 3, p. 170-200, CD
Lab 3	September 28	Systematic Min. Identification	Chapter. 8, 9, 10, 11, 12, and 14
Lab 4	October 5	X-Ray Crystallography	Chapter. 7, p. 290-331
Lab 5	October 12	No lab	No lab
Lab 6	October 26	Optics	Chapter. 8, 9, 10, 11, 12, and 14
Lab 7	November 2	Isotopic minerals and Uniaxial minerals	Chapter. 7 p. 291-303 and Bloss*
Lab 8	November 9	Uniaxial minerals	Bloss
Lab 9	November 16	Biaxial Minerals	Bloss

Lab Information and Syllabus:

All labs are due at the beginning of the following lab.
 I NEED ALL THE LABS DUE BY THE DUE DATES (THE BEGINNING OF THE NEXT LAB),
 OTHERWISE IT WILL BE DIFFICULT FOR ME TO GRADE THEM. ALSO I WILL POST THE KEY

TO EACH LAB BY THE DUE DATE SO IF YOU DON'T GET IN THE LABS TO ME THEY WILL NOT BE GRADED.

Reading from Bloss*:

Topic	page
Refractive index, isotropic and anisotropic media	6
Snell's law	8
Dispersion	12
Optical examination of isotropic substances, Refractive index measurement in liquids.	47
Optical indicatrices	106
Interference colors	65-90
Orthoscopic and conoscopic	106
Origin of isochromes	109
Origin of isogyres	112
Types of Uniaxial interference figures	116-120
Determination of optic sign	127-130
Extinction angles	145
Absorption and pleochroism	147
Biaxial crystals, Biaxial indicatrix	151-153
Biaxial interference figures	170-177
Determination of optic sign in biaxial minerals	197
Measurement of 2V and Measurement and significance of extinction angles	203, 207-210
Sign of elongation	211

Laboratory Supplies:

Below is a list of laboratory supplies needed for every laboratory exercise for Mineralogy 250 and a clue as to where the materials may be found or obtained.

Lab 1 Mineral Properties and hand specimen identification

Lab 2 Crystallography,

- Wooden blocks
- Large plastic crystal system models
- Mineral samples

Lab 3 X-ray and Density

- Demonstration of X-ray in Mudd
- Synthetic X-ray patterns for 14 Bravais lattices
- Synthetic X-ray patterns for cubic lattices out to 600
- X-ray diffraction chart recording

Lab 4 Systematic Mineral Identification: Native Elements, Sulfides, Sulfosalts, Oxides,

Hydroxides, Halides, Phosphates Systematic Mineral Identification: Carbonates, Sulfates, Silicates

- Review mineral identification techniques: color, hardness, etc.
- Review characteristics of the minerals of the week

Labs 6-9 Optical mineralogy

Familiarization of parts and their functions of the optical microscope. Immersion method determining refractive Index. Optical examination of Isotropic minerals in immersion oils, uniaxial and biaxial minerals, and optics of the most common rock forming minerals.

Microscopes, oils with different refractive index and many thin-sections consisting of different minerals will be available for these labs.

[Click here to return to Mineralogy main page](#)

Links

WHY DO WE MINE?