Course Syllabus as of August 23, 2017
Geol 2010 – Mineralogy, Fall 2017
Department of Geology and Geophysics, University of Wyoming

Instructor: John Kaszuba	Phone: (307) 766-6065
Office: 1010 Earth Sciences Building (ESB)	Email: John.Kaszuba@uwyo.edu
Class Meets: Tues & Thurs 8:35 – 9:25 am in Geology Building 216	
Office Hours: Mon 2-3, Tues & Thurs 9:30-10:30, and by appointment	

Teaching Assistant (all laboratory sessions meet in GE Room 202):
Lisa Kant Laboratory Sections: Tues 3:10 – 5:00 pm, Thurs 3:10 – 5:00 pm Office Hours, Room GE213: Mon 2-3, Tues 10-11, Thurs 10-11 and by appointment
Matt Edgin Laboratory Sections: Wed 1:10 – 3:00 pm, Thurs 1:10 – 3:00 pm Office Hours, Room GE202/304: Mon 1-3, Wed 3-4, and by appointment

Prerequisites: CHEM 1020 General Chemistry I, or concurrent.

Course Description: Introduction to rock-forming minerals. Includes introduction to crystallography, crystal chemistry and the occurrence and identification of common minerals, with emphasis on silicates. 3 credit hours (2 hours lecture and 2 hours lab each week).

The Earth is a geological system, and mineralogy serves as the foundation for its study. Minerals are the fundamental building blocks of the Earth. This class provides you with the basis on which you will build your geologic careers! Minerals form the Earth's substrate in which our food grows, they soften our water, they crack hydrocarbons, they cleanse hazardous wastes and they provide us with materials that bring our life above subsistence living. Consequently, it is imperative that minerals be understood and appreciated, even by laypersons. Mineralogy is even more important now as we confront many worldwide issues: the carbon cycle and issues of global climate change; where to store wastes, including radioactive and hazardous wastes and carbon dioxide; and where to locate aquifers for vanishing groundwater resources. Each of us can make a difference when asked to vote on these issues and when discussing these topics with neighbors. In addition, minerals are simply beautiful to observe! This class has been prepared with you in mind and to assist you in your future geologic endeavors. Our efforts into this course are considerable, we expect the same of you. Most of all, we love minerals and mineralogy and hope you will too.

Course Objectives & Outcomes: In this course we have two broad types of objectives, becoming technically competent in mineralogy and developing fundamental scientific competence in quantitative thinking skills important to mineralogy. Technical competence in mineralogy includes the following:

1) an understanding of the "language" of mineralogy and its subdisciplines of crystallography and crystal chemistry,
2) an understanding of the linkage between macroscopic properties and a mineral's internal structure

3) knowledge of the common rock forming minerals, particularly diagnostic physical properties and hand sample identification, geologic context and importance to earth processes, and societal relevance including economic value and whether exploitation of the mineral poses health consequences.
4) An understanding of how we use minerals to decipher the earth's (and other planet's) geologic history and evolution

Fundamental scientific competence in quantitative thinking skills includes the following:

1) three-dimensional thinking
2) use of graphs and graphical interpretation
3) forward and "reverse" thinking
4) applying the language and knowledge of mineralogy to solving problems.

Note that these fundamental scientific skills are also important to upper division Geology courses and to the scientific professional in general. Along the way our goal is to help instill an attitude of life-long learning and critical thinking!

Primary Text: Cornelis Klein and Barbara Dutrow, 2007, Manual of Mineral Science (Manual of Mineralogy), Wiley; 23rd edition, 716 pages, **ISBN-10:** 0471721573, **ISBN-13:** 978-0471721574. This book is also on reserve in the Geology Library.

Supplemental material:

1) M.D. Dyar, M.E. Gunter, and D. Tasa, 2007, Mineralogy and Optical Mineralogy (http://www.minsocam.org/MSA/DGTtxt/). This book is on reserve in the Geology Library.
2) W.D. Nesse, 2012, Introduction to Mineralogy, 2nd Edition, Oxford University Press. This book is on reserve in the Geology Library.
3) Other library reserves and materials as needed.

Note: please read assignments prior to class

Course Assignments and Grading: Grades will be based on a combination of lecture and laboratory exams/quizzes, homework assignments, and laboratory assignments. During the semester there will be two 1-hour exams in the lecture portion of the class. Exam questions will be based on material from lectures as well as from the book. A comprehensive final exam will be held for both lecture and lab (separately).

As professional geologists you will be expected to identify the common rock forming minerals. You will also be expected to know basic properties such as mineral formulas, distinguishing characteristics, modes of occurrence, etc. I will provide you with a list of about 120 minerals that you will be responsible for knowing for the course. These are the important minerals that all geologists need to know in order to be successful. Know these minerals, you will be tested on them without the benefit of notes or open books.

Most states require you take one or more tests before you can work independently as a professional geologist. To give you a sense of these tests, and the importance of mineralogy to these tests, each of the lecture exams will contain a few sample questions from tests of the Wyoming Board of Professional Geologists.

Letter grades will be assigned from the final numerical score, derived as follows:

Lecture	Exams (two during the semester)	(50 points each)	100 points
	Final		100 points
	Homework/miscellaneous activities	Varies	40 points
	Total lecture		240 points
Lab	11 Labs	15 points each	165 points
	1 Saturday Field Lab	20 points	20 points
	5 Quizzes	5 points each	25 points
	Final Exam		100 points
	Total Lab		310 points
Total Class			550 points
Extra Credit	Complete set of mineral flash cards	10 points total	

Notice that overall laboratory activities carry more weight than lecture activities (56% vs. 44%). Letter grades will be assigned from the final numerical score. I use standard percentages to assign grades (e.g., ≥ 90% = A, 80-89% = B, etc.). I do not grade on a curve.

Lecture Final Exam: Thursday, December 14, 8:00 – 10:00 am.

Lab Final Exam: Last week of classes during your normal laboratory period.

Attendance Policy: Attendance of labs is mandatory. University sponsored absences are cleared through the Office of Student Life. If you plan to be gone at any time during the semester and your absence will be officially authorized by UW, please contact me beforehand so that we can work out some way for you to make up any assignments. Any absences from class as a result of illness will require proper documentation from your physician.

Conduct: University Regulation 29, change 1, states that the instructor can "establish reasonable standards of conduct for each class which should be made known at the outset." This class requires engagement and participation. We do not always have to agree with each other, but we will treat each other with mutual courtesy and respect. The College of Arts and Sciences has assembled guidelines for attendance, classroom etiquette (no sleeping or cell phone use!), phone and email protocol, office hours and how to make appointments outside of office hours. Please see the following website for this useful information: http://uwadmnweb.uwyo.edu/a&s/Current/students_teachers_work.htm.

Academic Honesty: UW Regulation 6-802. The University of Wyoming is built upon a strong foundation of integrity, respect and trust. All members of the university community have a responsibility to be honest and the right to expect honesty from others. Any form of academic dishonesty is unacceptable to our community and will not be tolerated [from the UW General Bulletin]. Teachers and students should report suspected violations of standards of academic honesty to the instructor, department head, or dean. Other University regulations can be found at: http://uwadmnweb.uwyo.edu/legal/universityregulations.htm.

American Mineralogist Undergraduate Award: The Mineralogical Society of America's American Mineralogist Undergraduate (AMU) Award program recognizes outstanding students who have shown an interest and ability in the discipline of mineralogy. If a student exhibits exceptional achievement in mineralogy during the semester I will recognize this accomplishment by nominating one student for the MSA award. More information on the award is posted on the MSA website http://www.minsocam.org/MSA/Awards/UnderGrad_Award.html - AMU_nomination.

Online Resources: We will use *WyoCourses* for the online course website to post announcements, reading material, course syllabus, etc. Consult this website regularly for announcements and other information. Students are automatically enrolled in this course website. Students use their UWYO domain accounts to log into WyoWeb and then access WyoCourses via the link near the top center of the page.

Here are some helpful hints to make Mineralogy easier and more fun!

1) **Review Introductory Material in Physical Geology:** Class requires that you have a full knowledge of the rocks and minerals section of your Introductory Geology text. Please re-read this portion of your Physical Geology Book.
2) **Attend Class:** You will do much better if you attend class. Lecture material is derived from sources in addition to the text, and mineralogy books can be difficult to understand. Lectures will use visual aids to supplement the text and enhance class presentations. Questions from the class are always encouraged. Please inform me if you are going to be absent from class and get the notes from a friend.
3) **Lab:** The lab is the 'hands-on' part of the course. Lectures concentrate on concepts and principles, lab exercises put these principles to use. Therefore, you are required to attend lab. During this time, there is always someone available to help and answer questions! Lab assignments reinforce lecture material and aid in comprehension. They should be thoroughly understood.
4) **TA's:** The TA is in charge of the laboratory. Please consult with your TA regarding their policies and preferences for laboratory assignments.
5) **Reading:** Reading assignments should be completed prior to the class period as they serve as supplemental material. Bring your questions to class.
6) **Communication:** If you have questions, take advantage of the Teaching Assistants and the Professor. Make full use of office hours. Make an appointment to see the professor or the TA if needed.
7) **Students and Teachers Working Together:** the College of Arts and Sciences has assembled guidelines for attendance, classroom etiquette (no sleeping or cell phone use!), phone and email protocol, office hours and how to make appointments outside of office hours. Please see the following website for this useful information: http://uwadmnweb.uwyo.edu/a&s/Current/students_teachers_work.htm

Changes to the Syllabus: The course schedule is an outline of the major topics we will discuss in class. Given the breadth of material that we will discuss and the level of student interest, it may be necessary from time to time to deviate from this course outline. Thus, the schedule will be flexible and is likely to evolve through time, and any significant modifications will be announced in advance in class.

Disability Statement: If you have a physical, learning, sensory or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with, and provide documentation of your disability to University Disability Support Services (UDSS) in SEO, room 330 Knight Hall, 766-6189, TTY: 766-3073.

General lecture Outline and Reading Assignments for Geol 2010 - Mineralogy

#	Date	Lecture Topic	Required Reading Klein & Dutrow	Recommended Reading
1	31-Aug	Introduction, Minerals in Hand Sample, the "Big 9"	Chapter 1	Dyar et al.: Chapter 1 except section on optical classes
2	5-Sept	Minerals in Hand Sample, the "Big 9"	Chapters 2 and 22	Dyar et al.: Chapter 2 Nesse: Chapter 6 and p. 8-10, 204-205
3	7-Sept	Crystallography: Symmetry and Symmetry Operations	Chapters 1 and 6	Nesse: Chapter 2; Dyar et al.: Chapter 4
4	12-Sept	Crystallography: Crystal Systems		
5	14-Sept	Crystallography: Forms, Miller Indices		
6	19-Sept	Crystallography: Wrap Up		
7	21-Sept	Crystal Chemistry: Periodic Table and Chemical Bonding	Chapters 3 & 4	Nesse: Chapter 3 & p. 67-80
8	26-Sept	Crystal Chemistry: Coordination Number, Packing, Solid Solutions, Twinning I	---	---
9	28-Sept	Crystal Chemistry: Coordination Number, Packing, Solid Solutions, Twinning II	p. 90-103	Nesse: p. 81-83
10	3-Oct	**EXAM I**	---	---
11	5-Oct	Geologic Phase Diagrams	p. 104-108 and Chapter 11	Nesse: p. 83-84
12	10-Oct	Native Elements	Chapters 15	Nesse: Chapter 18
13	12-Oct	Oxides	Chapter 16	Nesse: Chapters 20
14	17-Oct	Sulfides	Chapters 15	Nesse: Chapter 19
15	19-Oct	Sulfates and Halides	Chapters 16 and 17	Nesse: p. 375-380, 409-413
16	24-Oct	Carbonates		Nesse: p. 359-374
17	26-Oct	Introduction to Silicates	p. 434-438, 575-576	Nesse: Chapter 11
18	31-Oct	Bowen's Reaction Series	---	---
19	2-Nov	Quartz and Silica Minerals	p. 467-470, 534-539	Nesse: p. 231-239
20	7-Nov	Feldspars and Feldspathoids	p. 470-477, 539-546	Nesse: p. 239-258
21	9-Nov	**EXAM II**	---	---
22	14-Nov	Olivine	p. 438-439, 484-487	Nesse: p. 338-341
23	16-Nov	Phase Equilibria	---	---
24	21-Nov	Pyroxene	p. 446-452, 505-513	Nesse: p. 294-310
25	23-Nov	Thanksgiving Holiday, no class	---	---
26	28-Nov	Finish Pyroxene, start	p. 452-456, 514-519	Nesse: p. 310-322

		Amphibole		
27	30-Nov	Amphibole	---	---
28	5-Dec	Phyllosilicates	p. 456-467, 519-534	Nesse: Chapter 13
29	7-Dec	Garnet, Al-rich silicates (Al_2SiO_5 minerals, staurolite, cordierite)	p. 439-446, 487-495, 503-504	Nesse: p. 341-354, 333-334

Laboratory Outline for Geol 2010 - Mineralogy

Week #	Week of	Lab	Topic	Quizzes/Exams (Closed Book, No Notes)
1	28-Aug	**No Lab**	First week of classes	---
2	4-Sept	Lab 1	Minerals in Hand Sample (The Big 9)	---
3	11-Sept	Lab 2	Minerals in the Field (Vedauwoo)	---
4	18-Sept	Lab 3	Crystallography	Quiz #1
5	25-Sept	Lab 4	Native elements, oxides, hydroxides	---
6	2-Oct	Lab 5	Sulfides	Quiz #2
7	9-Oct	Lab 6	Saturday Lab: Minerals in the Field (Laramie Anorthosite Complex). No lab Tues, Wed or Thur; **field lab Sat 14 Oct**	---
8	16-Oct	Lab 7	Quartz, feldspars, and feldspathoids	---
9	23-Oct	Lab 8	Carbonates, sulfates, phosphates, and halides	Quiz #3
10	30-Oct	Lab 9	Olivine, pyroxene, and amphibole	---
11	6-Nov	Lab 10	Phyllosilicates	Quiz #4
12	13-Nov	Lab 11	Al, Ca-Al, and Fe-Mg-Al silicates	---
13	20-Nov	**No Lab**	Thanksgiving Holiday	---
14	27-Nov	Lab 12	Minerals in Rocks and Review	Quiz #5
15	4-Dec	---	---	Lab Final

Lab 7, Saturday Field Lab: Saturday October 14, weather permitting. Backup date, Saturday November 11, weather permitting. We will leave at 8a and return to campus around 3p. This field lab is required, students who cannot attend must consult in advance with instructors for make-up assignment. This field lab replaces normally scheduled lab sections; labs will not meet Tues 10/10, Wed 10/11, or Thurs 10/12.

Lab Grading: Grades are administered by the TA. All laboratory sections will follow the same syllabus. Laboratory activities required of each student include 12 lab assignments, 5 lab quizzes, and 1 lab final. Lab assignments must be turned in at the beginning of lab to receive credit. Extra credit of 10 points will be awarded to students who develop a complete set of mineral flash cards.

Required Supplies and Materials: A hand lens is required for lab; you can purchase these at the bookstore.

Minerals to Know (~120 total) (Minerals discussed in Klein and Dutrow, 2007)
(know Formulas, Geologic Environments, Distinguishing Characteristics)
Fall 2017

Native Elements (7)	
Sulfur	S
Diamond	C
Graphite	C
Gold	Au
Copper	Cu
Platinum	Pt
Iron	Fe

Hydroxides (4)	
Brucite	Mg(OH)2
Gibbsite	Al(OH)3
Goethite	FeO(OH)
Diaspore	AlO(OH)

Oxides (11)			
(X_2O & XO)			
	Cuprite	Cu2O	
	Periclase	MgO	
	Zincite	ZnO	
(X_2O_3)	Hematite grp		
		Hematite	Fe2O3
		Corundum	Al2O3
		Ilmenite	FeTiO3
(XY_2O_4)	Spinel grp		
		Spinel	MgAl2O4
		Magnetite	Fe3O4
		Chromite	FeCr2O4
(XO_2)			
	Rutile group		
		Rutile	TiO2
		Cassiterite	SnO2
		Pyrolusite	MnO2
	Fluorite structure		
		Fluorite	CaF2

Sulfates (5)		
Barite group		
	Barite	BaSO4
	Celestite	SrSO4
	Anglesite	PbSO4
anhydrite	CaSO4	
Gypsum	CaSO4•2H2O	

Halides (2)	
Halite	NaCl
Sylvite	KCl

Fe-Sulfides (2)	
Pyrite	FeS_2
Pyrrhotite - Troilite series	Composition is $Fe_{1-x}S$ with X = 0.0 - 0.2. Stoichiometric pyrrhotite (x = 0.0) is troilite
Cu-Fe-Sulfides (3)	
Chalcocite	Cu_2S
Bornite	Cu_5FeS_4
Chalcopyrite	$CuFeS_2$
Other Sulfides (9)	
Galena	PbS
Sphalerite	ZnS
Cinebar	HgS
Molybdenite	MoS2
Marcasite	FeS2
Orpiment	As2S3
Realgar	As4S4
Enargite	Cu3AsS4
Arsenopyrite	FeAsS
Stibnite	Sb2S3
Pentlandite	(FeNi)9S8

Carbonates (9)		
	Know formula	Know contents
Calcite Group (Rhombohedral)		
Calcite	CaCO3	
Magnesite	MgCO3	
Siderite	FeCO3	
Rhodochrosite	MnCO3	
Aragonite Group (Orthorhombic)		
Aragonite	CaCO3	
Witherite	BaCO3	
Dolomite Group (Rhombohedral)		
Dolomite	CaMg(CO3)2	
Ankerite	CaFe(CO3)2	
Monoclinic carbonates with OH		
Malachite		Cu2CO3(OH)2
Azurite		Cu3(CO3)2(OH)2

Phosphates (1)		
	Know formula	Know contents
Apatite		$Ca_5(PO_4)_3(OH,Cl,F)$

Silicates (54)			
Class	Mineral	Know Formula	Know Contents
Nesosilicate			
	Forsterite	$Mg2SiO4$	
	Fayalite	$Fe2SiO4$	
	Zircon	$ZrSiO_4$	
see table below	Garnet	$A_3B_2Si_3O_{12}$	
	Kyanite	Al_2SiO_5	
	Sillimanite	Al_2SiO_5	
	Andalusite	Al_2SiO_5	
	Staurolite		$Fe_2Al_9O_6[(Si,Al)O_4]_4(OH)_2$ (hydrous Fe Al silicate)
	Titanite (aka Sphene)		$CaTiOSiO_4$
	Topaz		$Al_2SiO_4(F,OH)_3$
Sorosilicate			
	Zoisite		$Ca_2Al_3OSiO_4Si_2O_7(OH)$ hydroxy Ca-Al silicate
	Clinozoisite-Epidote		$Ca_2(Al,Fe^{3+})Al_2OSiO_4Si_2O_7(OH)$ hydroxy Ca-Al to Ca-Al-Fe silicate
Cyclosilicates			
	Cordierite		$Mg_2Al_3(AlSi_5)O_{18}$ Mg-Al silicate
	Tourmaline		Complex borosilicate $Na(Mg,Fe,Li,Al)_3Al_6(Si_6O_{18})(BO_3)_3(O,OH,F)_4$
	Beryl		$Be_3Al_2(SiO_3)_6$
Inosilicates (single chain)		$ABSi_2O_6$	
Quadrilateral pyroxenes	Diopside	$CaMgSi_2O_6$	
	Calcic clinopyoxene (cpx)	$Ca(Mg,Fe)Si_2O_6$	
	Hedenbergite	$CaFeSi_2O_6$	
	Augite		Ca, Mg, Fe, Al cpx
	Enstatite	$MgSiO_3$	
	Orthopyroxene	$(Mg,Fe)SiO_3$	
	Ferrosilite	$FeSiO_3$	
Sodic pyroxenes	Aegerine-augite		Ca, Mg, Na, Fe, pyroxene
	Aegerine (acmite)	$NaFeSi_2O_6$	
	Omphacite		Ca, Mg, Na, Al pyroxene
	Jadeite	$NaAlSi_2O_6$	
Pyroxenoids	Wollastonite	$CaSiO_3$	
Other	Spodumene	$LiAlSi_2O_6$	
Inosilicates (double chain)		$AX_2Y_5Z_8O_{22}(OH)_2$	
Quadrilateral amphiboles		$X_2Y_5Si_8O_{22}(OH)_2$	
	Tremolite	$Ca_2Mg_5Si_8O_{22}(OH)_2$	
	Actinolite	$Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	
	Ferroactinolite		$Ca_2Fe_5Si_8O_{22}(OH)_2$
	Anthophyllite		$Mg_7Si_8O_{22}(OH)_2$
	Cummingtonite-		$(Mg,Fe)_7Si_8O_{22}(OH)_2$

	Grunerite		
Sodic amphiboles		$X_2Y_5Si_8O_{22}(OH)_2$	
	Riebeckite		$Na_2(Fe^{2+},Mg)_3Fe^{3+}{}_2Si_8O_{22}(OH)_2$
	Glaucophane		$Na_2(Fe^{2+},Mg)_3Al_2Si_8O_{22}(OH)_2$
Hornblende	Hornblende		Na, K, Ca, Mg, Fe, Al amphibole
Phyllosilicates (see table below)			
	Smectite		$(Ca_{x/2},Na_x)(Al_{2-x}Mg_x)Si_4O_{10}(OH)_2.nH_2O$ (know that smectite is a TOT silicate with Ca , Na, and H2O between the TOT's)
	Illite		$K_{1-x}Al_2(Si_{4-x}Al_x)O_{10}(OH)_2$ (know that illite is a TOT K TOT phyllosilicate with less Al in the tetrahedral site than muscovite)
Tectosilicates			
	Quartz, Cristobalite, Tridymite, Coesite, Chalcedony, Opal, Chert	SiO_2	
	Albite	$NaAlSi_3O_8$	
	Labradorite		~ 50% albite & 50% anorthite solid solution
	Anorthite	$CaAl_2Si_2O_8$	
	Microcline	$KAlSi_3O_8$	
	Orthoclase	$KAlSi_3O_8$	
	Sanidine	$KAlSi_3O_8$	
	Nepheline	$NaAlSiO_4$	
	Leucite	$KAlSi_2O_6$	
	Sodalite		$Na_8(AlSiO_4)_6Cl_2$
	Scapolite		$(Na,Ca)_4(Al,Si)_3Si_6O_{24}(Cl,CO_3,SO_4)$

Garnets (6)

Pyralspites				**Ugrandites**		
A	**B**	**Mineral**		**A**	**B**	**Mineral**
Mg	Al	Pyrope		Ca	Cr	Uvarovite
Fe	Al	Almandine		Ca	Al	Grossular
Mn	Al	Spessartine		Ca	Fe	Andradite

Phyllosilicates

	Dioctahedral	Trioctahedral	Dioctahedral and Trioctahedral
O	Gibbsite $Al(OH)_3$	Brucite $Mg(OH)_2$	---
T-O	Kaolinite $Al_2Si_2O_5(OH)_4$	Serpentine $Mg_3Si_2O_5(OH)_4$	---
T-O-T	Pyrophyllite $Al_2Si_4O_{10}(OH)_2$	Talc $Mg_3Si_4O_{10}(OH)_2$	---
T-O-T - O - T-O-T	Chlorite $(Mg_5Al)(Si_3Al)O_{10}(OH)_8$		---
T-O-T K^+ T-O-T	Muscovite $KAl_3Si_3O_{10}(OH)_2$	Biotite $K(Fe,Mg)_3AlSi_3O_{10}(OH)_2$	---
	Illite – like muscovite, but less Al in tetrahedral site	---	Smectite – Na, Ca and H_2O between TOT sheets