University of Arkansas Department of Geosciences

GEOS 40803 / 52803 - Economic Geology

Professor: Office: E-mail:	Adriana Potra Gearhart Hall 22 <u>potra@uark.edu</u>
Required textbooks:	<u>Ore Deposit Geology</u> (2013), John Ridley (textbook I) <u>Introduction to Ore-Forming Processes</u> (2005), Lawrence Robb (textbook II) <u>Geology of Mineral Resources</u> (2015), M. Jebrak and E. Marcoux (textbook III)
Additional texts:	The Geology of Ore Deposits (2007), J.M. Guilbert and C.F. Park

Course Description:

Introduction to mineral deposits used as economic resources. Covers basic geology and geochemistry of mineral deposit formations and the formation of major classes of deposits. Examines the relationship between the distribution of ores, oil, gas, coal, and Plate Tectonics. Explores environmental issues associated with the extraction of earth resources.

Learning Objectives:

- 1. Confidently describe the geology, tectonic setting, and geochemistry that accompany metallic and non-metallic mineral deposit formation
- 2. Explain the formation of major classes of ore deposits
- 3. Describe the macroscopic and microscopic properties of major ore minerals
- 4. Describe the use of various economic minerals
- 5. Analyze the environmental concerns associated with extraction of earth resources
- 6. The <u>graduate students</u> will investigate an ore deposit and report their findings and interpretations related to genesis, tectonic history, and geochemistry. The project will consist of a written report (6-8 pages) and brief PowerPoint presentation.

Learning Outcomes:

- 1. Become familiar with the geologic and tectonic setting that accompany formation of ore deposits
- 2. Understand the geochemistry of ore deposits
- 3. Understand the processes that control the formation of various types of ores
- 4. Know how to classify ore deposits according to their (1) genetic type and (2) mineral association / commodity
- 5. Become familiar with basic principles of mining and exploration economics
- 6. Know the occurrence of important ore deposits worldwide

Mineralogy and Chemistry are a MUST for this course, and Petrology and Geochemistry are very USEFUL!

Evaluation

GEOS 40803 (400 points)			GEOS 52803 (600 points)			
Exam 1	100 pc	oints		Exam 1	100 points	
Exam 2	100 pc	oints		Exam 2	100 points	
Exam 3	100 pc	oints		Exam 3	100 points	
Homework	100 pc	oints		Homework	100 points	
				Final Project	200 points	
Undergrade G	rade:	A = 330 - 400	B = 260 - 329	C = 190 - 259	D = 120 - 189	F < 120
Graduate Gra	de:	A = 510 - 600	B = 420 - 509	C = 330 - 419	D = 240 - 329	F < 240

Lecture Outline and Reading Assignments

Class date	Lecture topic	Assigned reading (by page)
Week 1	Introduction: Mineral resources and ore deposits Major theories of ore genesis and associated ore deposits	I (1-20); II (1-15)
	Basic principles of mining and exploration economics	III (93-134)
Part 2: Igneous ore-f	orming processes and associated ore deposits	
Week 2	Petrological and geochemical background to magmatic ore formation	I (22-24); II (20-28)
	 Partial melting and fractional crystallization as ore-forming process Light rare-earth element (LREE) ores in carbonatites Chromite deposits Rare-metal pegmatites 	II (37-54) I (27-32) I (32-41) I (76-80)
Week 3	 Liquid immiscibility as an ore-forming process Base-metal Ni-Cu sulfide deposits in mafic & ultramafic rocks Platinum Group Elements (PGE) sulfide deposits Short group discussion – Box 2.3 Ores formed through incorporation of a mineral into magma Diamond deposits 	II (54-73) I (42-61) I (61-76) I (74-76) I (80-87); II (30-34)
	Summary of igneous processes	II (74)
Week 4	Article review	
Part 3: Hydrotherma	al ore-forming processes: generalities and background Short group discussion – Box 3.2 Hydrothermal systems: generalities and background 1 • Fluids in hydrothermal systems • Magmatic environment	I (128-132) I (101-103); II (75-85)
Week 5	 Short group discussion – Box 3.3 Hydrothermal systems: generalities and background 2 Mineral solubility and aqueous complexes Precipitation mechanisms for metals in solution Short group discussion – Box 3.5	I (136-139) I (153-159) I (176-178)
	 Hydrothermal systems: generalities and background 3 Hydrothermal alteration Metal zoning and paragenetic sequence 	I (98-100); II (166-174) II (174-177)
	Exam one	
Section 3A: Hydrothe Week 6	ermal ore deposits formed in magmatic and orogenic environments Porphyry deposits	I (105-132) ; II (106-108)
	Article review	
Week 7	Short group discussion – Box 3.1 Greisen and related ore deposits Skarn and carbonate-replacement deposits	<mark>I (117-119)</mark> I (132-135); II (108-112) I (135-148); II (113-117)
	Short group discussion – Box 3.6 Volcanic-hosted massive sulfide (VHMS) deposits	<mark>I (178-183)</mark> I (183-199); II (177-184)

Lecture Outline and Reading Assignments

Class date	Lecture topic	Assigned reading
Week 8	High-sulfidation epithermal Au-Ag deposits	I (151-162); II (117-122)
	Low-sulfidation epithermal deposits	I (164-176); II (117-122)
Week 9	Short group discussion – Box 3.7	L (213-216)
	Orogenic Au deposits	I (201-216): II (189-192)
	Carlin-type Au deposits	I (216-224): II (192-195)
		1 (210 22 1), 11 (1)2 1)3)
	Summary of hydrothermal deposits in magmatic and orogenic environments	II (125-126)
Section 3B: Hydrothern	nal ore deposits formed in sedimentary environments	
Week 10	Short group discussion – Box 4.1	I (257-261)
	Base-metal deposits in sedimentary basins I	
	Mississippi Valley-type (MVT) Pb-Zn deposits	I (249-261); II (202-209)
	Base-metal deposits in sedimentary basins II	
	• Sedimentary exhalative Pb-Zn-Ag deposits (SEDEX)	I (261-269): II (184-189)
	Stratiform sediment-hosted Cu deposits	I (269-275); II (198-202)
	Exam two (not cumulative)	
Week 11	Uranium deposits in sedimentary basins	L (275-286)
Week II	oranium deposits in sedimentary basins	1 (275-200)
	Summary of hydrothermal deposits in sedimentary environments	II (214-215)
	Article review	
Part 4: Ore deposits for	med in sedimentary environments	
Week 12	Short group discussion – Box 5.1	I (304-307)
	Generalities and background	II (246-247)
	I. Chemical precipitation from sea/lake waters	I (290-292)
	• Banded iron formations	I (292-307): II (266-272)
	Phosphorus denosits	I (311-316): II (277-279)
	 Evaporitas 	H(362,372)
	• Evaporites	III (302-372)
	• Maine	
	o Hydroinermai	
Week 13	Short group discussion – Box 5.2	I (331-334)
	II. Mechanical concentration of heavy minerals	I (316-318)
	Alluvial deposits: Placer and paleoplacer	I (322-334); II (247-266)
	Fossil fuels – oil/gas formation and coalification	II (287-307)
	Summary of deposits in sedimentary environments	II (307-308)
Part 5: Supergene ores		
Week 14	Generalities and background	I (337-338); II (219-223)
	In-situ (pedogenic) supergene ores	I (339-341)
	• Lateritic deposits (A1 Ni)	I (341-348)· II (223-228)
	Supergene ores formed by overprinting of hypogene ores	I (348-354): II (228-233)
	Au and PGF in laterites	I (3 10 337), II (220-233)
	 Supergene Cu 	
		W (2.15)
	Summary of supergene ores	II (245)

Class date	Lecture topic	Assigned reading
Week 15	Global tectonics and metallogeny	II (311-343)
	Article review	
Week 16	Graduate Student presentations of final projects	
WCCK 10	Graduate Student presentations of final projects	
TBA	Final Exam (not cumulative)	
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POLICIES

STUDENT SUPPORT: U of A Cares offers a supportive and encouraging partnership with students by linking them with appropriate resources that will allow them the opportunities to overcome barriers on their path to success; both personal and educational at **uofacares.uark.edu**

STUDENTS WITH DISABILITIES: University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. Students who have a documented disability and require accommodations must contact the instructor at the beginning of the semester to make arrangements for necessary classroom adjustments or accommodations. Please note, students must first verify eligibility for these through the Center for Educational Access (contact 479–575–3104 or visit <u>http://cea.uark.edu/</u> for more information on registration procedures).

EXCUSED UNIVERSITY ABSENCES are: (1) illness of the student, (2) serious illness or death of a member of the student's immediate family or other family crisis, (3) University-sponsored activities for which the student's attendance is required by virtue of scholarship or leadership/participation responsibilities, (4) religious observances, (5) jury duty or subpoena for court appearance, and (6) military duty. The instructor has the right to require that the student provide appropriate documentation for any absence for which the student wishes to be excused.

INCLEMENT WEATHER: If the University is open, class will be in-session. The University's inclement weather policy is available at <u>emergency.uark.edu</u>

ACADEMIC HONESTY STATEMENT: "As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail. Each University of Arkansas student is required to be familiar with and abide by the University's 'Academic Integrity Policy' which is found at <u>https://honesty.uark.edu/policy/index.php</u> Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor."

Academic Integrity: Exams and assignments must be a student's own work. No cheating or plagiarism will be tolerated. If you are suspected of academic dishonesty, the Academic Integrity process will be utilized to its fullest extent.

SEXUAL ASSAULT AND DOMESTIC/DATING VIOLENCE: If you are in danger, dial 9-1-1. For confidential help, call the University Victim Advocate at (479) 575-7252. The University of Arkansas prohibits sexual harassment or acts of sexual assault, domestic violence, dating violence and stalking committed against students, employees, campus visitors, and other persons who use University facilities. Sexual assault is any form of sexual activity where consent is not consciously and voluntarily given. Anyone can be a victim of sexual assault. Sexual harassment is prohibited by University policy and is a form of sex discrimination prohibited by Title VII of the Civil Rights Act of 1964 and by Title IX of the Education Amendments of 1972. Sexual assault is a crime, as defined by the Arkansas criminal code. Important sexual assault information and guidance to file a formal report is available at <u>respect.uark.edu</u>.

DIVERSITY AND INCLUSION MISSION STATEMENT: The Department of Geosciences is committed to enhancing diversity and promoting inclusion at all levels of the department. The department is dedicated to maintaining an organizational and educational climate where differing ideas, abilities, backgrounds, and needs are fostered with opportunities for faculty, staff and students from divergent experiences to participate and contribute. The Department of Geosciences recognizes that a wide variety of perspectives, from all its members are important and necessary components of a diverse and inclusive department and of a genuinely wide-ranging contemporary education.

TECHNOLOGY POLICY: The use of cell phones, smart phones, tablets, laptops, etc., for purposes other than note taking or learning Economic Geology concepts is not allowed during class. You are in class to learn, not socialize with your media! <u>Flagrant violation of this policy will result in you being dismissed from class for the day</u>!

EMERGENCY PROCEDURES: Many types of emergencies can occur on campus. Instructions for specific emergencies such as severe weather, an active shooter, or fire can be found on the web at <u>emergency.uark.edu</u>

SEVERE WEATHER (e.g., Tornado Warning):

- Follow the directions of the instructor or emergency personnel.
- Seek shelter in the basement or an interior room or hallway on the lowest floor, putting as many walls as possible between you and the outside.
- In a multi-story building, if you cannot get to the lowest floor, go to a hallway in the center of the building.
- Stay in the center of the room, away from exterior walls, windows, and doors.

VIOLENCE or ACTIVE SHOOTER (C.A.D.D.):

- CALL. 9-1-1
- AVOID. If possible, evacuate to a safe area outside the building. Follow directions of police
- officers.
- DENY. Barricade the door with desks, chairs, bookcases, or any items. Move to a place inside the
- room where you are not visible. Turn off the lights and remain quiet. Remain there until told by
- police it is safe.
- DEFEND. Use desks, chairs, cell phones, or whatever is immediately available to distract and/or
- defend yourself and others from attack.

CONCEALED CARRY ON CAMPUS: Handguns are only allowed on campus (including all classrooms) to the extent specifically authorized by state law. Everyone who lawfully possesses a handgun and an enhanced carry permit is always required to keep the handgun concealed from public view and is responsible for carrying the handgun in a safe manner. If an individual carries a concealed handgun in a personal carrier such as a backpack, purse, or handbag, the carrier must remain within the individual's immediate vicinity (within arm's reach). During this class, you may be required to engage in activities that require you to be physically separate from your belongings and you should plan accordingly. Any student who violates the concealed carry laws while on campus may be subject to criminal prosecution and/or discipline by the University, up to and including dismissal. If you observe someone displaying a handgun or other weapon on campus, it should be reported to the University of Arkansas Police Department (<u>uapd.uark.edu</u>). For more information: <u>safety.uark.edu</u>.