EAS105

The Dynamic Earth Through Time

2 Credits

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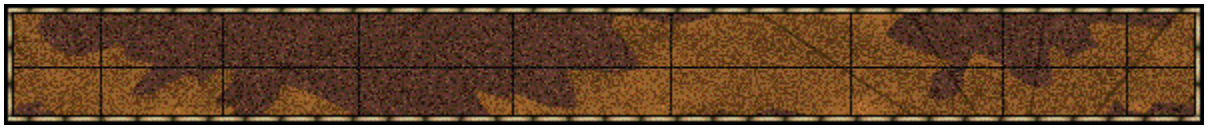

The Dynamic Earth Through Time

Calendar Description

The plate tectonic framework of a dynamic Earth as it relates to the origin of major groups of minerals and rocks. Earthquakes, structural geology, and the origin of mountain belts. Surface processes and their sedimentary products. History of life and extinctions.

Rationale

The objective of this course is to tell the story of how Planet Earth formed within the Milky Way Galaxy, and how it changed in the eons of its existence. This story includes the origin, diversity, evolution and extinction of life forms. Geological themes introduced in EAS 100 will be addressed in greater detail in EAS 105, with a focus on the geosphere, the rock cycle and plate tectonics.

EAS 105 complements EAS 100, and the two courses together form the foundation of all further earth science studies.

Prerequisites

EAS100

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to (cognitive skills)

1. place the Earth and its geothermal heat and materials in the context of the formation of the universe and solar system.
2. describe the importance of the plate-tectonic theory, and the seismic exploration of the Earth Interior.

3. quote examples of the role of plate tectonics in shaping the Earth continents and ocean basins.
4. apply plate-tectonics to the positioning of terranes, and geology of Canada.
5. explain the overarching classification scheme for minerals based on process of crystallization.
6. discuss the chemical nature of the main mineral groups.
7. explain the role of igneous rocks and processes in the context of the rock cycle.
8. describe the link of magmatic processes with plate-tectonic lithospheric motion.
9. list the main igneous rock types and their relationships to plate tectonics.
10. interpret the range and style of rock deformation in various metamorphic facies.
11. describe the link of plate-tectonics, rock deformation, and metamorphic grade.
12. itemize the range of deformed rock types and their significance in a paleogeographic context.
13. describe metamorphic rock types and their relationship to plate tectonics.
14. explain the connection of soils, sediments, sedimentary rocks, and environments with surface processes.
15. describe the main weathering and material transport mechanisms observed on the Earth surface.
16. quote the main sedimentary rock types and their relationship to plate tectonics.
17. describe the units of the geological time scale, the eons, eras, periods, and epochs.
18. list the geological characteristics of relative geological time units, based on principles of geology.
19. epitomize the various radioisotope systems that allow us to determine absolute geological time.
20. explain the geological character of Precambrian Earth, its craton configuration, and its fossils.
21. describe the succession of ancient life, driven by evolutionary change.
22. correlate the evolution of life in the context of plate tectonics and climate change.
23. describe the index fossils used in biostratigraphy of various eons, eras, and periods.

24. correlate plate-tectonics, continental configuration, ocean basin connection, mountain building, and life.

Upon successful completion of this course, students will be able to (applied skills)

25. calculate the spreading and subduction rates, based on measurements of tectonic zones.
26. use physical and chemical properties in the identification of rock-forming minerals.
27. identify the main igneous rock types by their textures and mineral composition.
28. explain the igneous processes through geological map and air-photo interpretation.
29. build structural block diagrams, geological sections, and interpret geological maps.
30. investigate the main metamorphic rock types by their textures and composition.
31. explain the metamorphic processes through isograde map, and air-photo interpretation.
32. name the main sedimentary rock types by their textures and composition.
33. interpret the sedimentary processes through the study of isopachous maps, lithofacies maps and air-photos.
34. describe and sketch fossils of typical faunas and floras of the geological time periods.
35. reconstruct paleo-environment and paleo-community, based on its fossil fauna and flora

Resource Materials

Required Text(s):

Monroe, J. S ., & Wicander, R. (2015). *The changing Earth* (7th ed.). Stamford, Connecticut: Cengage Learning, 712 pp.

Waldron, J. W. F. (Editor) (2018). *EAS 105, The dynamic Earth through time, laboratory manual*. Edmonton, AB: Department of Earth and Atmospheric Sciences, University of Alberta.

Cuny, R. (2018). *EAS 105. Earth through time; Course notes*. Lloydminster, AB: Lakeland College.

Reference Texts:

Chesterman, C. W., & Lowe, K. E. (1979). *The National Audubon Society field guide to North American rocks and minerals*. New York, N.Y.: Knopf, 850 pp.

Motta, A., Crespi, R., & Liborio, G. (Editors Prinz, M. *et al.*) (1978). *Simon and Schuster's guide to rocks and minerals*. New York, N.Y.: Simon and Schuster, 607 pp.

Thompson, I. (1982). *The National Audubon Society field guide to North American fossils*. New York, N.Y.: Knopf, 846 pp.

Conduct of Course

This is a 3 credit course with 3 hours of lecture and 3 hours of lab per week. (3-0-3).

Lectures - 3 hours a week:

Lectures are supported by Power Point data projection, whiteboard, and occasionally by a video movie. In addition to the printed Course Notes, and the files placed on the educational database D2L, students are expected to take their own notes. The library houses earth science references, and it is used to access the earth science literature and online databases. Students are expected to do the assigned reading in the textbook and laboratory manual on a weekly basis. The main topics to be covered in the lectures are listed below:

1. Plate-tectonics and the rock convection in the lithosphere and mantle of Planet Earth.
2. Minerals and their atomic structure, and crystallization.
3. Igneous processes including magmatic intrusions and volcanoes, and an overview over igneous rocks.
4. Deformation of rocks, earthquakes and seismic waves, and structural geology of folds and faults.
5. Metamorphic grades, facies, and maps, with an overview over metamorphic rocks.
6. Surface processes and their products: the effects of flowing water, movement of ice and wind.
7. An overview over sedimentary rocks, sedimentary facies, and formations.
8. Geochronology, the geological timescale, principles of geology, and absolute dating with radioisotopes.
9. Precambrian Earth and Precambrian fossils; the North American Craton and the Canadian Shield.
10. Paleozoic Earth and Paleozoic fossils.
11. Mesozoic Earth and Mesozoic fossils.
12. Cenozoic Earth and Cenozoic fossils.

Laboratory work - 3 hours per week:

The laboratory is conducted weekly starting the second week of classes. External students who join the class must pass a safety quiz before they are permitted to take part in the labs. All labs are graded. Completion of the labs and a passing grade on this component of the course are mandatory to obtain a passing grade in EAS 105. Lab attendance is mandatory. The lab assignments consist of filled out worksheets and material taken from the Laboratory Manual. Students shall hand in completed lab assignments at the beginning of each following lab session.

Late lab assignments generally suffer a 5% per day decrease on the grade. In legitimate cases, an extension may be granted.

Evaluation Procedures

The student's performance is evaluated in terms of percentage points that reflect the number of correct answers out of the total number of questions on exams and lab assignments. The practical work and participation in the laboratory is part of the evaluation, to encourage active learning and safety awareness.

The weighting of the course is as follows:

Laboratory Component:

Laboratory Reports and Assignments	20%	
Laboratory Final Examination	15%	
Laboratory Practical Work	5%	
Laboratory Subtotal		**40%**

Lecture Component:

Lecture Quiz	5%	
Midterm Lecture Exam (examination during regular class hours)	20%	
Final Lecture Exam (3-hour examination during final exam week)	35%	
Lecture Subtotal		**60%**
Total		**100%**

Grades are based upon your earned percentage of cumulative marks. However, in the laboratory component students must achieve a mark of 50% out of 100% or higher, on lab reports, worksheets, laboratory exam, and practical work combined, to pass the course. The quiz, midterm and final lecture exams are composed of a 2: 1 mixture of multiple choice questions and short answer questions. **No supplemental assignments or exam re-writes are allowed in the University Studies Department**. There are no lecture assignments.

Students who do not fulfill all course requirements may receive an incomplete (IN) at the end of the course, until they fully comply with lecture and laboratory rules. If no action is taken on the part of the student, the incomplete (IN) will automatically convert to a failing grade (F).

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Regular attendance is essential for success in any course. Absence for any reason does not relieve a student of the responsibility of completing course work and assignments to the satisfaction of the instructor. Poor attendance may result in the termination of a student from a course(s).

If you do not meet the established attendance requirements, your instructor will recommend that the Registrar withdraw you from the course. A failing grade of RW (Required to Withdraw) will appear on your transcript.

In cases of repeated absences due to illness, the student may be requested to submit a medical certificate.

Instructors have the authority to require attendance at classes.

1. Attendance at all laboratory sessions is mandatory in EAS 105. If more than 2 labs are missed, excused or unexcused, the student will either be required to withdraw (RW) or will be assigned a failing grade (F) for the entire course.
2. Students are only allowed to submit lab reports for labs they have attended. If the student's absence is excusable, the missing lab report will not be counted. If the student's absence is inexcusable, the missing lab report will be assigned a mark of 0. Generally, lab reports and filled-in worksheets are due at the beginning of the following laboratory session.
3. Make-up labs are difficult or impossible to set up. Only students with an excusable absence may arrange for a make-up lab.

Course Units/Topics

Week	Type	Lecture and Lab Titles	Text: Monroe & Wicander
		I. The Earth system	
1	Lec 1	Introductions and course procedures; subdisciplines, overview over Earth interior, plate tectonics and Wilson cycle, rock cycle, geological time scale.	chapter 1
	Lab -	(no lab)	
		II. Minerals and Rocks	
	Lec 2	Minerals, definition, chemical composition/classification, atomic bonds, elemental particles.	chapter 3
	Lec 3	Physical properties, crystal habits/systems, polymorphs, pseudomorphs, substitutions, F. Moh's scale of hardness.	chapter 3
2	Lec 4	Silicate polymerization levels correlate with cleavage planes, hardness, crystal forms.	chapter 3
	Lab 1	Mineral identification by physical properties; UV fluorescence, radioactivity, chattoyescence.	manual, lab 1
	Lec 5	Igneous rocks, intrusive/extrusive textures, color density, melt/crystallization, N.L.Bowen reaction series.	chapter 4
	Lec 6	Igneous ultramafic, mafic, and felsic composition, magma differentiation, intrusive bodies	chapter 4
3	Lec 7	Types of volcanoes, lavas, and ejecta; volcanic landscapes, types of eruptions	chapter 5
	Lab 2	Igneous rock identification, mafic/felsic, igneous environments (maps), polarizing microscope.	manual, lab 2
	Lec 8	Mechanical/chemical weathering, Wentworth scale, erosion, lithification, soils	chapter 6
	Lec 9	Clastic/precipitated/organic sedimentary rock textures, composition, rock color, diagenesis.	chapter 7

4	Lec 10	Sedimentary structures, depositional environments, on-lap/off-lap depositional sequences, well logs, petroleum window, oil traps, coal grades	chapter 7
	Lab 3	Sedimentary rock identification, clastic/precipitated/organic, structures, depositional environments, polarizing microscope.	manual, lab 3
	Lec 11	LECTURE QUIZ 1; basins/domes, formations, unconformities, geological, isopachous, lithophacies, and paleogeographic maps; sections and columns	chapter 7
	Lec 12	Metamorphic rocks, foliated texture, porphyroblasts, metamorphic isograde maps	chapter 8
5	Lec 13	Kinds of metamorphism, metamorphic grade/facies, rock deformation in subduction zones and orogens	chapter 8
	Lab 4	Metamorphic rock identification, metamorphic grade, facies, foliation, polarizing microscope.	manual, lab 4
		III. Structural Geology and Plate Tectonics	
	Lec 14	Continental drift, *Glossopteris/Mesosaurus*, terranes, suture zones, ophiolites, aulacogens, triple junctions, plate boundaries convergent/divergent/transform	chapter 2
	Lec 15	Paleomagnetism, thermoremnant/stratoremnant, magnetic lineations, reversals, gravity anomalies, isostasy, plate motion driving force	chapter 2
6	Lec 16	Structural geology, folds, faults, strike-dip symbols, principles of geology, depositional sequences, correlation	chapter 10
	Lab 5	Structural geology (folds, faults, intrusions), geological maps, sections, principles of geology, time scale, block diagrams, relative/absolute dating, regional history	manual, lab 5
	Lec 17	Earth interior. earthquakes, seismic P/S waves, reflection/refraction, rock density increase, crystal collapse zones, meteorites, chondrules, xenoliths	chapter 9
		IV. Fossils, Stratigraphy, Geochronology	
	Lec 18	Fossil preservation, DNA, cladistics, fossil classification, domains/kingdoms, evolution	chapters 7,18
7	Lec -	MIDTERM BREAK - READING WEEK (no classes)	
	Lab -		
	Lec -		

	Lec -		
8	Lec 19	Lithostratigraphy/biostratigraphy, concurrent range zone, assemblage zone, individual range zones, cosmopolitan/endemic fossils	chapter 17
	Lab 6	Plate tectonics, geological sections, rocks at rifts and subduction zones, fault zone decompression	manual, lab 6
	Lec 20	Geological timescale: relative dates: principles of geology, sequences, index fossils; absolute dates: radiometric dates, fission-tracks; eons, eras, periods, and epochs	chapter 17
	Lec 21	MIDTERM LECTURE EXAM	
		V. Earth and Life in the Precambrian Eons	
9	Lec 22	The Earth in the Hadean and Archean eons, wave/quantum theories of light, red shift, relativity theory, cosmologies, galaxies	chapters 1, 19
	Lab 7	Precambrian fossils (Banded Iron Formation, stromatolites), rocks of the Canadian Shield and other shields, supercontinent Rodinia	manual, lab 7
	Lec 23	Nuclear fusion/fission, solar nebula, cold heterogenious accretion of planets, differentiation and outgassing	chapters 1, 19
	Lec 24	Precambrian time scales, outgassing/atmospheric change, oldest rocks: tonalite gneisses/komatiites	chapter 19
10	Lec 25	Archaean rock sequences, protobionts and origin of life, earliest evidence of prokaryotic life	chapter 19
	Lab 8	Continental positions and local events in Alberta, fossil faunas, floras, and rocks of the Paleozoic Era: sketch and describe selected specimens	manual, lab 8
	Lec 26	Precambrian cratons, accreted terranes, orogenic and greenstone belts, aulacogens, assembly of the supercontinent Rodinia	chapter 19
	Lec 27	Proterozoic glaciations, diamictites; single cells in stromatolites, banded iron formation, and eukaryotic arcritarchs	chapter 19
11	Lec 28	Famous fossil finds: Warrawoona, Fig Tree, Gunflint Chert, Ediacara Hills, Conception Bay, evolution from the bacterial level to invertebrate animals	chapter 19
	Lab 9	Continental positions and local events in Alberta, fossil faunas, floras, and rocks of the Mesozoic Era: sketch and describe selected specimens	manual, lab 9

		VI. Earth and Life in the Paleozoic Era	
	Lec 29	The non-orogenic base of the Cambrian (*Trichophycus pedum* zone), warm anoxic oceans, the Sauk transgression: sandstones - shales - carbonates succession	chapter 20
	Lec 30	Epicontinental seas, basins filled with carbonates and evaporites, the transgressional Tippecanoe, Kaskaskia, and Absaroka sequences start with characteristic sandstones	chapter 20
12	Lec 31	Orogenies in eastern Laurentia are due to continental collisions: Taconic, Acadian, Ouachitan, Allegheny correlate with Famatinian, Caledonian, Hercynian orogenies	chapter 20
	Lab 10	Fossil faunas, floras, and rocks of the Cenozoic Era: sketch and describe; ice age, extinctions, hominids	manual, lab 10
	Lec 32	Orogenies in western Laurentia result from subduction of oceanic crust and accretion of volvanic arc terranes: Antler and Sonoma/Cassiar terranes	chapter 20
	Lec 33	Clastic wedges, like he Queenston, Catskill, Old Red Sandstone were deposited adjacent to the source mountains; assembly of Pangea and Gondwana glaciation	chapter 20
13	Lec 34	Paleozoic marine faunas of the Burgess Shale and Chengjiang, terrestrial fauna of the Karoo basin; floras of Rhynie, Gilboa, and Pottsville coal shales	chapter 21
	Lab 11	LABORATORY EXAM	
		VII. Earth and Life in the Mesozoic Era	
	Lec 35	Break-up of Pangea; hot Triassic with rifts and flood basalts, wet Jurassic with equatorial transform faults, then hot and wet Cretaceous with Zuni transgression	chapter 22
	Lec 36	Golconda arc accretion - Sonoma/Cassiar, batholith emplacement - Nevadan, thrust faults - Sévier, and folds - Laramide orogenies; Sundance Sea, Morrison Formation	chapter 22
14	Lec 37	Mesozoic fossils: ichthyosaurs, synaptosaurs, plesiosaurs, mosasaurs, pterosaurs, dinosaurs/birds, therapsids, cycads, conifers, angiosperms, ammonites, clams	chapter 22
	Lab -		

		VIII. Earth and Life in the Cenozoic Era	
	Lec 38	Intermontane basins, epeiric Canonball Sea, Farallon Plate subduction, North Atlantic rift separates Greenland from Baltica, Antarctica splits from Australia; mammals	chapter 23
	Lec 39	Messinian crisis, Behringia, Panama, Wallacea land/filter bridges, closure of the Tethys Ocean, orogenies of Himalayas and Alps, Pleistocene glaciations, hominids	chapter 23
15	Lec -	FINAL LECTURE EXAM WEEKS	
	Lab -		
	Lec -		
	Lec -		

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