

# G302 DEVELOPMENT OF THE GLOBAL ENVIRONMENT

SPRING 2006

INFORMATION

COURSE: G302 SECTION: 25028  
TIME: 11:15AM -12:30PM MW IN GY143  
WEBSITE: <http://www.indiana.edu/~g302/home.html>  
INSTRUCTOR: SIMON BRASSELL, PROFESSOR OF GEOLOGICAL SCIENCES  
OFFICE: GY313 PHONE: (812) 855-3786 EMAIL: [SIMON@INDIANA.EDU](mailto:SIMON@INDIANA.EDU)  
OFFICE HOURS: MON. & WED. 12:30 - 1:20PM, OR BY APPOINTMENT

## COURSE DESCRIPTION:

This course provides a broad-based introduction to the history of the Earth from its origin to the present day. It explores the processes and events that have shaped the development of our earth system, integrating aspects of astronomy, physics, chemistry and biology within the geological timescale. Its emphasis is on changes in the global environment induced by physical forces, chemical cycles, life processes, climatic variations and by serendipity.

## MAJOR THEMES:

Origins of matter, stars and the chemical elements; formation of the Earth; development of the atmosphere, oceans and continents over geological time; origin of life, its evolution and extinction; catastrophic events; past, present and future climate change.

## LEARNING OBJECTIVES:

The central aim of the course is to foster knowledge of the combination of critical factors that have shaped the development of the global environment. The course endeavors to build an understanding of the Earth system that provides answers to the following key questions:

- What combination of processes led to the formation of planet Earth within our solar system?
- How do the characteristics of the Earth differ from those of other planets and why?
- Has the chemical composition of Earth predetermined its evolutionary history?
- How well can ancient processes on Earth be reconstructed and what evidence is required?
- What factors exercise critical control on the present-day global environment?
- Have these factors varied significantly over geological time? How did they affect the Earth?
- How does the widespread existence of life and its activity affect the Earth system?
- What critical events have dramatically changed Earth's environment? When did they occur?
- How has global climate varied over geological time? What are Earth's climatic extremes?
- Is human activity changing the global environment? How are these changes manifest?
- Can detrimental effects be reversed? How resilient is the Earth system?

## CLASS TIMES & COURSE FORMAT:

Class meetings on Monday and Wednesday from 11:15am to 12:30pm in GY143; they consist of lectures and discussions sessions.

Course grades are based on performance in class assignments, on-line quizzes, and exams, and on contributions to discussions. Several parts of the course (quizzes & position papers) use Oncourse (<http://oncourse.iu.edu>), which also provides access to learning resources and the class home page.

## GENERAL COMMENTS:

*Web pages:* Please browse the class web pages for more information on the course, assignments, etc. and report any problems or difficulties.

*Email:* Direct any questions about the course, especially difficulties encountered with Oncourse assignments, to [simon@indiana.edu](mailto:simon@indiana.edu). Always include a subject with any messages, and please use an appropriate form of address and signature, as appropriate (see Contacts webpage).

## COURSE COMPONENTS AND ASSESSMENT:

*Position Paper:* A two-page paper written on a topic selected from a range of prescribed subjects, or on an approved student-selected topic. The goal of the paper is to compose a cogent, structured discussion of the chosen topic rooted in sound scientific arguments and principles. The paper is developed and evaluated through four iterations as follows:

1. An initial extended outline/rough draft (5%) critiqued by instructors – due February 6.
2. A revised draft (electronic format) for anonymous peer review (5%) – due March 1.  
All students will be required to review two other position papers (8%) – due March 27.
3. A complete final draft reviewed by instructors (5%) – due April 5.
4. A final copy (8%) – due April 24.

A detailed description of the basis for grading the individual position papers is posted on the web, together with guidelines for preparing and compiling objective reviews.

*Quizzes:* Three on-line quizzes and problems (5% each) administered through Oncourse. Examples of illustrative questions will be provided on Oncourse and discussed in the class prior to the first quiz. These quizzes will include multiple-choice questions similar to the questions in the exams, but also require assessment or interpretation of information or data sets pertinent to course topics.

NOTE: Answers to the on-line quizzes must always represent your own individual effort.

*Discussion Sessions:* Four discussion sessions are scheduled, which occur within regular class meetings. These sessions will seek to discuss and answer questions on selected topics, with students assigned to groups (each consisting of 5-10 individuals) based on their preference. For every session there will be:

1. An initial survey to assess prior knowledge of each topic and help focus on the critical issues considered in the forthcoming discussion.
2. Links to web pages that provide resources on the individual topics.
3. A series of preparative questions that are intended to prompt debate about the forthcoming discussion in class. Completion of these questions will be assessed solely in terms of evidence of preparation for the discussion rather than detailed content (4 x 1%)
4. A separate questionnaire to express a preference for discussion topic.
5. A summative questionnaire for completion after the discussion session to reflect on the topic (4 x 1%) and to identify students meriting recognition for their contributions to the discussion. Points for individual participation (4 x 2%) in the discussion sessions will be based on both instructor and peer evaluations.

The initial survey, preparative questions and summative questionnaires will be posted on Oncourse.

*Exams:* Three written exams consisting of two in-class exams on Feb. 13 and Mar. 27 (10% each), and a comprehensive final scheduled for May 4 (10:15 – 12:15 a.m.; 18%). Each will comprise a series of multiple choice and short answer questions. Examples of illustrative questions will be distributed and discussed in the review sessions prior to the exams.

## TEXT AND RESOURCES:

*Recommended Text:* Lunine, J.I. Earth: Evolution of a Habitable World (ISBN 0521644232)

This text provides a general introduction to many of the course themes in a narrative format. It offers a comprehensive treatment of several of the class topics and an adequate representation of most others. Most importantly it represent a companion to the class that supplements and augments the lecture materials. Its contents are not followed directly, and topics are considered in a different order from this text.

*Lecture Resources:* Copies of the powerpoint slides for all of the lectures will be downloadable as pdf files from the class website and from Oncourse. The materials for the discussion sessions may comprise parts of the text supplemented by recommended readings and papers typically available on the web. Links will be provided to access them from the course website.

## CLASS PREREQUISITES:

Previous courses in general geology or oceanography or chemistry or other introductory science classes are beneficial. A basic understanding of chemical principles and scientific concepts is especially helpful, although all concepts are considered without presumption of any prior knowledge. If you are uncertain of any assumptions made in the class please ask for clarification.

## SCHEDULE OF CLASS MEETINGS: TOPICS AND ASSIGNMENTS

## COURSE INTRODUCTION AND CONCEPTS

Jan. 9: Introduction to Course Components and Topics.

## PART I: THE DAWN OF TIME

## BEGINNINGS OF THE UNIVERSE: FROM THE INFINITE AND THE SUBATOMIC

Jan. 9: Big Bang; Age and Dimensions of the Universe; Galaxies and Star Clusters.

Jan. 11: Synthesis and Abundance of Elements; Radioactive and Stable Isotopes.

## SOLAR SYSTEM EVOLUTION AND METEORITES: PLANETS AND NEIGHBORS IN SPACE

Jan. 16: *Martin Luther King Jr. Day — no class*

Jan. 18: Solar System; Planetesimals; Terrestrial and Jovian Worlds; Meteorites

**General Course Questionnaire: Jan. 18 – 25.**

## BIRTH OF THE EARTH AND MOON: A COUPLED SYSTEM

Jan. 23: Accretionary Processes; Radioactive Heat; Gravity; Density

Jan. 25: Interior and exterior features of planets; cores, surfaces and atmospheres

**On-line Quiz #1 Jan. 26 – 30**

**Survey and Questionnaire for Discussion #1 Jan. 26 – 30**

## SEGREGATION OF EARTH LAYERS: BUILDING A DYNAMIC SYSTEM

Jan. 30: Composition of the Earth; Formation of the Core, Mantle and Crust.

Feb. 1: *Discussion: Extraterrestrial Environments and Life; Formation of the Moon*

**Reflections on Discussion #1 Feb. 2 – 6**

**Position Paper Extended Outline/Rough Draft due Feb. 6**

## RADIOACTIVE CLOCKS AND GEOLOGICAL TIME: ABSOLUTE AND RELATIVE TIME

Feb. 6: Radioactivity; Decay Times; Age of the Earth and Meteorites

Feb. 8: Principles of Stratigraphy; Sedimentary, Magnetic, Biological, Isotopic

**Feb. 8: Review Session**

**Feb. 13: First Exam**

## PART II: DEVELOPMENT OF THE FACE OF THE EARTH

## TECTONICS AND CONTINENTAL CONFIGURATIONS: RIFTING AND DRIFTING

Feb. 15: Sea Floor Spreading; Convergence, Divergence; Formation of Ocean Basins

**Survey and Questionnaire for Discussion #2 Feb. 16 – 20**

Feb. 20: Paleogeography; Paleomagnetism; Supercontinents and Superoceans

Feb. 22: *Discussion: Fragmentary Records of Time; Growth of the Continents*

**Reflections on Discussion #2 Feb. 23 – 27**

**Position Paper First Draft due Mar. 1**

## EVOLUTION OF ATMOSPHERIC COMPOSITION: OXIDATION OF EARTH

Feb. 27: Atmospheric Composition and Circulation; Wind Belts; Climate Control

Mar. 1: Proxies for Ancient Atmospheres; History of Carbon Dioxide and Oxygen

**On-line Quiz #2 Mar. 2 – 6**

## EVOLUTION OF OCEAN CHARACTERISTICS: EARTH'S WATERY ENVELOPE

Mar. 6: Ocean Dynamics; Temperature, Salinity and Density-Driven Circulation

## BIOLOGICAL EFFECTS ON EARTH PROCESSES: EVOLUTIONARY TRENDS

Mar. 8: Origin and Development of Life; Emergence of Animals; Land Plants

**Survey and Questionnaire for Discussion #3 Mar. 8 – 20**

MAR. 11-19: SPRING BREAK

SCHEDULE OF CLASS MEETINGS: TOPICS AND ASSIGNMENTS (CONTD.)

THE EVOLVING EARTH SYSTEM: UNIFORMITY VERSUS CHANGE

Mar. 20: Integrated Causes and Effects; Secular Changes in Geological Phenomena

Mar. 22: *Discussion: Gaia Hypothesis; Biogeochemical History of Earth*

**Reflections on Discussion #3 Mar. 23 – 27**

**Reviews of Position Paper Drafts due Mar. 27**

CATASTROPHES & BOLIDE IMPACTS: EXTINCTION EVENTS

Mar. 27: Event Stratigraphy; Punctuated Earth History; Iridium Anomalies; K/T Boundary;

**Mar. 27: Review Session**

**Mar. 39: Second Exam**

PART III: CLIMATE CHANGE

LONG-TERM CLIMATE TRENDS: GEOLOGICAL PACEMAKER

Apr. 3: Climate Proxies; Temperature History; Cretaceous Black Shales; CH<sub>4</sub> 'burps'

**Position Paper Complete Final Draft due Apr. 5**

ICE AGES & MODERN CLIMATES: CHANGES OVER HUMAN TIMESCALES

Apr. 5: Evidence for Past Glaciations; Climatic Cycles; Ice Ages; Little Ice Age; Ice Cores

**Survey and Questionnaire for Discussion #4 Apr. 6 – 10**

Apr. 10: Temperature and Ice Volume; Deep Water Circulation; Global Conveyor

Apr. 12: *Discussion: Causes of Extinction; Icehouse and Greenhouse Worlds, Snowball Earth*

**Reflections on Discussion #4 Apr. 13 – 17**

**On-line Quiz #3 Apr. 13 – 17**

FUTURE GLOBAL ENVIRONMENTAL CHANGE: HUMAN DIMENSION AND INFLUENCE

Apr. 17: Carbon Dioxide and Global Warming; Ozone; Oceanic Biological Pump

Apr. 19: Modern Extinction; Environment Destruction

**Position Paper Final Copy due Apr. 24**

**Apr. 24: Review Session**

**May 3: 10:15 a.m. - 12:15 p.m. in GY143 FINAL EXAM**