JASON ACADEMY

Structure of the Earth SYLLABUS

This course examines the physical composition of our planet and the forces (both internal and external) that continuously shape it. The course is cross-disciplinary when appropriate and is especially designed for secondary school teachers who are currently teaching or who are preparing to teach courses in middle and high school Earth science. The course combines technical explanations of geological processes and phenomena with an explanation of the physical composition of matter, minerals, and various rock types. The original course content documents are supplemented with original animated graphics, other web-based resource links, and self-directed reviews of literature on various discussion topics presented during the course.

About the Instructor

Stephen M. Tomecek is a geologist and educator who has spent the last 13 years as Executive Director of Science Plus, Inc., a company that provides science staff development and enrichment programs for schools and organizations throughout the United States. Prior to creating Science Plus, he worked as a science instructional specialist and Earth science teacher in New York City and served as the Science Program Supervisor for the New York Hall of Science.

Performance Objectives

In this course, students will:

1. Develop a broad understanding of the most important principles of geology, including the nature of matter; the formation of minerals and crystals; the processes of erosion and deposition of sediments; and plate tectonic theory, including supporting evidence related to volcanoes, earthquakes, and the internal structure of the planet.
2. Develop a classroom action plan on a selected aspect of geology for use with their own students. Unit plans will have a research base reported as a rationale for instructional approaches.
3. Identify their state content standards and assessment areas focusing in on the structure of Earth and the geological processes that shape the planet.
4. Learn how to conduct an effective web search of online resources dealing with various topics in geology and share their findings with their course colleagues.
5. Critique other geological resources, such as articles in professional journals and books on physical geology.
6. Learn different methodologies to present geological content to their students.
7. Share various teaching strategies with their classmates and present their own opinions on recent theories focusing on the internal structure of the Earth and its impact on earthquakes and volcanic activity.
8. Develop a working understanding of plate tectonic theory as well as an understanding of how the Earth has evolved over time.

Course Delivery

Critical to the professional-development experience of teachers today is learning to function effectively in an online learning environment, one that is destined to expand in the future. The Structure of Earth is an online course completed in five weeks, with an additional one-week grace period for submitting assignments. Although students may work on assignments offline, all course content, links to supplementary information, interaction among students in the class, class discussions, assessments, submission of assignments, and interaction with the instructor are carried out online, through email and the course site. This online format is designed for educators who need access to professional development on a flexible schedule and who are in different locations worldwide. Not all participants in this course will earn college credit; some are earning CEU's or auditing. Students earning college credit are required to participate in advanced discussions and complete the assignments outlined in this document.

Recommended Reading

Project Earth Science: Geology by Brent A. Ford, NSTA Press.

Rocks & Minerals: Hands-On Science Series by Barry Fried and Michael McDonnell

COURSE OUTLINE

WEEK 1 • *Crystals, Minerals, and the Atomic Structure of Matter*

This week provides a general introduction to the atomic structure of matter, chemical bonding, and the formation and properties of minerals.

Topics Include:

A. Matter, Matter, Everywhere. Defines the meaning of matter, including its properties and states. The section includes an activity to determine the density of an irregular solid and discusses the concept that the surface of the Earth can be subdivided into a lithosphere, hydrosphere, and atmosphere.

B. Dividing the Indivisible. Introduces the structure of atoms and the fact that most atoms can be further subdivided into smaller particles called electrons, protons, and neutrons. Discusses the relative size and scale of atoms and their components.

C. It's All Elementary. Discusses the nature of chemical elements and links to an interactive periodic table of elements. In addition, it introduces the concept of chemical isotopes and electron configuration within atoms.

D. Common Bonds. Introduces the process of chemical bonding and explains how compounds form from individual elements. Explains the difference between ionic and covalent bonds and provides a hands-on activity to demonstrate molecular attraction.

E. Crystals, They're Habit Forming! Explains the process of crystal formation within a rock and describes the various ways that crystals can grow. Introduces the concept of crystal habit as a defining property of a mineral and discusses the six crystal systems used by geologists.

Assignments

Introduce yourself on the Teachers' Lounge Discussion Board. If you're a classroom teacher, tell us where you teach and how long you've been teaching. Also, let us know what you hope to get out of this course. If you'd like, you can also create a student homepage. Read the Course Documents for Week One. Identify the source minerals for five objects commonly used in and around your home or school. Give the name of the mineral and some of its diagnostic physical properties. For example: Pencil lead is made from the mineral graphite, which is almost pure carbon. Graphite is always black or dark gray, has a black streak, and is one of the softest minerals (a 1 on Mohs' scale of hardness). Post your assignment on the Course Application and Content Discussion Board.

For this week's discussion question, consider the following: Since their earliest days, humans have learned how to exploit natural mineral resources. From making simple rock tools to extracting metal from ores, each time we've discovered a new resource, society has taken a big leap forward. Often, students don't even think about the links between the way we live our lives and the minerals we use. Pointing out some of

COURSE OUTLINE

WEEK 1 • *Crystals, Minerals, and the Atomic Structure of Matter*

Topics Include (cont'd):

F. Breaking Up Is Hard To Do! Explains the process whereby minerals break, including the properties of fracture and cleavage. In addition, we introduce the property of mineral hardness, including Mohs' scale, and offer a classroom activity where students test and rate the hardness of minerals.

G. Mineral Color, Luster, and Streak. Discusses the use and limit of using color as a diagnostic property in identifying a mineral and explains why the powdered streak of a mineral is a far better characteristic to use. In addition, it provides detailed instructions of how to have students do their own streak test of mineral samples.

H. Silicates on Parade. Discusses the nature and composition of silicate minerals, the most common minerals found on Earth. Explains the structure of the silicon tetrahedron, the basic building block of all silicate minerals, and provides instructions for conducting a student lab on silicate mineral identification.

I. Non-silicate Minerals. Explains the structure of some of the more important non-silicate minerals (including sulfates and carbonates) and discusses the overall economic importance of mineral resources.

Assignments (cont'd)

these connections helps make Earth science "real" for them. Can you think of some specific examples where the discovery and use of a new mineral resource has changed the way we live our lives? Post your ideas to the Course Content and Application Discussion Board.

COURSE OUTLINE

WEEK 2· *The Earth Beneath Our Feet—Constructive Forces*

This week provides an introduction to the constructive forces that shape the crust of the planet, including volcanoes, earthquakes, and tectonic uplift.

MAJOR IDEAS

Instructor: Please provide.

Topics include:

A. Volcanoes: Building the Crust from Inside Out. Explains the importance of volcanoes and the role they play in forming new crust. Discusses the various types of volcanoes, their hazard potential, and their distribution on Earth's surface.

B. The Inside Story: Intrusive Igneous Rocks. Explains the difference between intrusive igneous rocks and volcanic igneous rocks and discusses how textural difference can be used to determine the environment of an igneous rock's origin. Includes a demonstration on how to make a simulated igneous rock.

C. Making Mountains Out of Molehills. Describes the process of mountain building and explains the different ways that Earth's crust gets uplifted. Includes a demonstration to simulate crustal uplift due to converging tectonic plates.

D. Earthquakes and Seismology. Explains the origins of earthquakes and describes the generation and propagation of different types of earthquake waves. Includes a discussion on earthquake damage/measurement scales and an activity on measuring seismic waves.

E. We All Have Our Faults! Describes the different types of faults and the forces responsible for motion along them. Includes an activity for locating local seismic zones near your school.

F. The Big Squeeze: Metamorphic Processes in Action. Explains the differences between contact and regional metamorphism and describes how metamorphic textures can be used to determine the origin of a particular rock sample. Includes a simulation of how a solid state change can occur in a rock if the pressure is great enough.

Assignments

Read the Course Documents for Week Two. Identify three additional web sites not mentioned in the course documents that provide current information on seismic and/or volcanic activity around the world. Find out if there has been any recent earthquake activity in your local region or state by logging onto one of these web sites. Identify the date and Richter magnitude of the last event. Post your answers to the Course Application Discussion Board.

For this week's discussion question, consider the following: Earthquake prediction has always been tricky business. Just when scientists think that they have found a key indicator that will unlock the process, things don't work out as they planned. The question is, are there any truly effective means for predicting earthquakes and should we continue to spend money in trying to solve the problem, or should we just chalk it up to fate? Post your ideas to the Course Content and Application Discussion Board.

COURSE OUTLINE

WEEK 3· *Tearing Down the Earth—Destructive Forces*

This week provides a general introduction into the destructive forces that shape the Earth's crust, including weathering, and erosion by streams, wind and ice. It also introduces sedimentary processes and the rock cycle.

MAJOR IDEAS

Instructor: Please provide.

Topics include:

A. Weathering of Rocks. Explains the processes of chemical, physical, and biological weathering of rocks and discusses how these agents of change help to create sediment. Includes a classroom activity on rock weathering.

B. Mass Movements and Gravity. Explains how gravity acts as the driving force behind erosion, providing sediments with the potential energy they need to move down hill. Describes the different types of "mass wasting" events and describes an activity dealing with the angle of repose of different sediments.

C. Stream Erosion. Explains the role that running water plays in shaping the landscape and the types of erosion and sediment transport that occur in streams. Includes a pop-out on the water cycle as the driving force behind stream erosion.

D. A River Runs Deep: The Development of Stream Systems. Describes the development of different types of stream systems and explains how drainage patterns are controlled by many factors, including the underlying structure of the bedrock. Includes a lab activity using stream tables in the classroom.

Assignments

Read the Course Documents for Week Three. Using local resources, books, and/or web sites, determine what general rock types (igneous, sedimentary, or metamorphic) are found in your local community. Based on these rock types, describe how the general environment of your region has changed over time. Post your assignment to the Course Application Discussion Board.

Instructor: Should there be a discussion question included here?

COURSE OUTLINE

WEEK 3• *Tearing Down the Earth—Destructive Forces*

Topics include (cont'd.):

E. Glaciers in Action. Explains the mechanics of glacial flow and describes how glaciers can be agents of erosion, transport, and deposition. Discusses evidence for past ice ages on Earth and how glaciers can be used to identify climatic change.

F. Wind Erosion and Transport. Explains how wind is often overlooked as an agent of sediment erosion and transport and discusses the origin and migration of dunes in an arid environment. Describes a student activity used to demonstrate wind erosion.

G. Reach the Beach—Coastal Erosion and Deposition. Explains the dynamic interplay of wind, waves, and current action in the erosion and transport of sediment in coastal zones. Discusses the development of coastal landforms and the significance of global warming in accelerating global sea-level rise.

H. Deposition and the Formation of Sedimentary Rocks. Discusses the different types of sedimentary rocks and the importance of sedimentary structures in identifying a historical sequence of depositional environments. Describes a lab activity in which students can observe the formation of graded beds.

I. The Rock Cycle. Summarizes the components of the rock cycle and describes the processes by which minerals can be recycled into different rocks. Explains the importance of the principles of superposition and uniformitarianism and how they allow geologists to unravel past geological events by "reading the rocks."

COURSE OUTLINE

WEEK 4: *The Development of Plate Tectonic Theory*

This week provides a general introduction to modern plate tectonic theory and discusses the various lines of evidence used to support it.

MAJOR IDEAS

Instructor: Please provide.

Topics include:

A. Mapping Earth's Surface. Explains the importance of maps in determining both the surface features and internal structure of the Earth. Discusses the use of scales in calculating the true sizes of geographic and geologic features, and provides a classroom activity on how to convert one scale to another.

B. Continental Drift: The Birth of an Idea. Discusses the work of Alfred Wegener and his early theories of continental drift. Describes a classroom activity for reuniting Pangaea.

C. The Ocean Floor: What a Relief! Explains how topographic measurements of the ocean floor helped to provide key evidence in support of the idea that Earth's crust is a dynamic entity. Discusses how evolving technology has helped to increase our overall scientific knowledge.

D. Sea Floor Spreading. Explains how sampling and age-dating rocks from the ocean crust led scientists to an understanding that the distribution of the sea floor changed over time, ultimately providing a mechanism for continental drift.

Assignments

Read the Course Documents for Week Four and use them or external web sites to develop a timeline for the development of plate tectonic theory. Post your timeline to the Course Application Discussion Board.

For this week's discussion question, consider the following: Today, plate tectonic theory is treated almost as a fact of life. It's used to explain everything from locations of earthquakes and volcanoes to the distribution of animal and plant species around the globe. It's hard to imagine a time when plate tectonic theory wasn't accepted by the geological community, but some of us older geology types do recall when the idea of drifting continents and shifting plates was considered more science fiction than science fact. Eighty years ago Alfred Wegener was ostracized for his outlandish ideas of continental drift. Less than 50 years ago, people like Harry Hess and J. Tuzo Wilson were still fighting uphill battles trying to get the geologic community to "see the light." One of the most important things you can instill in your students is the idea that science itself is dynamic, and just like the Earth is constantly changing, so is the way we interpret it. Remember, less than 500 years ago most

COURSE OUTLINE

WEEK 4: *The Development of Plate Tectonic Theory*

Topics include (cont'd.):

E. Wandering Poles and Magnetic Stripes. Describes the phenomena of remnant magnetism in rocks and explains how periodic changes in the direction of Earth's magnetic field helped geologists unravel the motion of crustal plates. Provides an activity using either probes or compasses to simulate how detection of magnetic shifts in rocks helps to trace past plate motions.

F. Ring Around the Ocean. Explains how the plotting of earthquakes and volcanic activity around the Earth helped to confirm the idea that sections of the crust were free to move over time. Describes the mechanics of a subduction zone and the importance of the Pacific "Ring of Fire."

G. Plate Tectonic Theory: Wegener's Revenge. Explains how modern plate tectonic theory helped to pull all the pieces together and how it serves as a unifying principle in geology today.

Assignments (cont'd.)

people believed that the Earth was the center of the universe and the world was flat! Currently there are a number of controversial geologic theories that are being proposed to explain a number of different geologic phenomena. One involves the cause of the mass extinction that wiped out the dinosaurs at the end of the Cretaceous Period. The other has to do with the possibility that there is a large natural nuclear reaction is going on at the center of our planet, which may be the cause of Earth's magnetic field. How might you use the struggle of scientists who fought for acceptance of plate tectonic theory as a way of introducing some of these new ideas to your classes? Do a web search to see what you can find about these two theories and share your thoughts. Here are two names to search: Walter Alvarez, for the dinosaur extinction, and J. Marvin Herndon, for the "nuclear planet" theory. As luck would have it, the August 2002 issue of Discover Magazine has a feature article on Dr. Herndon, so you can begin by searching their web site at www.Discover.com. I'll also put some links to helpful sites on the External Links tool. Post your ideas to the Course Content and Application Discussion Board.

COURSE OUTLINE

WEEK 5• *The Inside Story*

Participants review the principles of equity in assessment, and explore the implications of multiple intelligence theory in assessment in the light of the National Science Education Standards.

MAJOR IDEAS

Instructor: Please provide.

Topics Include:

A. Earth's Internal Structure. Explains the current model of Earth's internal structure, including the distribution of crust, mantle, and outer and inner cores.

B. Density: That Sinking Feeling. Explains how density differences between the rocks of the crust and mantle help to drive plate tectonic action. Describes a classroom demonstration that simulates how the crust "floats" on denser material below and discusses how density settling allows subduction to take place.

C. Convection Currents and Geothermal Energy. Explains how the differential heating of material in the mantle helps to generate large-scale convection currents, which provide the motor for plate tectonic action.

D. Earth's Magnetic Field: The Dynamo Effect. Discusses the origins of Earth's magnetic field and describes the so-called dynamo effect. Provides a student activity on measuring the intensity of a magnetic field.

E. Earthquake Shadow Zones. Explains how seismic data has been used to identify different layers inside the Earth and discusses the discovery of the "Moho."

F. Origins of the Earth. Discusses current theories on the origins of the Earth and explains how the geophysical data supports the "proto-planetary" hypothesis.

Assignments

Read the Course Documents for Week Five and use them along with external web sites to discuss the ways that geologists' views regarding the internal structure of the Earth have changed over the last 100 years.

For this week's discussion question, consider the following: Over the last few years, astronomers have identified more than 80 new planets orbiting other stars in our galaxy, but none of them appear to have the same physical characteristics of Earth. In fact, the more scientists discover, the more it appears that Earth is a very unique place when it comes to its ability to support higher life forms. Despite this fact, the human population of our planet continues to act as if the natural systems of the Earth have an unlimited capacity to absorb pollutants and provide resources. Throughout this class, the underlying focus has been the idea that Earth is dynamic and in a state of continuous change. Today we are faced with problems concerning global climate change, stratospheric ozone depletion, and sea-level rise, just to name a few. How might you tie some of these global environmental issues to a unit on the dynamic Earth? Post your ideas to the Course Content and Application Discussion Board.

Take the final examination.

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GRADING PROCEDURES

The final grade for this course is based on

- completion of the course assignments (50%),
- substantive participation in weekly discussions (25%),
- and performance on assessments (25%).

Accumulated points of 100 possible points during the course determine CEU credit and letter grades for ONE graduate unit as follows:

- 90–100 = grade of A
- 80–89 = grade of B
- 70–79 = grade of C
- 70–100 = credit for 5 CEU's

Student participation and demonstrated knowledge are evaluated weekly. Postings on the discussion boards should be guided by the following rubric:

- **Level 4:** High-quality professional discourse that invites inquiry. The message creates an inviting framework by sharing a personal reflection; presenting an interesting and well-articulated dilemma, challenge, or issue; or raising a thought-provoking question
- **Level 3:** Thoughtful professional discourse. The message shares information, an issue, or a question in a thoughtful way, which might focus on specific details, explore the "why's" as well as the "what's," or explore others' beliefs and practices.
- **Level 2:** Collegial discussion and/or "shop talk." Message could be a response to a previous message; a request; a description of classroom practice; or an issue, dilemma, or challenge that reflects the beliefs or practice of the author but lacks self-reflection and/or an invitation to others to respond.
- **Level 1:** Factual statements or informational. Message is usually a question, a brief statement of fact or opinion, or an announcement that does not tend to stimulate ongoing professional discussion, thoughtful reflection, or examination of beliefs and/or practice.

Students earning graduate credit will complete an academic assignment in consultation with the instructor consisting of a research paper or action research paper in a scholarly format, supported by appropriate references. Students earning a second graduate credit will complete an additional project, also in consultation with the course instructor. An additional maximum of 100 points may be earned for the second project.