

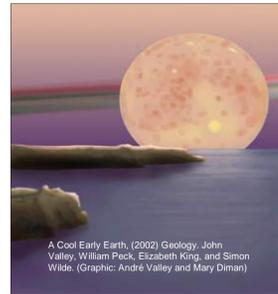
TEACHING ABOUT THE EARLY EARTH: EVOLUTION OF TECTONICS, EARLY LIFE, AND THE EARLY ATMOSPHERE

ED33B-1229

Mogk, D W, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717, mogk@montana.edu; **Manduca, C A**, Science Education Resource Center, Carleton College, Northfield, MN 55057, cmanduca@carleton.edu; **Kirk, K**, Science Education Resource Center, Carleton College, Northfield, MN 55057, kkirk@carleton.edu; and **Williams, M L**, Dept. of Geosciences, Univ. Massachusetts-Amherst, Amherst, MA 01003, mlw@geo.umass.edu

The Early Earth: A fertile ground for teaching geoscience

The early history of the Earth is the subject of some of the most exciting and innovative research in the geosciences, drawing evidence from virtually all fields of geoscience and using a variety of approaches that include field, analytical, experimental, and modeling studies. At the same time, the early Earth presents unique opportunities and challenges in geoscience education: how can we best teach "uncertain science" where the evidence is either incomplete or ambiguous? Teaching about early Earth provides a great opportunity to help students understand the nature of scientific evidence, testing, and understanding.



Early Earth Workshop: from the On the Cutting Edge series

To explore the intersection of research and teaching about this enigmatic period of Earth history, a national workshop was convened for experts in early Earth research and undergraduate geoscience education. The workshop was organized around three scientific themes: evolution of global tectonics, life, and the early atmosphere.

Goals of the workshop:

- Explore the intersection of research and education about Early Earth
- Learn about new research on the early Earth
- Understand the early Earth as a system that incorporates the solid earth, ocean, atmosphere, climate, and early life.
- Consider how to move exciting new ideas about the early Earth into teaching geoscience
- Produce ideas, activities and resources for teaching about the early Earth



Resources for Educators: Ideas for the classroom and lab

Strategies for Teaching Uncertain Science

- Draw comparisons from other planets, moons or solar systems.
- Seek modern analogs, such as hydrothermal vents.
- Use computer models to predict processes based on what we do know.
- Conduct laboratory experiments on a small scale to test hypotheses about some of the chemical, physical and biological processes that may have been important in the early earth environment.
- Employ a teaching strategy that capitalizes on the excitement of discovering something that is unknown
- Dealing with uncertain science can be daunting, so choose the topic and the approach carefully.



Teaching ideas for exploring the early solid earth, early atmosphere, and early life



Examples of solid earth teaching ideas

- What's up with continental crust? How and when did it form? Did it form quickly or slowly?
- How do planets lose heat?
- How did the Earth form through accretion, and how is this process related to the age of the Earth?



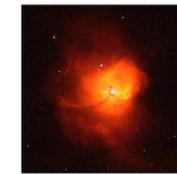
Example teaching ideas about the early atmosphere

- Understanding Faint Young Sun Problem
- What is the evidence for the timing and rise in the concentration of oxygen in the earth's early atmosphere?
- Climate change in the Archean and Proterozoic



Teaching about early life

- Early Life Mock Trial
- Are Archean stromatolites biogenic?
- What is the evidence for Pre-Phanerozoic life, and does it extend back into the Archean?



What are the "key questions" about the early Earth? How can we use those key questions for teaching?

These questions pose some of the great mysteries of the early formation of our planet and present wonderful opportunities for teaching about the process of science.



- How do we extrapolate backward to understand the conditions of the Hadean Earth?
- Why is Earth among all terrestrial bodies in the solar system (e.g. Moon, Mars, Venus and meteorites) the only body to have silicic crust?
- When and how did the continental crust form?
- When did oceans form on Earth? What evidence is preserved in the rock record?
- What was the nature of the pre-biotic terrestrial atmosphere?
- What is our current understanding about the origin of the atmosphere?
- Was there a single, last uniform central ancestor (LUCA) or did life emerge multiply on Earth at different times and in different environments?

More materials for teaching about the early earth

Research talks presented at the workshop

Zircon images and teaching materials

Microbial Life – Educational Resources

Using an Earth History Approach

Deep Time – Teaching the Geologic Time Scale

Teaching Evolution

