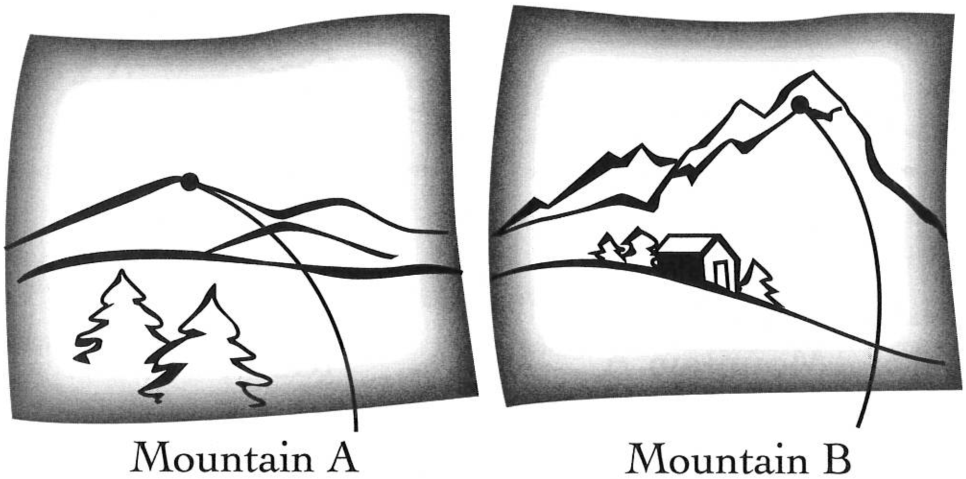
Mountain Age

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' ideas about processes that affect the shape of mountains. While determining the relative age of mountains involves a variety of complex interacting factors, this probe is designed to determine if students consider weathering factors or if they intuitively believe taller mountains are older.

Related Concepts

weathering, erosion, landforms

Explanation

There is no single correct answer to this probe because shape and height alone cannot be used to determine the age of mountains. However, the probe is useful in recognizing the role of weathering and erosion in shaping landforms such as mountains. Mountains are formed as the result of uplift of the Earth's crust or volcanic activity. While it makes intuitive sense to students that taller mountains are older, mountains cannot be accurately compared for age based on height and shape alone. Several variables are involved in the shape and height of mountains. Weathering and erosion rates may depend on (1) water (e.g., rainfall, freeze-and-thaw cycles, transport), (2) material composition and condition, and (3) other factors such as slope.

Uplifted mountains that are jagged at the top may be relatively young mountains, but they can also be older than smaller rounded mountains. The rock forced upward as the mountain formed over long periods of time has not yet eroded to become smooth. Mountains that are rounded have been subjected to weathering and erosion of rock over long periods of time by water, wind, and ice, causing the mountains to look smooth and rounded. The assumption that one is older than the other cannot be made on appearances alone. However, if the composition and climate conditions are the same, it could be logically inferred that Mountain A may have had more time to be shaped by weathering and erosion.

Curricular and Instructional Considerations

Elementary Students

Elementary students' opportunities to learn focus primarily on phenomena they can observe. Students examine changes in Earth materials and build an understanding that surface features of the Earth change due to processes like weathering and erosion caused by wind and water. They begin to develop the notion that some changes are slow and some are rapid. These are grade-level expectations in the national standards. However, the results of processes that happen over long periods of time are difficult for young children to imagine.

Middle School Students

Middle school students develop more complex understandings about constructive and destructive geologic processes, including the long periods of time it takes for some of these processes to occur. They examine how these forces combine to result in various landforms such as mountains. They begin to use ideas about geologic processes to explain the building up and wearing down of mountains over long spans of geologic time. They recognize the role of water and wind, combined with properties of materials and long spans of time, in shaping mountains. These are grade-level expectations in the national standards. However, students at this age may hold on to preconceived ideas such as mountains grow bigger and taller over time, which explains why many students intuitively select B. This probe is useful in eliciting students' ideas for the purpose of shaping instruction that targets their preconceptions.

High School Students

Students transition from a descriptive focus on processes that affect the formation and wearing down of mountains to more sophisticated scientific explanations. They combine knowledge about plate tectonics and mountain formation with an understanding of what happens to mountains over long periods of time, including the many variables involved. Students at this level are more apt to grasp the notion of the long periods of time necessary for these processes to occur and the complexity of the factors involved and to understand the evidence that supports these ideas. This probe is useful in determining students' prior understanding of middle school concepts before building on their ideas with more sophisticated concepts.

Administering the Probe

If students live in an area of the country where familiar mountains can be used as examples (e.g., Appalachian or Rocky Mountains), you may wish to point them out. Using photos to contrast actual mountains such as Mount Everest and Mount Washington may be more helpful than the small graphics in the probe. This probe may be used with "Beach Sand" (p. 163) to elicit ideas about weathering of rock in a different context.

Related Ideas in *National Science Education Standards* (NRC 1996)

K–4 Changes in the Earth and Sky

- The surface of the Earth changes. Some changes are due to slow processes, such as weathering and erosion.

5–8 Structure of the Earth System

★ Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

★ Interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the Earth system. We can observe some changes such as earthquakes and volcanic eruptions on a human timescale, but many processes such as mountain building and plate movements take place over hundreds of millions of years.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 1993)

3–4 Processes That Shape the Earth

- Waves, wind, water, and ice shape and reshape the Earth's land surface by eroding rock and soils in some areas and depositing them in other areas, sometimes in seasonal layers.

5-8 Processes That Shape the Earth

★ Some changes in the Earth's surface are abrupt (such as earthquakes and volcanic eruptions) while other changes happen very slowly (such as uplift and wearing down of mountains). The Earth's surface is shaped in part by the motion of water and wind over very long times, which acts to level mountain ranges.

Related Research

- Earth (and space) sciences have a unique aspect of scale that may be problematic for students. For example, comprehending the length of time it takes for mountains to erode is difficult for some students (Ault 1994).
- A study by Freyberg (1985) revealed that many students think the Earth today is the same as it has always been and that any changes to the Earth were sudden and comprehensive. However, it is important to note that students in this study did not have formal instruction in the topics addressed (AAAS 1993).

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

- In summaries of several studies conducted by J. C. Happs in the early 1980s, Driver et al. (1994) indicated that students have a variety of ideas about the composition of mountains and their formation. Children described mountains as "high rocks" or "clumps of dirt or soil." Some students believed all mountains came from volcanoes or molten rock and some believed they were formed from "rock pushed up." Happs's studies revealed that most children in the study were unable to use a theory of mountain building that involved plate tectonics (Driver et al. 1994).
- Stavy and Tirosh (1995) identified intuitive rules students use to reason various problems. The rule "more A, more B" is a common rule students use in their reasoning. In the context of this probe, students may apply this rule and think that because a mountain is taller, then it must be older.

Suggestions for Instruction and Assessment

- Elementary students can begin by first-hand observations of processes of weathering and erosion by using rock tumblers, water, and sandboxes. Once they grasp the processes of weathering, erosion, and deposition, they can begin to connect these processes to the features of landforms and how they change.
- Elementary and middle school students may confuse growth of organisms with growth of mountains. They may believe mountains grow over time in much the same way that organisms grow and become taller, and fail to recognize the role of weathering and erosion. Comparing and contrasting these two processes may help older students understand why size cannot be an accurate indicator of mountain age.
- Because most students do not have direct experience with the processes that shape the Earth or their long-term nature, some explanations should wait until late in grades 5–8 (NRC 1996).
- Students should have opportunities to see a variety of landforms in photographs and videos and describe how they came to be. Yet, be aware that some pictures may lead to faulty interpretations. For example, students may cite evidence based on observations in pictures that glaciers chip mountains away so the more ragged one is older because glaciers occurred a long time ago.
- Be explicit about the span of geologic time that is necessary for these processes to occur. Yet, understand how difficult it is for elementary and middle school students to imagine these time spans.
- Use models to help students visualize the results of processes that happen over long periods of time.
- Help students link the ideas that different types of materials weather differently and that weather and climate in different regions of the world affect geologic processes. These foundational ideas will help them see why it is difficult to visually determine relative age of mountains based on their size and shape.

- Because an individual mountain is often part of a system of mountains, be sure to include comparisons among mountains within different mountain ranges.
- High school instruction may include the historical episodes that led to the modern understanding of the age of the Earth and that features such as mountains are formed over long periods of time and are still in the process of change. Examining the types of evidence that led to this modern notion will help students accept a modern theory of the geologic processes that change mountains over time.
- Be aware that some popular creationist beliefs may impede students' understanding of how mountains came to be. Some creationist views propose that mountains were formed by a single, instantaneous creation.
- "Because direct experimentation is usually not possible for many concepts associated with earth science, it is important to maintain the spirit of inquiry by focusing the teaching on questions that can be answered by using observational data, the knowledge base of science, and processes of reasoning" (NRC 1996, pp. 188–189).
- Help students distinguish between *weathering* and *erosion.* Some students use these terms interchangeably. Weathering is the wearing away whereas erosion is the carrying away.

Related NSTA Science Store Publications and NSTA Journal Articles

American Association for the Advancement of Science (AAAS). 2001. *Atlas of science literacy.* (See "Changes in the Earth's Surface," pp. 50–51.) New York: Oxford University Press.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London and New York: RoutledgeFalmer.

Gilbert, S. W., and S. W. Ireton. 2003. *Understanding models in earth and space science.* Arlington, VA: NSTA Press.

Keeley, P. 2005. *Science curriculum topic study: Bridging the gap between standards and practice.* Thousand Oaks, CA: Corwin Press.

Monnes, C. 2004. The strongest mountain. *Science and Children* (Oct.): 35–37.

Stavy, R., and D. Tirosh. 1995. *How students (mis-) understand science and mathematics: Intuitive rules.* New York: Teachers College Press.

Related Curriculum Topic Study Guides

(Keeley 2005)
"Landforms"
"Processes That Change the Surface of the Earth"
"Weathering and Erosion"
"Models"

References

American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

Ault, C. R. 1994. Research in problem solving in earth science. In *Handbook of research on science teaching and learning,* ed. D. Gabel. New York: Simon and Schuster.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London and New York: RoutledgeFalmer.

Freyberg, P. 1985. Implications across the curriculum. In *Learning in science,* eds. R. Osborne and P. Freyberg. Auckland, New Zealand: Heinemann.

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