

SHARING GEOLOGY WITH THE PUBLIC IN ARIZONA'S "ROUTE 66 COUNTRY" USING INTERPRETIVE AND PLACE-BASED EDUCATIONAL TECHNIQUES

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Many national parks and other geoh heritage areas are located along and near Historic US Route 66 (now subsumed by I-40) from Flagstaff to Grants, including Grand Canyon National Park, Sunset Crater Volcano National Monument, Meteor Crater, Petrified Forest National Park, and El Malpais National Monument. These areas provide more than just spectacular scenery. They are classic world-renowned geologic sites. Outstanding examples of geologic features and processes, records of vast swaths of geologic time, incredible exposure of stratified rocks, significant fossil localities, and evidences of the dynamic nature of the planet are some of the hallmarks of these locales, making them important places for increasing the public's understanding of Earth and how it works.

Many geologists also use sites in this region of northern Arizona to teach geology to students either in field trips or the classroom. These geoh heritage areas are frequently utilized in introductory-level or non-major geosciences courses such as geology of national parks, or geology of the Southwest. Professional geologists may find that using principles of heritage interpretation (Tilden, 1957; Beck and Cable, 2002; NAI, 2007) and a place-based teaching approach (Semken, 2011) are effective techniques for communicating geologic stories. Interpretive techniques and place-based teaching strategies are especially important when communicating with the general public. Utilizing these methods helps people to appreciate the importance and relevance of the geosciences not only to the understanding of geoh heritage areas, but also as an integral part of their lives. These sites can also help to convey the so-called "Big Ideas" of public Earth science literacy (ESLI, 2009). While all nine of these "Big Ideas" are evoked by the geological heritage sites along Historic Route 66, four of them are especially teachable here:

"Earth is 4.6 billion years old"; "Earth is a complex system of interacting rock, water, air, and life"; "Earth is continuously changing"; and "Life evolves on a dynamic Earth and continuously modifies Earth."

By communicating more than just information, the goal of interpretation is to help people understand and appreciate the significance of geoh heritage sites. Interpretation is an integral aspect of the National Park Service mission because it is a preservation tool, yielding increased sense of stewardship for park areas.

The National Association for Interpretation defines interpretation as "a mission-based communication process that forges emotional and intellectual connections between the interests of the audience and the meanings inherent in the resource" (NAI, 2007). It is an informal educational activity with the purpose of revealing meanings and relationships rather than just communicating information and facts (Tilden, 1957).

Fostering a sense of place is at the heart of interpreting geology (Lillie et al., 2011). The sense of place encompasses the range of human connections to a locality, including humanistic and scientific knowledge of place, and emotional attachments to place. Senses of place can be held individually or by groups, and for any given place they are as diverse as the people who have ever interacted with or experienced that place (Semken, 2005).

Using places is an inherent part of teaching Earth sciences. Teaching that is situated in specific places—and intentionally leverages, evokes, or enhances the sense of place—is referred to as place-based teaching (Semken, 2005). Typical characteristics of a place-based approach to teaching include: a focus on local or regional landscapes and environments; outdoor learning or other forms of experiential learning; meaningful integration of local or indigenous ways of understanding Earth systems and processes; use of humanistic ways of knowing place as context for scientific discovery; creative expression of learning; and affirmation of the natural beauty of places (Semken, 2005, 2011).

Place-based teaching and interpretation share many attributes. Both disciplines can be utilized by geologists wanting to promote meaningful learning experiences for students and park visitors. Geologists may also partner with interpreters and environmental educators on park and partner organization staffs to reach audiences outside of the formal educational system. Potential park audiences are large. For example, of the 4.5 million people who visited Grand Canyon National Park in 2011, nearly 220,000 attended park interpretive programs. Many more people viewed interpretive exhibits, including the Yavapai Geology Museum and the Trail of Time exhibition (Karlstrom et al., 2008; Crow et al., 2011). Partnering with park and heritage-area staff allows exchange of interpretive



Park Ranger Allyson Mathis, interpreting the Geology of Grand Canyon

and geologic expertise, which leads to enhancement of interpretive programming given by park employees and place-based formal education presented by professional geologists.

Interpretive methods and principles that present geology as an integral part of a site's overall natural and cultural history are effective in increasing relevance and meaning for general audiences. Interpreting geology as part of a larger story helps animate the topic. Geology is part of every park's story, even at historic sites such as El Morro National Monument, southeast of Gallup, New Mexico. A key aspect of the local story is geological—people have utilized the reliable spring at the base of the sandstone cliff for thousands of years. Geology impacts climate, ecosystems, and the plants and animals of an area, including endemic species. Geologic history can be read in the lithologies, structures, and landforms of a region. Evidence for the timing and nature of the eruption and formation of Sunset Crater Volcano includes not only geological information, but also analyses of archaeological sites near the volcano, tree-ring morphology, and dating of pottery tempered with Sunset Crater cinders (Elston et al., 2011). Telling the “whole story” at Sunset Crater Volcano National Monument thus involves the integration of volcanology, archaeology, dendrochronology, and other disciplines.

Highlighting the visual appeal of scenery can help form connections for visitors between geology and their experience of natural areas. The spectacular scenery of parks and other heritage areas is a major reason why people visit them. Geologists may appreciate Grand Canyon primarily for its amazing display of the rock record, but most park visitors are drawn by the canyon's incredible beauty. People approach these landscapes with not only intellectual curiosity, but may seek spiritual or inspirational connections, opportunities to soak in natural beauty, or recreational activities. At Petrified Forest National Park, visitors revel in the stark beauty of the Painted Desert, marvel at the display of colors in the petrified wood, and are also intrigued by the park's dinosaur fossils. These experiences may inspire a greater curiosity as to how geologists reconstruct past ecosystems. Making connections between the aesthetic and the scientific improves understanding, broadens meaning, and builds a more complete appreciation of a region and its natural history.

Key aspects of interpretation of geologic subjects include presenting scientific information at a technical level appropriate for the audience, ensuring that the information is relevant to non-specialists, and using analogies and other methods that draw on visitors' personal experience. It is essential that information

presented in an interpretive program is accurate, but it does not have to be highly precise. In other words, if presenting precise information requires the inclusion of jargon, builds on advanced knowledge of a subject, or includes a large number of technical details, more generalized information incorporating fewer specifics may be more effective. For example, when discussing the formation of Grand Canyon, it is far more important for the public to understand that the canyon results from incision by the Colorado River along the southwest margin of the Colorado Plateau, than to know the full complexity relating to the origin and evolution of the modern landscape.

Stating information in common terms and placing it into context increases understanding and comprehension. For example, it is more understandable to say that the age of the Kaibab Formation at Grand Canyon is “270 million years old” or “older than the Age of the Dinosaurs,” rather than to say that it is “Permian.” It may be better to describe Sunset Crater's eruption as “volcanic fireworks,” than defining it as Strombolian (Lillie et al., 2011). A presentation to the general public or to students in an introductory geology course should provide opportunities for the audience to understand and learn. This is far better than presenting a scientific talk that leaves people grasping for comprehension.

Like other experts, geologists are more able to see patterns and relationships in geologic features and processes than typical park visitors, most of whom are geologic novices. Knowledge of audience characteristics is an integral part of interpretation (Tilden, 1957), and it is helpful for geology interpretive programs and products to integrate material relevant to the general public and incorporate aspects of common geologic knowledge such as the three major types of rocks, or anything related to dinosaurs (Lillie et al., 2011). It is also important to address topics that answer common visitor questions, such as the causes of coloration of strata, or how geologists tell time.

Geologists have greatly valued the geologic resources of the southern Colorado Plateau ever since pioneering geologists such as John Strong Newberry, John Wesley Powell, and Grove Karl Gilbert first conducted scientific studies in the region later traversed by I-40. The use of place-based teaching and interpretive techniques helps geologists share their knowledge and appreciation of these outstanding geoheritage areas with audiences beyond geologists and other scientists. Effective interpretation and place-based education will not only promote stewardship of these sites, but will help increase Earth science literacy, as these scenic areas draw visitors from around the world.

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