

GEOMYTHOLOGY © Adrienne Mayor
 in *Enclopedia of Geology*, ed Richard Selley, Robin Cocks, and Ian Palmer.
 Forthcoming, Elsevier, fall 2004.

Geomythology (also called “legends of the earth,” “myths of observation,” “natural knowledge,” and “physico-mythology”) is the study of etiological oral traditions created by pre-scientific cultures to explain—in poetic metaphor and mythological imagery—geological phenomena such as volcanoes, earthquakes, floods, fossils, and other natural features of the landscape. (A related field, “archaeo-astronomy,” studies pre-scientific knowledge of sky phenomena.) Two types of geomyth have been identified: folk explanations of notable geological features, and often-garbled descriptions of catastrophic geological events that were witnessed in antiquity. In the case of geomorphic events that occurred in the pre-human past, observation and imagination led to mythic explanations that were handed down over millennia. In the case of natural cataclysms within living human history, descriptions were transmitted over generations, often accruing supernatural details. Because of the mythological language of oral folklore, scientists and historians have often missed the kernels of truth and rational concepts embedded in geomythological narratives. Some geomyths are simply fanciful stories based on imagination or popular misconceptions, such as tales of creatures or humans that were magically transformed into rock to explain the shapes of landforms. Many geomyths, however, contain surprisingly accurate insights into geological processes, as well as important eyewitness data from the distant past. Modern scientific investigations have revealed that much ancient folklore about the earth was based on rational speculation and understandings grounded in careful observations of genuine but extraordinary physical evidence over time.

Geomythology in Classical Antiquity

Although the term “geomythology” was coined in 1968 by the geologist Dorothy Vitaliano, and it is often considered a new field of study, the concept was known and applied since antiquity. Euhemerus, a Greek philosopher (ca 300 BC) held that myths about divinities and their activities were poetic accounts of real people and events. His approach, called euhemerism, was taken up by other classical scholars who rationalized myths by stripping away supernatural and impossible details to reveal an underlying core of facts. Some of the rationalizing deconstructions of hero and monster myths by the Greek euhemerist Palaephatus (4th century BC) may seem contrived, but others, such as his interpretation of the myth of Cadmus sowing the dragon teeth, are quite sophisticated. Palaephatus suggested that the tale represented an ancient misunderstanding of fossil elephant molars, which were frequently found in the ground and treasured by kings in archaic Greece before knowledge of elephants was brought back from India by Alexander the Great in the 4th century BC.

Many other classical Greek and Latin writers identified archaic myths about creation and primal creatures, first written down in the 8th century BC by the epic poets Homer and Hesiod, as symbolic ways of describing actual events and processes in deep time or within human memory. In his account of Atlantis and in other works, for example, the philosopher Plato (4th century BC) correctly described large-scale changes in prehistoric

land masses and coastlines in the Aegean. In the 1st century BC, the Latin poet Ovid expressed accurate conceptions of geomorphology and the process of petrification in his “Metamorphoses,” verses about the transformations of mythic beings. Around the same time, the Greek geographer Strabo validated traditional geomyths as cryptic historical records, observing that “the ancients expressed physical notions and facts enigmatically by adding mythical elements.”

In his 5th-century BC tragedy “Prometheus Bound,” the Greek dramatist Aeschylus recounted the myth of Zeus burying Typhoeus, a monstrous, many-headed dragon with many voices that embodied primal chaos, under Mount Etna in Sicily, Europe's largest and most active volcano. The etiological account explains Etna's eruptions as Typhoeus's struggles to escape the subterranean prison: his roars and hisses were the auditory features of the volcano, and his fiery breath was supposed to melt rock, creating the periodic lava flows that endangered towns on the slopes of Etna. In the 1st centuries BC and AD, the Latin epic poet Virgil and the natural historian Pliny the Elder suggested that the one-eyed giant Cyclopes described by Hesiod in his “Theogony” (ca 750 BC) were meant to personify other active volcanoes in the Mediterranean.

Contributions of Geomythology to Modern Science

Robert Hooke was the first modern scientist to employ classical geomythology as historical evidence. To support his theory of vast geological alterations over time, in a series of lectures in 1667-78 Hooke drew on geomythology of landform changes and earthquake-related lore recorded by Plato, Pliny, Strabo, Virgil, and Ovid (as well as biblical scriptures). Hooke sought the empirical evidence of mythic narratives to show that great floods and earthquakes had repeatedly transformed the earth in the deep past, and could justify the presence of petrified marine remains on mountaintops.

Another early geomythologist was the father of paleontology, Georges Cuvier (b. 1769). Cuvier compiled a collection of ancient Greek accounts and North and South American Indian traditions about the discoveries of petrified bones of remarkable size to demonstrate the worldwide distribution and longstanding observations of the fossilized remains of immense creatures, which Cuvier was the first to identify as extinct elephants. Edward Burnet Tylor (1865) was another early pioneer of geomythology. He called traditional legends about natural history “myths of observation” to emphasize that they were reasonable efforts to account for mysterious physical evidence.

Vitaliano was the first modern geologist to systematically match the insights contained in various cultures' myths about geology to modern scientific knowledge, thereby giving the study of folklore a disciplinary status. As the first stirrings of geological observation and hypothesis-forming that would later evolve into the earth sciences, geomyths are significant milestones in the history of science. As Vitaliano and others have noted, scientific theories themselves are analogous to etiological geomyths in that both are efforts to explain mysterious observed facts. The ability to link traditional descriptions with present-day science is a notable contribution to scientific knowledge. Geomyths can provide previously unknown additional data for studying geological events that were actually witnessed in the pre-scientific past. The study of geomythology also helps reveal

the processes of transmitting cultural memories over many generations and the origins and functions of oral mythopoesis.

Scientific analysis of geomyths can verify the historical foundations of many myths previously viewed as imaginary products of creative storytelling. For example, in 1999, the frozen mummy of Kwaday Dan Sinchi (“Long Ago Person Found”) was discovered in a melting glacier between Yukon Territory and northwestern British Columbia, Canada. Radiocarbon dating showed that the young man had lived in the 1400s. He carried a waterproof hat woven of roots from the Pacific coast, a leather bag of dried fish and plants, tools made from both coastal and inland trees, and a cloak made from gophers that live far inland. These finds confirmed the ancient oral traditions of the local Champagne and Aishihik First Nations, which describe their ancestors using the glaciers as trade routes to travel between the interior and coast.

Examples of Geomythology

Geomyths from around the world explicate the gamut of geological phenomena, from seismic and volcanic events to fossil deposits, such as shells and marine creatures stranded far from the sea and strange, oversized, unfamiliar skeletons embedded in rock. Extraordinary landmarks and the sudden disappearance or appearance of islands; climactic changes; great floods and changing watercourses; natural petroleum fires and deadly gases emitted from the earth; the formation of minerals and gems underground; and myriad other large and minute natural features of the landscape are all featured in geomythology.

For example, legends of deadly miasmas and “birdless places” often arose in regions where toxic natural gases are released from vents in the earth, affecting plants and wildlife. The ancient image of the cave-dwelling, fire-breathing monster, the Chimera, that dwelled in what is now modern Turkey was no doubt influenced by observations of spontaneously burning natural gas wells in Asia Minor. In 2002, a team of a team of archaeologists and geologists confirmed a long-discounted classical Greek tradition that the priestess possessed by the god Apollo at the Oracle of Delphi was inspired by fumes emanating from a crack in the earth. The team discovered that intoxicating methane and other gases escape from fissures at the ancient site of the Oracle.

Volcanoes and earthquakes are well represented in geomyths. The spectacular volcanoes of Hawaii inspired legends of the fire goddess Pele digging a series of great fire pits as she traveled across the islands. Geologists point out that the legend reflects an ancient awareness that the volcanic activity from northwest to southeast was progressively younger. The Greek myths of the cosmic wars between Zeus and the Titans, Cyclopes, and Typhoeus as described in Hesiod’s “Theogony” were scientifically analyzed in 1992 by historian of geology Mott T. Greene. Hesiod’s poem contains some very old oral stories that date to the second millennium BC. Greene demonstrated that the violent battle with the one-eyed Cyclops can be matched to anciently observed volcanic phenomena associated with the solitary Mt Vesuvius and the solfataric gas emissions in the fields of fire near Naples, Italy. In contrast, the god’s conflict with Typhoeus and the Titans represents Mt Etna’s multiple cones, and the hissing and roaring features, lava flows, and

deep tectonic earthquakes. Moreover, the details of Hesiod's poem suggest that it forms a chronological record of datable major eruptions of Mt Etna in about 1500 BC and in 735 BC, and the Plinian eruption in 1470 BC on the island of Thera-Santorini which destroyed the Minoan civilization.

Ancient Greek earthquake lore distinguished between local, weak volcanic tremors, attributed to struggling giants imprisoned by Zeus in the earth, and large-magnitude tectonic quakes with tsunamis, which were attributed to Poseidon, the earth-shaking god of the sea. In West Africa, where tectonic shocks typically emanate from the west, the natives imagined a giant who tires of facing east clumsily shifting position. Highly seismic Japan has elaborate quake myths, with some tales attributing the earthquakes and tsunamis to the movements of a colossal serpent-dragon surrounding the island. According to traditions in India and many other cultures, earthquakes were said to be caused by giant creatures burrowing underground.

In Samos, an Aegean island with rich Miocene mammal fossils and subject to severe earthquakes, ancient Greeks devised an ingenious myth (5th century BC) to explain both geological features. Before the era of humans, it was said that the island was populated by enormous monsters called Neades, whose deafening shrieks caused the very earth to collapse upon them. According to ancient writers, their huge bones were displayed in situ, and archaeologists have found fossil relics in the ruins of the Temple of Hera on the island. By the 1st century AD the great bones were identified as the remains of Indian elephants brought to Greece by the god Dionysus. Not only are earthquakes on Samos distinguished by loud roaring, but many of the fossils on Samos are those of large, extinct elephant ancestors and the bone deposits are often found trapped underneath earthquake-faulted blocks.

Fossil remains generated a variety of geomyths speculating on the creatures' identity and cause of their destruction. Many ancient cultures, from China and India to Greece, America, and Australia, told tales of dragons, monsters, and giant heroes to account for fossils of animals they had never seen alive. Some scenarios of their destruction in deep time anticipated catastrophic extinction theories, first suggested scientifically by Cuvier, while other ancient accounts leaned toward more recent gradualist theories.

For the ancient Greeks, the Gigantomachy, the cosmic wars in which the gods destroyed giants and monsters and buried them underground, accounted for abundant deposits of the fossil skeletons of enormous, extinct Tertiary mammals found in "giants' battlefields" all around the Mediterranean. In the Siwalik foothills of the Himalayas, ancient Greek travelers reported that Indians displayed bizarrely horned dragons with sparkling gems embedded in their skulls. The origin of the myth came to light when paleontologists in 19th century discovered rich fossils of giant giraffids and oddly tusked proboscids encrusted with calcite crystals. In China, the "dragon" bones collected and ground into medicine turned out to be the fossils of extinct mammals and dinosaurs. In Central Asia, the legend of the gold-guarding Griffin, a creature with the body of a lion and beak of a raptor, arose as nomadic prospectors on their way to gold deposits came upon conspicuous fossils of beaked quadruped dinosaurs in the Gobi Desert.

In Europe, observation of dinosaur tracks in Triassic sandstones in the Rhine Valley probably influenced the legend of the slaying of the dragon Fafnir there by the Germanic hero Siegfried. For Aborigines near Broome, northwest Australia, the footprints of Cretaceous carnosaur and stegosaur dinosaurs in sandstone near Broome, form a “song-line” from Dream-Time. The trackways are considered the trail of a giant “Emu-man” of myth. Where tracks head out to sea and back to shore, legend tells of him wading into the ocean and returning. Wherever he rested, Emu-man’s feathers made impressions in the mud, a logical interpretation of fern fossils in sandstone, which resemble large feathers. According to an Aztec legend preserved by sixteenth-century Spanish explorers, the great feathered serpent--god Quetzalcoatl left his hand and seat prints in stone near Mexico City, one of the earliest geomyths recorded in America. Pleistocene fossils of large mammals are in fact abundant around ancient Aztec sites near Mexico City and the tracks of these probably account for the myth.

Myths of a devastating flood are nearly universal. Recently, a team of geologists studied sediments in the Black Sea region and concluded that Mesopotamian and biblical flood myths originated when the rising Mediterranean suddenly broke through the Bosphorus, inundating the populous farmlands of the Black Sea basin about 6,000 years ago. The awareness that a vast sea once covered the American Southwest in Cretaceous times is evident in Zuni Indian traditions about the bizarre huge marine monsters of a long-past era before humans evolved, whose remains are found along with shells and ripple marks in the desert bedrock. The Zuni creation myth describes how the sea was dried out by a great conflagration. Indeed, giant marine reptiles of the Cretaceous are found in Zuni lands, along with the burned stumps of great prehistoric forests in the desert.

Remarkable landforms have long elicited folk etiologies to explain their origins and notable features. Devil’s Tower in Wyoming, a prominent volcanic formation in the American West with distinctive grooves and facets, was said by Native Americans to have been formed when a gigantic bear clawed at the rock in an attempt to reach children trapped on the top. The unusual Cuillin Mountains of Skye, Scotland, were fabled to have been formed when the Sun hurled his fiery spear into the ground. Where it struck, a huge blister or boil appeared and grew, swelling until it burst and discharged molten, glowing material that congealed to form mountains perpetually covered in snow. Geologists have remarked that the legend accurately recounts the formation of a volcanic dome, which grows, bursts, and spews glowing-hot magma. The Cuillins consist of glabbro, crystallized molten matter, and the surrounding mountains of granite, the Red Hills, are indeed snow-capped in contrast to the steeper Cuillins

Controversies and Future Directions

In recent years, the horizons of geomythology have been expanded by Native American scholars who relate their culture’s geological traditions to modern scientific knowledge. These scholars also grapple with the controversial questions raised by geomyths: How far can human memory, perpetuated in spoken traditions over generations, extend back in time? Strabo was the first to address this issue in the 1st century BC: The very magnitude

of time encompassed in folk memories makes legends seem incredible, he wrote, yet it is worth trying to decipher what the ancients understood and witnessed.

In the Renaissance, naturalistic approaches to the meaning of ancient geomyths vied with moralistic interpretations; and debates over the validity of traditional folk knowledge continued into the scientific era. For example, debate raged in the nineteenth century over Native American legends that seemed to contain ancestral memories of mastodons hunted until their extinction in the Ice Age 10,000 years ago. The possibility was supported by twentieth-century archaeological discoveries of mammoth kill sites that matched local tribal lore about elephant-like monsters.

One method of testing the reliability of oral geology traditions is to examine traditions about geomorphic events in specific geographic areas with datable chronologies. Greene's analysis of Hesiod's very ancient volcano data is one example of this approach. In 2003, geologists found that Homer's description of the landforms around Troy, now radically changed, is actually consistent with the way the region actually looked 3 millennia ago. Another convincing geomyth of surprising antiquity is the Klamath Indians' oral tradition about the largest Holocene eruption in North America, the volcanic explosion of Mount Mazama in the Cascades Range of southern Oregon. About 7,500 years ago, the spectacular eruption blew off the top of the mountain and rained ash over a half million square miles. The resulting caldera formed Crater Lake. Surviving paleo-Indian witnesses created a detailed oral tradition of the violent event, expressed in a mythological story that has been transmitted in the original Native American language over some 250 generations. The Klamath myth contains geological facts about the eruption and collapse of the mountain that were unknown to scientists until the early twentieth century.

Future directions in geomythology will continue the search for evidence of very early geological knowledge—based on logical reasoning or firsthand observations of natural phenomena—embedded in ancient mythologies. Some of the most interesting new research trends in geomythology are the investigations by anthropologists, psychologists, and folklorists into the evolutionary psychology of the oral mythmaking process itself, to learn more about the mechanisms of preserving and perpetuating ancestral human memories over millennia. Such studies may help solve an urgent geological dilemma that requires today's scientists to think geomythologically: the permanent and safe geological disposal of thousands of tons of highly radioactive nuclear waste from reactors and weapons production. The transuranic waste is expected to remain radioactive for 100,000 years. The plan is to bury the dangerous materials very deep in the earth and guarantee that the sites remain undisturbed for at least 10,000 years. The vast geological and chronological scale of the project means that warnings to succeeding generations must survive in meaningful form until the year AD 12,000. Scientific proposals for ensuring that inadvertent human intrusion will not occur at such burial sites in the far distant future have called for the creation of new, long-lasting geomythological "traditions," with written and visual markers of menacing design, to explain to future civilizations the grave perils of what lies buried underground.

See also

Biblical Geology, History of Geology

Further Reading

Barber E and P Barber (Forthcoming) *The Myth Principles*. Princeton University Press, Princeton, NJ.

Birkett K and Oldroyd D (1991) Robert Hooke, physico-mythology, knowledge of the world of the ancients and knowledge of the ancient world. In: Gaukroger S *Uses of Antiquity*, pp. 145-170, Kluwer Academic Publishers, CITY.

Cataldi R, Hodgson SF, Lund JW, eds (1999) *Stories from A Heated Earth: Our Geothermal Heritage*. Geothermal Resources Council, International Geothermal Association, Sacramento, CA.

Clark E (1952) *Indian Legends of the Pacific Northwest*. University of California Press, Berkeley, CA.

Deloria V (1997) *Red Earth, White Lies*. Fulcrum, Golden, CO.

Echo-Hawk RC (2000) Ancient history in the New World: integrating oral traditions and the archaeological record in deep time. *American Antiquity* 65: 267-290.

Greene MT (1992) *Natural Knowledge in Preclassical Antiquity*. Johns Hopkins University Press, Baltimore.

Hale JR, de Boer JZ, and Chanton J (2001) New evidence for the geological origins of the ancient Delphic oracle (Greece). *Geology* 29: 707-710.

Kraft, J C, Rapp G, Kayan I, and Luce JV (2003). Harbor areas at ancient Troy: sedimentology and geomorphology complement Homer's Iliad. *Geology* 31, 163-166.

Mayor A (Forthcoming, 2004) *Fossil Legends in the New World*. Princeton, Princeton University Press.

Mayor A (2000) *The First Fossil Hunters: Paleontology in Greek and Roman Times*. Princeton University Press, Princeton, NJ.

Mayor A and Sarjeant WAS (2001) "The folklore of footprints in stone: from classical antiquity to the present." *Ichnos* 8, 2: 1-22.

Rappaport R (1997) *When Geologists Were Historians, 1665-1750*. Cornell University Press, Ithaca.

Ryan W and Pitman W (1998) *Noah's Flood: The New Scientific Discoveries about the Event that Changed History*. Simon and Schuster, New York.

Tylor EB (1865) *Researches into the Early History of Mankind*. London, rpt University of Chicago Press, Chicago, 1964.

Vitaliano D (1973) *Legends of the Earth: Their Geological Origins*. Indiana University Press, Bloomington.