Dating Fossils & Rocks

July 2009

- FAQ
- Geologic Time Scale
- Web Resources

Photo credit: Francois Gohier

FREQUENTLY ASKED QUESTIONS

What is a fossil?
Fossilization is an exceptionally rare occurrence. After death, organisms tend to decompose quickly. What scavengers like vultures and hyenas leave behind, flies, ants, worms, and bacteria quickly consume. Scientist **Olivia Judson** provides this good example of what happens to an adult male gorilla in the tropical rainforests of the Congo; "An adult male gorilla— all 330 pounds of him—will be reduced to a pile of bones and hair within 10 days of his death. Within three weeks, there will be nothing left but a few small bones."

A fossil normally preserves only a portion of an organism, usually that portion that was partially mineralized during life, such as bones and teeth. Trace fossils are the marks left by a living organism, such as feces, footprints or impressions of feathers or leaves. Organisms usually need to be covered by mud, sand, tar or some other sediment as soon as possible or frozen or dessicated (dried out) for fossilization to occur.

How old does something have to be to be a fossil?
Fossils, by definition, are the remains or traces of organisms that lived at least 10,000 years ago. This date marks the end of the Cenozoic Era and the Pleistocene Period on the geologic time scale. Paleontologists consider materials younger than 10,000 years ago “recent”.

How old is the oldest fossil on earth?
The oldest uncontested fossils on earth are 2 billion year-old stromatolites in Minnesota, Wisconsin, and Ontario. Composed of layers of sediments laid down by colonies of cyanobacteria, stromatolites still exist, but are quite rare today.

How old is the earth?
The earth itself is around 4.5 billion years old. (**USGS**)

How old is the sun?
The sun formed around 4.6 billion years ago. (See **NASA Web Archive** for more information)

How do researchers determine radiocarbon dates? How accurate are they?
Radiocarbon dates come from organic matter that contain the element carbon. Ice cores, pollen, wood, hair, bone,

shell, bird egg shell, and coral are some of the things datable by this technology which depends on measuring the atomic decay rate of carbon isotopes. Material older than about 50,000 years can't be dated with radiocarbon techniques because too little of the original radioactive material remains. Modern labs can measure samples as small as 100 mg (0.003 oz) to a precision of ±16 years (**Radiocarbon Web Info**)

Can all fossils be dated with radiocarbon dates?
Most fossil are dated by decay of isotopes such as Uranium 235, Potassium 40, and Rubidium 87 that have much longer half-lives than carbon 14. These isotopes aren't found in the fossils themselves, but in the rock encasing the fossils

Who decides what the geologic time scale should say?
Geologists in the International Commission on Stratigraphy make proposals based on the most recent studies to constantly update the geologic time scale of the world's rocks. **This chart** uses both radiometric, relative comparisons, fossils, and reversals in the earth's magnetic field to order events in the history of the earth.

GEOLOGIC TIME SCALE

CENOZOIC present to 65 million years ago (mya)	Holocene (Recent)	Today - 10,000 yrs. ago	Beginning of human agriculture; continents elevate (rebound) after Pleistocene ice melts
	Pleistocene	10,000 yrs ago to 2.6 mya	Repeated ice ages; *Homo sapiens* and *Homo neanderthalensis*; *Smilodon* and other large mammals extinct at end
	Pliocene	2.6 to 5.3 mya	Sea cows abundant; Isthmus of Panama connects North and South America
	Miocene	5.3 to 23.7 mya	Giant shark *Megalodon* is apex predator
	Oligocene	23.7 to 33.9 mya	Grasslands spread, forests recede
	Eocene	36.6 to 55.8 mya	Early whales, horses, primates, bats evolve; climate very warm, then cooler
	Paleocene	55.8 to 65 mya	Mammals flourish after end-Cretaceous extinctions
MESOZOIC 65 to 251 mya	Cretaceous	65 to 144 mya	First flowers attract pollinators; *Tyrannosaurus-rex* and other non-bird dinosaurs, pterosaurs, ammonites extinct at 65 mya
	Jurassic	144 to 206 mya	First birds; super-continent Pangea separates; giant herbivorous dinosaurs (sauropods) tower over small mammals
	Triassic	206 to 248 mya	First dinosaurs and first mammals (both small) occupy Pangaea

PALEOZOIC 251 tp 542 mya	Permian	248 to 290 mya	Reptiles dominate land; continents come together, forming Pangea; major extinction at end wipes out 95% of all life
	Carboniferous	290 to 354 mya	First reptiles leave fossil footprints; large amphibians common
	Devonian	354 to 417 mya	Land colonized by first amphibians; sharks and rays appear in oceans
	Silurian	417 to 443 mya	First reefs with corals, bony fish, clams, snails appear in oceans; first insects and spiders evolve on land
	Ordovician	443 to 490 mya	First land plants invade warm wet lowlands
	Cambrian	490 to 543 mya	First vertebrates are the jawless fishes; invertebrate trilobites dominate oceans
PRECAMBRIAN 542 to 4,500 mya	Proterozoic	543 to 2,500 mya	First microscopic organisms in oceans
	Archean	2,500 to 3,800 mya	Much volcanic activity; first small continents
	HADEAN	3,800 to 4,500	Oldest known rocks on earth
4,600 mya	Earth forms		

Important Web Resources:

- **University of California, Berkeley**'s in-depth paleontology and earth history website.
- **University of Waikato in New Zealand**'s excellent website explaining radiocarbon dating, with links to research laboratories world-wide plus links to specific projects that used radiocarbon dating.

About the Photograph:

Living stromatolites in Shark Bay World Heritage Site of Western Australia are built by colonies of bacteria that draw energy from the sun and carbon dioxide, releasing oxygen (photosynthesis). A sticky goo that surrounds the bacteria allows precipitation of minerals and entrapment of sediments, making a bulbous structure. Scientists are still finding a few new sites where they live today but they were quite abundant on earth some 2 billion years ago, and perhaps earlier. Geologists credit stromatolite activity for creating the earth's first atmospheric oxygen and making animal life possible.

Return to the **Fact Sheets** page