

ACTIVITY: Determining the Age of Fossils



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Objective: Learners will model fossil dating methods to understand how fossils are studied.

Introduction: Fossil dating is the process of determining the age of fossils to understand the history of life on Earth. Scientists use different methods, such as relative dating and radiometric dating, to estimate how old a fossil is. In relative dating, fossils are compared to other fossils or rock layers to establish their age based on their position in the Earth's strata. Radiometric dating, on the other hand, measures the decay of certain isotopes in the fossil or surrounding rocks to provide a more precise age. The most famous of these techniques is radiocarbon dating, which works for organic materials up to about 50,000 years old, but there are several other techniques using different elements that can be used for much older rocks. These techniques help scientists piece together the timeline of life on Earth and track the evolution of different species over millions of years.

Have learners:

1. Make observations of the image of the Grand Canyon on the handout ([also available here](#)). Discuss:
 - ▶ *What observations did you make? What evidence is there that the rock layers differ from each other?*
 - ▶ *What similarities can be seen in different parts of the canyon (i.e., layers correlate from one area to another)?*
 - ▶ *What other evidence might be in the rocks that could help identify or describe them that can't be seen on the image?*
2. Complete the **Layers of Time** activity developed by Walnut Canyon and Wupatki National Monuments. This activity is focused on archaeology and uses examples of buried human artifacts, but is also relevant to paleontology and the burial of fossilized organisms.
 - a. Discuss how horizontal layers are deposited, as well as processes that can change them (e.g., the stepped surfaces above and below layer D shows faulting, where the left side of the layer has moved up in relation to the right side).
 - b. Discuss how the fossils or artifacts found within layers can help determine the age of the rock layers.
 - c. Read the **section of this website on trilobites** as a good example of index fossils. Discuss how trilobite species fit each part of the definition of an index fossil:
 - easily identifiable species
 - lived for a relatively short time (in geologic terms)
 - widely distributed (geographically)
 - d. Look over other examples of **index fossils** and the geologic times during which each lived.

3. Return to the image of the Grand Canyon in Step 1.
 - a. Discuss the relative age of the rock layers, then look at an **image of Grand Canyon with select formations labeled**.
 - b. If you want to look at the Grand Canyon in more detail, **use a diagram with all formations labeled**.
 - c. Use a **diagram** to compare the ages of the Grand Canyon rock formations with four other parks.
4. Study the abbreviated Geologic Time Scale on the handout.
 - a. Discuss how the start and end of different geologic times correlate to significant geologic and biologic events.
 - b. Pose ideas about how scientists discovered various events on the time scale (e.g., a significant decline in fossils over a large area could be evidence of a mass extinction).
 - c. You may also want to view the detailed **Geologic Time Scale** from The Geological Society of America (GSA).
5. Read about the **Geologic Timescale, Geologic Dating Techniques, and Numeric Ages**.
6. Watch a video on **Radiocarbon Dating** (view the entire video, or watch from 4:37-5:52 to focus on carbon dating).
7. Complete an activity on determining the absolute age of rocks and fossils:
 - **U.S. Geological Survey (USGS)**
 - **Association of American State Geologists (AASG)**
8. Read about how dating of geologic features, like **volcanic ash**, can also help determine the age of nearby fossils.
9. Research fossils of varying ages that have been found in National Parks: **Fossils Through Geologic Time**.

HANDOUT: Determining the Age of Fossils

Study the image of the Grand Canyon and make observations about the rock layers. You may want to use a pencil to make notes or mark areas that stand out to you.



Grand Canyon National Park, Michael Quinn

Study the abbreviated Geologic Time Scale. Note that the subdivisions of the Precambrian are not shown, and that time is reported in MYA (millions of years ago).

Eon	Era	Period	Epoch	MYA	Life Forms	North American Events
Phanerozoic	Cenozoic (CZ)	Quaternary (Q)	Holocene (H)	0.01	Extinction of large mammals and birds Modern humans	Ice age glaciations; glacial outburst floods
			Pleistocene (PE)			
		Neogene (N)		2.6	Spread of grassy ecosystems	Cascade volcanoes (W) Linking of North and South America (Isthmus of Panama) Columbia River Basalt eruptions (NW) Basin and Range extension (W)
			Pliocene (PL)	5.3		
			Miocene (MI)	23.0		
		Paleogene (PG)	Oligocene (OL)	33.9	Early primates	Laramide Orogeny ends (W)
			Eocene (E)	56.0		
			Paleocene (EP)			
				66.0	Mass extinction	
	Mesozoic (MZ)	Cretaceous (K)			Placental mammals	Laramide Orogeny (W) Western Interior Seaway (W)
				145.0	Early flowering plants	Sevier Orogeny (W)
		Jurassic (J)			Dinosaurs diverse and abundant	Nevadan Orogeny (W) Elko Orogeny (W)
				201.3	Mass extinction First dinosaurs; first mammals Flying reptiles	Breakup of Pangaea begins
		Triassic (TR)				Sonoma Orogeny (W)
	Paleozoic (PZ)	Permian (P)		251.9	Mass extinction	
		Pennsylvanian (PN)		298.9	Coal-forming swamps Sharks abundant First reptiles	Supercontinent Pangaea intact Ouachita Orogeny (S) Alleghany (Appalachian) Orogeny (E) Ancestral Rocky Mountains (W)
				323.2		
		Mississippian (M)		358.9	Mass extinction First amphibians First forests (evergreens)	Antler Orogeny (W) Acadian Orogeny (E-NE)
		Devonian (D)		419.2	First land plants Mass extinction Primitive fish Trilobite maximum Rise of corals Early shelled organisms	Taconic Orogeny (E-NE) Extensive oceans cover most of proto-North America (Laurentia)
		Silurian (S)		443.8		
		Ordovician (O)		485.4	Marine Invertebrates	
		Cambrian (C)				
	Proterozoic			541.0	Complex multicelled organisms	Supercontinent rifted apart Formation of early supercontinent Grenville Orogeny (E)
					Simple multicelled organisms	First iron deposits Abundant carbonate rocks
	Archean	Precambrian (PC, W, X, Y, Z)		2500	Early bacteria and algae (stromatolites)	Oldest known Earth rocks
				4000		
	Hadean	Precambrian (PC, W, X, Y, Z)			Origin of life	Formation of Earth's crust
				4600	Formation of the Earth	

NPS, Geologic Resources Inventory, 2018

Note that the dates on the geologic time scale are approximations that are revised as dating techniques and technologies are improved.

- ▶ Which division of geologic time is the longest: eon, epoch, era, or period? Which is the shortest? How can you tell?
- ▶ Which period shown on the geologic time scale is the longest? What events mark the beginning and end of this period?