Answers: Geologic Dating Assignment

**Article: “Dating Sedimentary Rock”**

1. Why can’t scientists use carbon-14 dating on dinosaur bones?

It is because carbon-14 completely decays in 60,000 years. There is no ratio of parent to daughter element left to study. In other words, dinosaur fossils are too old. Plus, dinosaur fossils are often NOT made of bone. Instead, they are made of sedimentary rock (e.g., mold & cast fossil). Therefore, there is no original organic material in the fossil to study with carbon-14.

1. Why can’t scientists use uranium-238, uranium-235, and potassium-40 on dinosaur fossils?

This is because these isotopes are not found in organic material in large amounts and dinosaur fossils are most often made of sedimentary rock. Unfortunately, sedimentary rock does not contain these isotopic elements in large enough amounts. Plus, sedimentary rock is made of many different substances from many different time periods.

1. What can scientists use uranium-238, uranium-235, and potassium-40 on?

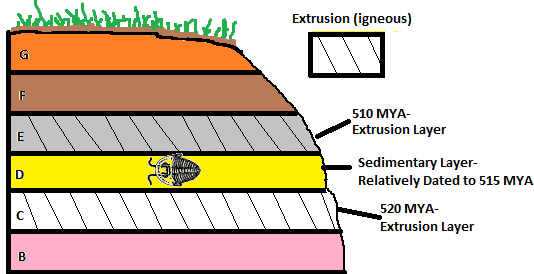
Mostly, these isotopes are used to date igneous rocks or igneous material (e.g., volcanic ash).

1. Explain why fossils form in sedimentary rock and not igneous.

Fossils form in sedimentary rock because sediment quickly covers the bone and preserves it or the shape of the bone (e.g., cast/mold). On the other hand, igneous rock is extremely hot when it is extruded from the earth (i.e. lava). This makes it impossible for it to be preserved by this form of rock.

1. Explain why the absolute age of dinosaur fossils cannot be determined, due to the way that fossils commonly form (i.e., cast and mold).

Fossils commonly form by way of a cast and mold preservation method. First, the animal is covered by sediment that, over time, cements together to make sedimentary rock. Often, the bone decays away over time and leaves a void space (i.e., opening) in the shape of the bone (i.e., mold). This space is then filled by minerals and other sediments creating a cast of the bone. In other words, many dinosaur fossils are not bone, but instead are sedimentary rock casts that are formed in the shape of the bone.

1. Explain how scientists use the absolute age of igneous rock (e.g., volcanic ash) to relatively date the sedimentary rock that contains dinosaur bones.

Scientists find layers of extrusions (i.e., layers of hardened lava) and then radioactively date these layers. The method they use to date the fossils is called “bracketing”. In bracketing, scientists must find the fossil in a sedimentary layer, and then find one layer of igneous material (e.g., extrusion, ash) above and one layer of igneous material below the fossil/sedimentary layer. Using the law of superposition scientists can determine the relative age of the fossil with this bracketing method.

1. Beyond radioactive dating, explain other dating methods that scientists use. (hint- 2 other methods)

Other techniques include analyzing **amino acids** and measuring changes in an objects **magnetic field**.

**Article: “How Carbon-14 Dating Works”**

1. How do scientists know the age of human mummy remains?

Radiometric dating of Carbon-14

1. What methods do scientists use to find the age of human artifacts or mummified remains?

They study the ratio of carbon-14 (i.e., parent isotope) to carbon-12. **In other words, they use radiometric dating to determine the age of the organic material.**

Moreover, carbon-14 radioactively decays into nitrogen-14, when plants/animals die. However, carbon-12 does not decay, because it is a stable element. Scientists get the ratio of carbon-14 to carbon-12 and compare that ratio to currently living organic matter. They do this, because all living organic matter has the same exact ratio of carbo-14 to carbon-12.

1. What is the age of the oldest material we can date with carbon-14?

About 60,000 years old.

1. Why are only certain types of materials dated with carbon-14? (e.g., bone, cloth, wood, plants)

This is because carbon-14 is only abundant in organic material (e.g., plants & animals).

1. Explain how carbon-14 isotopes are made.

Carbon-14 is created through a chemical reaction between the sun’s rays, a free neutron, and the neutrons collision with nitrogen.

Moreover, C14 forms in the atmosphere where cosmic rays, striking oxygen and nitrogen atoms in the upper atmosphere liberating neutrons, strike nitrogen gas which becomes C14. Subsequently, this isotope combines with oxygen to create radioactive carbon dioxide that is absorbed by water and taken into the tissues of living things

1. Where is carbon-14 found?

In organic material (e.g., plants, animals, shells).

**Article: “How do scientists determine the age of dinosaur bones?”**

1. How do scientists determine the absolute age of a specimen (i.e., rock, dinosaur bones, etc.)?

They use radiometric dating (i.e., studying the ratio of isotopes to stable elements).

1. The author of the article used a pyramid as a metaphor for radioactive decay. What is another metaphor that describes radioactive decay?

Popcorn… The kernel is similar to an unstable isotope (i.e., parent element) and the popcorn is similar to the stable element (i.e., daughter element) the isotope decayed into.

1. Explain why the amount of isotopes present in a specimen is important (i.e., why size of sample is important).

Radiometric dating is based on probability (i.e., averages); scientists need a large sample size in order to get an accurate reading. In other words, the more data points the scientists have, the more accurate the average will be to the true value (i.e., the absolute age).

1. Explain why isotopes with a short half-life will not work to date dinosaur bones.

Dinosaur fossils are older than 65 million years. If an isotope is used that decays rapidly, say 60,000 years, it would not be useful. For radiometric dating to work, there must be some parent element and some daughter element. Otherwise, there would not be a ratio to study. This ratio is how scientists determine the absolute age. In other words, if all of the popcorn has popped, there is no way to determine the absolute age.

**Article: “Dating a Fossil”**

1. Explain how scientists date fossils with carbon-14 (i.e., what they measure)?

They study the ratio of carbon-14 (i.e., parent isotope) to carbon-12. **In other words, they use radiometric dating to determine the age of the organic material.**

Moreover, carbon-14 radioactively decays into nitrogen-14, when plants/animals die. However, carbon-12 does not decay, because it is a stable element. Scientists get the ratio of carbon-14 to carbon-12 and compare that ratio to currently living organic matter. They do this, because all living organic matter has the same exact ratio of carbo-14 to carbon-12.

1. Why can’t you use carbon-14 on an 80,000 year old tree?

After 60,0000 years carbon-14 will have decayed into nitrogen-14. Meaning, it has too short of a half-life to measure a tree that old. There would be no parent material to compare with; no ratio to study.

1. Why might it be hard to use radioisotopes for dating organic material in the future?

Since the 1940’s, the use of nuclear bombs and nuclear power has had an impact on the amount of uranium isotopes released into the environment. This nuclear activity has spread uranium isotopes all over the planet. These isotopes are even found in living humans. Therefore, it will be hard to study uranium as a radiometric dating device, because new uranium isotopes are constantly being absorbed. This absorption consistently changes the parent to daughter ratio.

1. **Explain why C-14 can be used to date a 40,000 year old tree, but Uranium cannot.**

Uranium is not abundant in organic material (i.e., plants and animals). Uranium is found in igneous rocks and carbon-14 is found in organic material (plants/animals).