Geology, Mineral resources, and Natural environment in our society

History of the Earth

Mineral resources have been formed during long history of the Earth. We see outline of this history.

1.Geologic Age based on fossil

2.Radiogenic Age

3.Geologic ages in the Earth

·Relative age：The geologic age in which the time order is based on superposition or fossil content.

·Radiometric age: The geologic age expressed in years determined by quantitatively measuring decay product of radioactive elements.

·Geologic time is roughly divided into Precambrian, Paleozoic, Mesozoic and Cenozoic. The former shows no life or primitive life, the latter three eras have abundant evidence of life.

1 Relative ages

The geologic age of a fossil organism, rock, or geologic feature or event defined relative to other organisms, rocks, or features or events rather than in terms of years.

Index fossil (Leading fossil): The fossil which give geologic age.

Facies fossil: The fossil which give information on environment, such as climate, salinity of water etc.

Index fossil
Ex., Trilobite, Ammonite, Dinosaurs etc.

Trilobite
Index fossil in Early Paleozoic
(NNP Photo Library)

Ammonite

Index fossil in Late Paleozoic to Mesozoic

(Tokyo Science)

Paleozoic (541–252 Ma) The life evolution like invertebrates, fish and amphibian is shown.

Mesozoic (252–66 Ma) Generally warm climate and age of Reptile. Dinosaurs evolved to bird.

Cenozoic (66Ma–Present) Cold climate is dominant. Age of Mammal and human.

Fusulina limestone in Late Paleozoic is used Industrial Mineral Resources.

Photo is cited from Google planetscope

2 Radiogenic age

Geologic age expressed in years determined by quantitatively measuring radioactive elements and their decay products.

Isotopes are variants of a particular chemical element which differ in neutron number. All isotopes of a given element have the same number of protons but different numbers of neutrons in each atom.

For example, carbon-12, carbon-13, and carbon-14 are three isotopes of the element carbon with mass numbers 12, 13, and 14, respectively.

Carbon-14 decay produces nitrogen-14. Time which the carbon-14 decreases half of it is Half Time, 5700 years.

How to know age by radiogenic decay

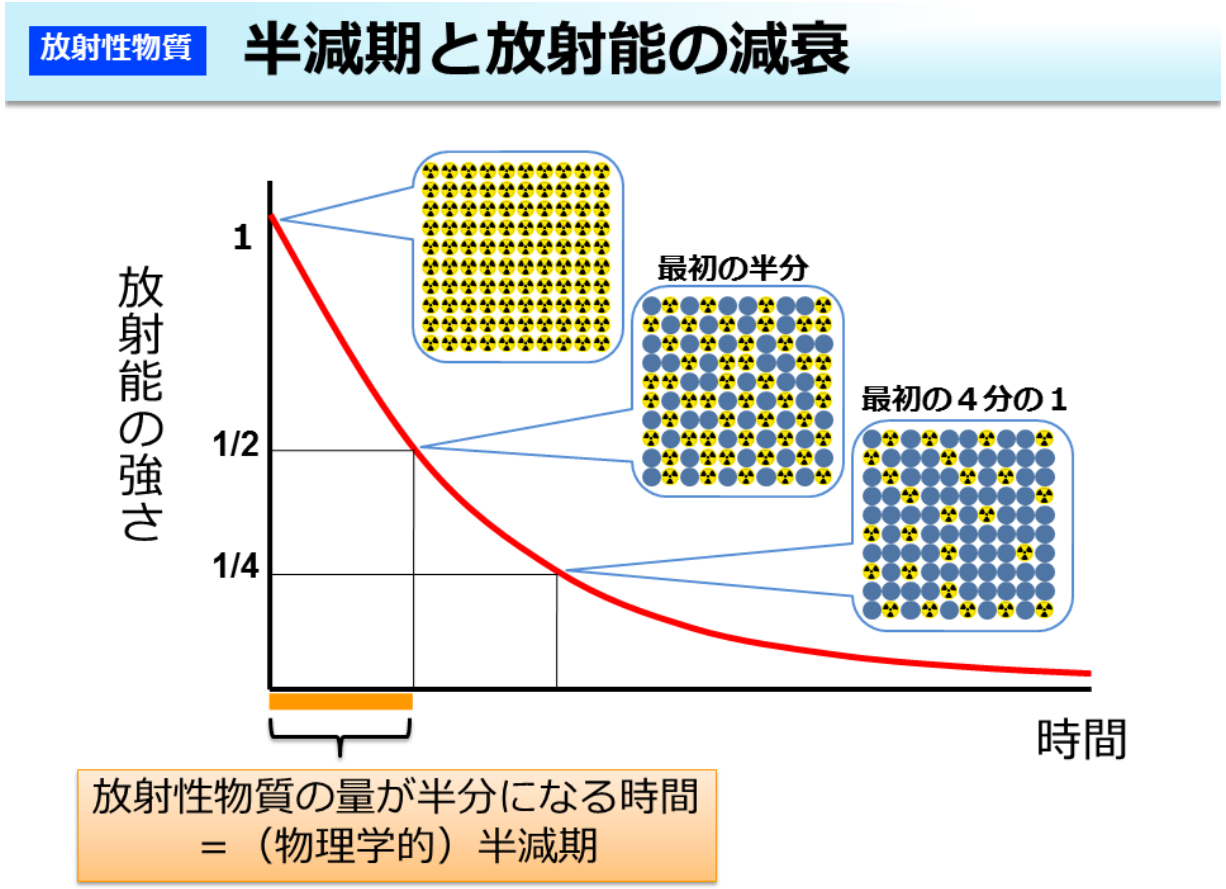
If two times of Half Time passed, the radiogenic element reduces one forth.

First half time results in decreasing of half of the material.

Next half time results in decreasing of half of the material which is half of original.

This type decreasing is called exponential function decreasing.
(Figure is cited from the Ministry of Environment HP).

Question: Carbon−14 of the sample decayed 75 %. When did this sample produce? Half year is 5700 years.



Half Time and decreasing the radiogenic element The ordinate is radiogenic strength (amount of radiogenic element). The abscissas is time.

Knowing the history of the Earth

Example

If whole history of the Earth assumes 1 year, when does the human appear? Use “the beginning of the Earth is 4.6 billion years ago and Appearance of the human is 2.5 million years ago”

1year ＝365days＝365 x 24（hours）＝8760 hours＝8760 x 60 x 60（seconds)＝31,536,000 seconds.

Appearance of the human/History of the earth 2.50 million y./4.6 billion y.＝0.00054.

When we assume 4.6 billion y. is one year, 4631,536,000 sec. x 0.00054 ＝17100 sec＝4.75hours＝4hours 45min.

The human appears at 19:45, December 31.

3 Geologic Time (Relative Time)

Geologic time determined by the placing of events in a chronologic order of occurrence, especially time as determined by organic evolution or super position

Era, Time	Period or Era in Precambrian Time	Life
Cenozoic Era	Quaternary Neogene Paleogene	Age of Mammals Age of Flowering Plants
Mesozoic Era	Cretaceous Jurassic Triassic	Age of Reptiles (Dinosaurs) Age of Gymnosperm
Paleozoic Era	Permian/ Carboniferous/ Devonian/ Silurian/ Ordovician/ Cambrian	Age of Amphibians, Fish, Invertebrates
Precambrian Time	Proterozoic/ Archaean/ Hadean	

Radiometric age: Start of Paleozoic 541, Start of Mesozoic 252, Start of Cenozoic 66 (million years ago)

Events in each geologic age

Precambrian

Hadean（4.6–4.0 billion years old） During Hadean time, the Solar System was forming, probably within a large cloud of gas and dust around the sun, called an accretion disc.

Archean（4.0–2.5billion years old） Earth's crust cooled enough that rocks and continental plates began to form. All life during the more than one billion years of the Archaean was bacteria.

Proterozoic (2.5 billion years – 541 Ma)

With the beginning of the Middle Proterozoic comes the first evidence of oxygen build–up in the atmosphere.

Most of banded iron deposits were produced in this time.

Picture is cited from Yamaguchi University

I show a supplement.

USGS popular science
Litwin, Weems and Holtz
https://pubs.usgs.gov/gip/dinosaurs/

Video

Video (11 min 35 sec) History of the Earth

https://www.youtube.com/watch?v=Q1OreyX0-fw