

## Nuclei with Long Half-lives

**Example** Radioactive materials that had existed in the universe since before the birth of the earth and were taken into the earth upon its birth

4.6 billion years since  
the earth's birth



**Series** A radioactive nucleus repeats disintegration until becoming stable, accompanying changes in nuclides each time.

- Uranium-238 Half-life: 4.5 billion years
- Thorium-232
- Uranium-235

**Non-series** A radioactive nucleus directly disintegrates into a stable nucleus.

- Potassium-40 Half-life: 1.3 billion years
- Rubidium-87, etc.

Some nuclei that emit radiation have very long half-lives. Uranium-238 has a half-life of 4.5 billion years. Since the earth is about 4.6 billion years old, the amount of Uranium-238 that had existed at the time of the earth's birth has now reduced to half.

Some radionuclides become stable after a single emission of radiation, while some transform into various radionuclides as they disintegrate many times, until becoming stable.

For example, Uranium-238 emits  $\alpha$  (alpha)-particles and transforms into Thorium-234, which is also a radionuclide. Thorium-234 further emits  $\beta$  (beta)-particles and transforms into Protactinium-234, which is also a radionuclide. They constitute a series in which the original element transforms into different atoms more than 10 times before becoming stable Lead-206.

Potassium-40 also has a long half-life of 1.3 billion years. This is another naturally occurring radionuclide that was taken into the earth upon its birth. However, Potassium-40 transforms into stable Calcium-40 through a single disintegration without constituting a series.

(Related to p.10 of Vol. 1, "Parent and Daughter Nuclides," and p.11 of Vol. 1 "Half-lives and Radioactive Decay")

Included in this reference material on March 31, 2013

Updated on March 31, 2015