

# 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

**Series**

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

- Uranium-238
- Thorium-232
- Uranium-235

Half-life: 4.5  
billion years

**Non-series**

A radioactive nucleus directly disintegrates into a stable nucleus.

- Potassium-40
- Rubidium-87, etc.

Half-life: 1.3  
billion years

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. Potassium-40 transforms into stable Calcium-40 or Argon-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")

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