Uranium

Natural uranium

Uranium is naturally present in the Earth's crust, which contains 2 to 3 grams per tonne on average; certain granites may contain as much as 10 grams per tonne. Uranium is also present in surface and deep waters at a concentration of a few milligrams per cubic metre. The exploitable ore reserves are mainly divided between Australia, Kazakhstan, Canada, the US, South Africa, Namibia, Brazil, Niger and Russia.

Uranium ore

Natural uranium is primarily composed of two isotopes (same chemical properties, but different nuclear properties) in the following proportions: 99.27% for uranium-238 and 0.72% for uranium-235; other isotopes are present in trace quantities.

Enriched uranium

Uranium-235 is the isotope of interest for the civil and military nuclear industry because it is fissile: when struck by neutrons, nuclei break apart and release energy.

Uranium is told to be enriched when the amount of U-235 is increased beyond the natural level. The standard fuel used in nuclear power reactors is uranium enriched to 3-5%. Fuel in research reactors is more highly enriched, generally to 20%. Military applications require much higher levels of enrichment.

Uranium enrichment is based on the difference in mass between the U-235 and U-238 isotopes. Since this difference is small, enrichment involves several basic stages. The following processes are used:

- Gaseous diffusion: most widely used after World War II; consumes a great deal of energy. This process was used in the US, UK, France, Russia and China.
- Ultracentrifugation: a more economical process currently used by the US, Urenco (the Netherlands, UK and Germany), France (starting in 2009), Russia, China and Japan.

Other processes (mass spectrometry, chemical or laser separation, etc.) have been studied but have yet to be deployed on an industrial scale.

Uranium toxicity

Toxicity of uranium in its natural state is primarily chemical. Effects are similar to those of other heavy metals such as lead, particularly its impact on the kidneys.

Radiotoxicity of uranium becomes significant when it has been enriched. Half-life of U-238 is 4.5 billion years; that of U-235 is 700 million years. Uranium-235 therefore decays faster than uranium-238 and is responsible for most of uranium's radiotoxicity. The radiological risk of natural uranium, which has a low level of U-235, is negligible compared to its chemical toxicity. When U-235 enrichment exceeds 30%, radiotoxicity becomes the most significant risk.

Protection systems in nuclear facilities are aimed at preventing inhalation and ingestion of uranium.