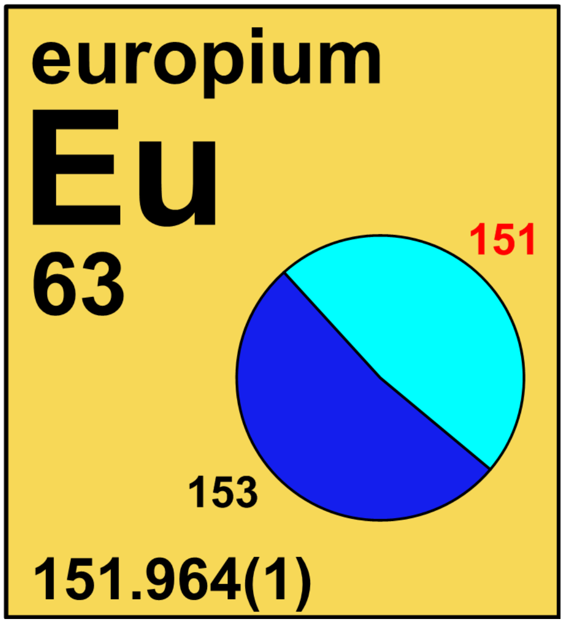
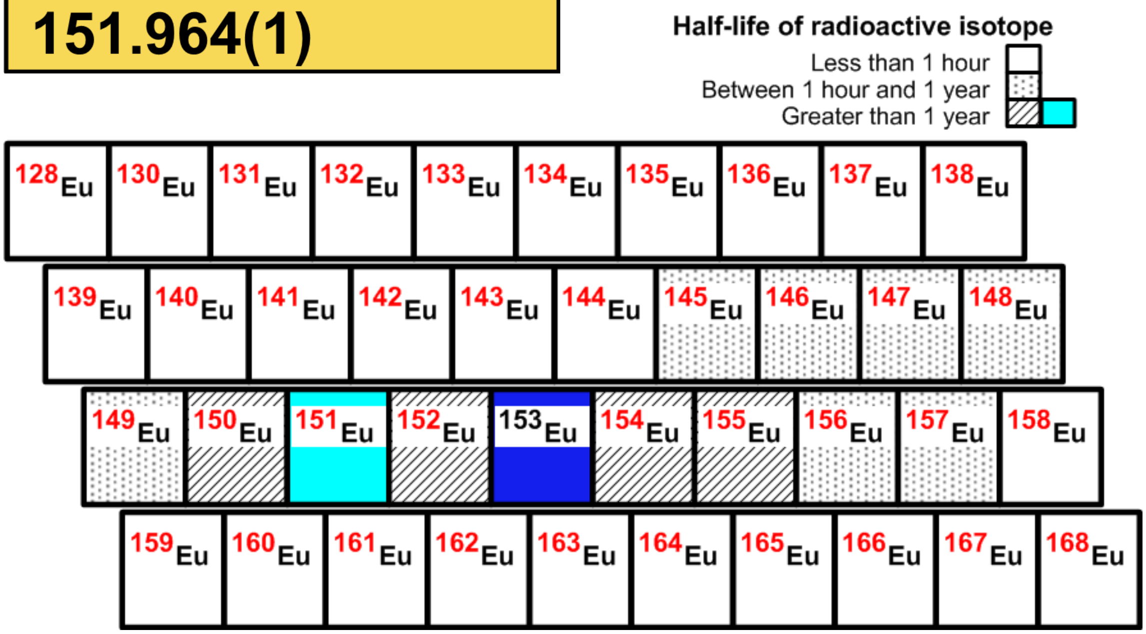
4.63 europium



Stable isotope	Relative atomic mass	Mole fraction
^{151}Eu†	150.919 86	0.4781
^{153}Eu	152.921 24	0.5219

† **Radioactive isotope** having a relatively long **half-life** (5 × 10^{18} years) and a characteristic terrestrial **isotopic composition** that contributes significantly and reproducibly to the determination of the **standard atomic weight** of the **element** in **normal materials**.



4.63.1 Europium isotopes in geochronology

For more than 40 years, weapons-grade plutonium was manufactured by the Krasnoyarsk Mining and Chemical Combine in the now closed town of Krasnoyarsk Krai, Russia, using single-pass uranium-graphite production reactors [444]. Water from the Yenisei River was used for heat removal from the reactor core. Radioactively contaminated water was discharged into the Yenisei River and was a primary source of contamination of bottom sediments and floodland for hundreds of kilometers down gradient from the Krasnoyarsk Mining and Chemical Combine. In 2002, radioactive contamination of the bottom sediments and floodlands was composed primarily of ^{137}Cs, ^{152}Eu, ^{154}Eu, and ^{60}Co [444]. The decrease in the **isotope-amount ratio** $n(^{154}\text{Eu})/n(^{152}\text{Eu})$ down the depth profiles (Figure 4.63.1) enables one to determine the age of bottom sediments and floodlands of the Yenisei River and calculate their average formation rates [444].

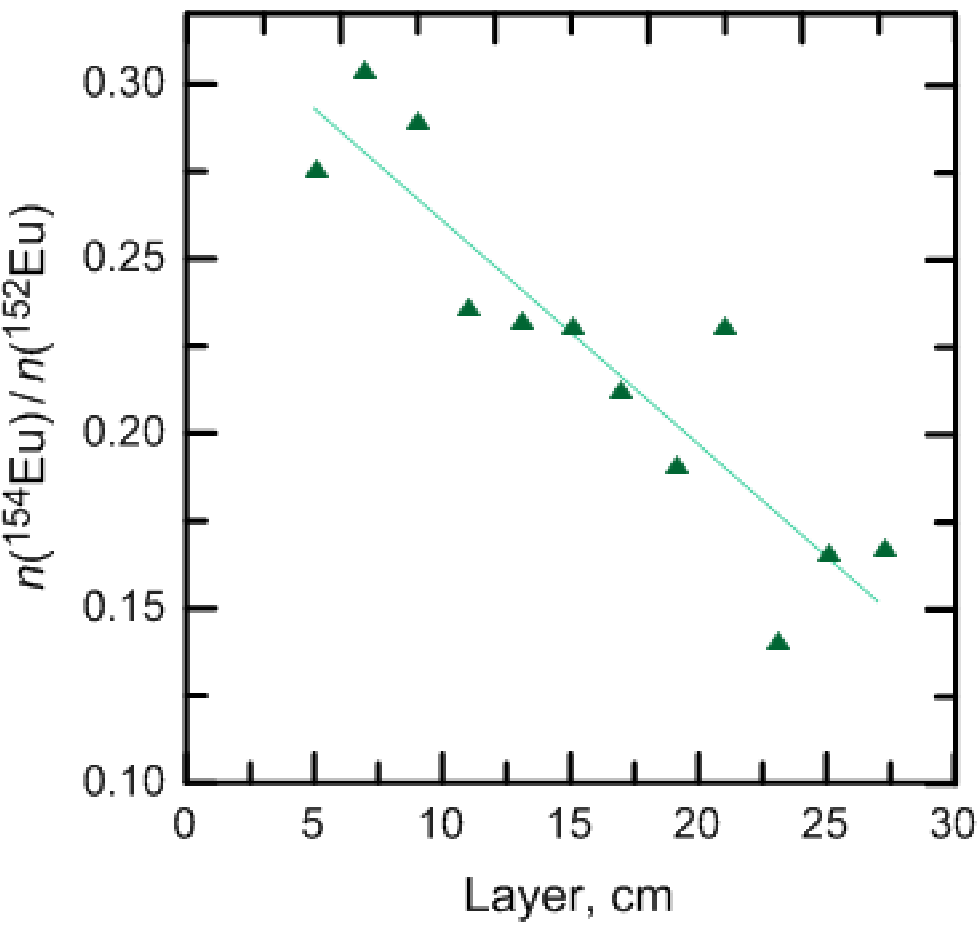


Fig. 4.63.1: Variation in the **isotope-amount ratio** $n(^{154}\text{Eu})/n(^{152}\text{Eu})$ along the vertical profile of floodland sediments at the tail end of Atamanovskii Island, Russia (modified from [444]).

4.63.2 Europium isotopes in industry

Europium **isotopes** have been used in nuclear-control applications because they are good **neutron** absorbers [445]. ^{152}Eu (with a half-life of 13.5 years), which is produced by ^{151}Eu via the neutron capture reaction ^{151}Eu (n, γ) ^{152}Eu, and ^{54}Eu are used as reference sources for calibration in **gamma ray** spectroscopy (Figure 4.63.2) [446].

Fig. 4.63.2: ^{152}Eu is used as a reference source for calibrating gamma-ray spectrometer systems like the one pictured here. (Photo Source: Snyder and Duval, 2003. U.S. Geological Survey Open-File Report 03-029) [447].

4.63.3 Europium isotopes used as a source of radioactive isotope(s)

Reactions on ^{153}Eu can produce the therapeutic **radionuclide** ^{153}Sm (with a half-life of about 1.9 days) via fast neutron irradiation ^{153}Eu (n, p) ^{153}Sm [448].