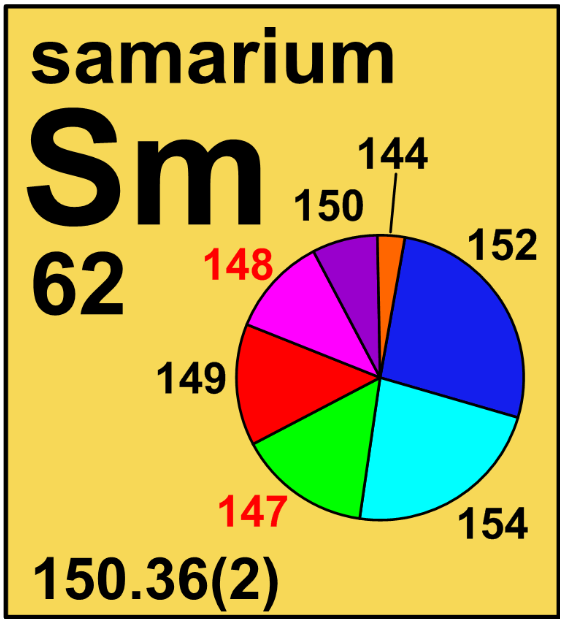
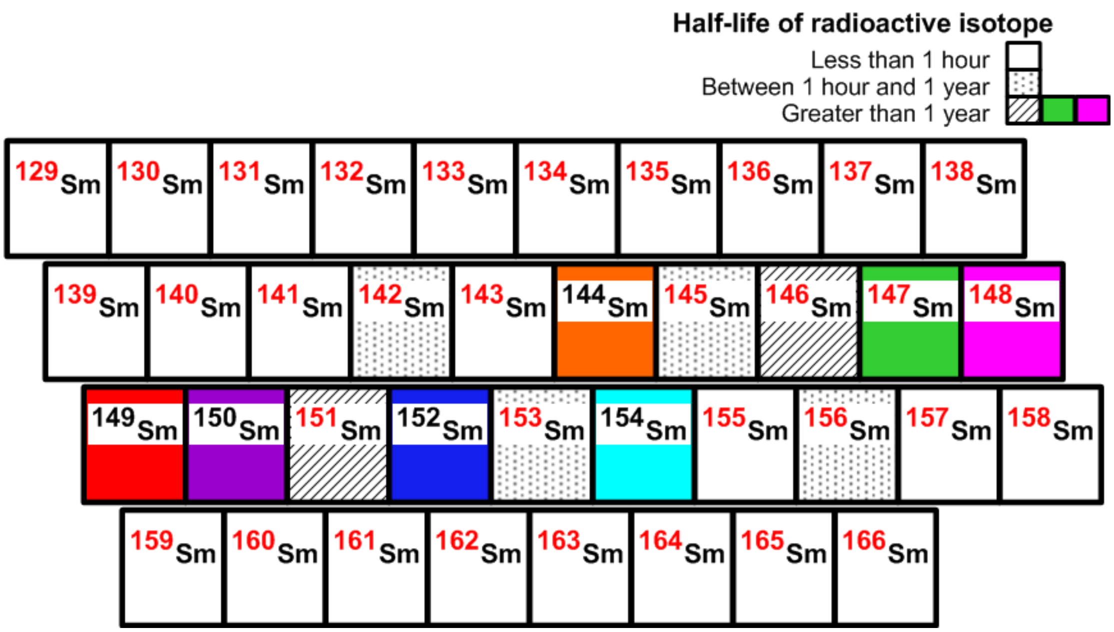
## 4.62 samarium




| Stable isotope | Relative atomic mass | Mole fraction |
|---|---|---|
| $^{144}$Sm | 143.912 01 | 0.0308 |
| $^{147}$Sm$^{\dagger}$ | 146.914 90 | 0.1500 |
| $^{148}$Sm$^{\dagger}$ | 147.914 83 | 0.1125 |
| $^{149}$Sm | 148.917 19 | 0.1382 |
| $^{150}$Sm | 149.917 28 | 0.0737 |
| $^{152}$Sm | 151.919 74 | 0.2674 |
| $^{154}$Sm | 153.922 22 | 0.2274 |

† **Radioactive isotope** having a relatively long **half-life** 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**. The half-lives of $^{147}$Sm and $^{148}$Sm are 1.06 × 10$^{11}$ years and 7 × 10$^{15}$ years, respectively.




### 4.62.1 Samarium isotopes in Earth/planetary science

One possible origin for the Moon is from debris ejected by an indirect giant impact of Earth by an astronomical body the size of Mars when the Earth was forming [433]. The kinetic energy liberated is thought to have melted a large part of the Moon forming a lunar magma ocean.

Samarium **isotope** measurement results [434], along with measurements of isotopes of hafnium, tungsten, and neodymium[435], suggest that lunar magma formed about $70 \times 10^6$ years after the Solar System formed and had crystallized by about $215 \times 10^6$ years after formation. $^{147}$Sm is used to study the formation of potassium, rare earth **elements**, and phosphorus-rich rocks [436].

### 4.62.2 Samarium isotopes in geochronology

$^{147}$Sm is used for determining formation ages of **igneous** and metamorphic rocks via analysis of the minerals which compose them, such as those shown in Figure 4.62.1 [437-439].

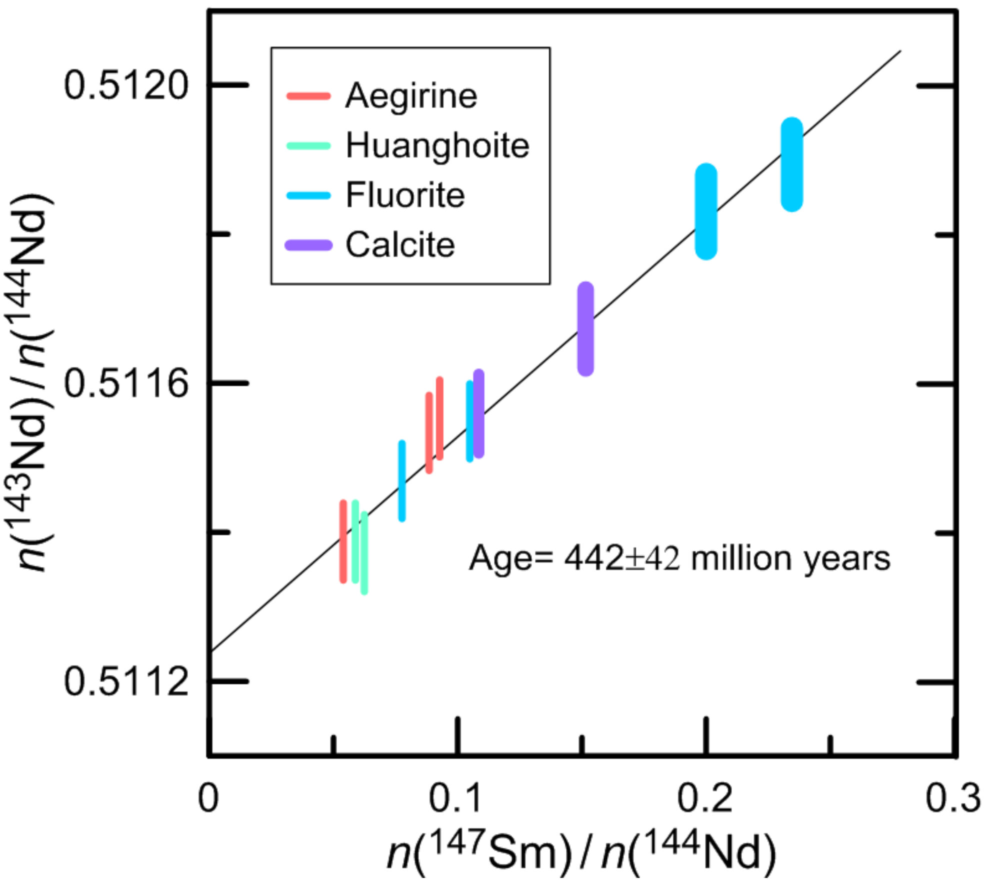



**Fig. 4.62.1:** Cross plot of $n(^{143}\text{Nd})/n(^{144}\text{Nd})$ **isotope-amount ratio** and $n(^{147}\text{Sm})/n(^{144}\text{Nd})$ **mole ratio** of carbonate and fluorocarbonates at the Bayan Obo rare-earth-element-niobium-iron deposit in Inner Mongolia, China (modified from [439]). $^{143}$Nd is produced by decay of $^{147}$Sm. Rock containing higher amounts of $^{147}$Sm at time of mineralization will over time produce higher amounts of $^{143}$Nd (e.g., fluorite samples). Alternatively, rocks containing lower amounts of $^{147}$Sm at time of mineralization will over time produce lower amounts of $^{143}$Nd (e.g., huanghoite samples). Samples from an older mineralization event will have proportionally more $^{143}$Nd because of the longer accumulation time for $^{143}$Nd; thus, the slope of the line through the samples above correlates to the time since mineralization (formation), and such a line is called an **isochron**.

### 4.62.3 Samarium isotopes in medicine

The **radioisotope** $^{153}Sm$ (with a half-life of 1.9 days) is used in medicine to treat the severe pain associated with cancer that has spread to bones (Figure 4.62.2) [440-442].

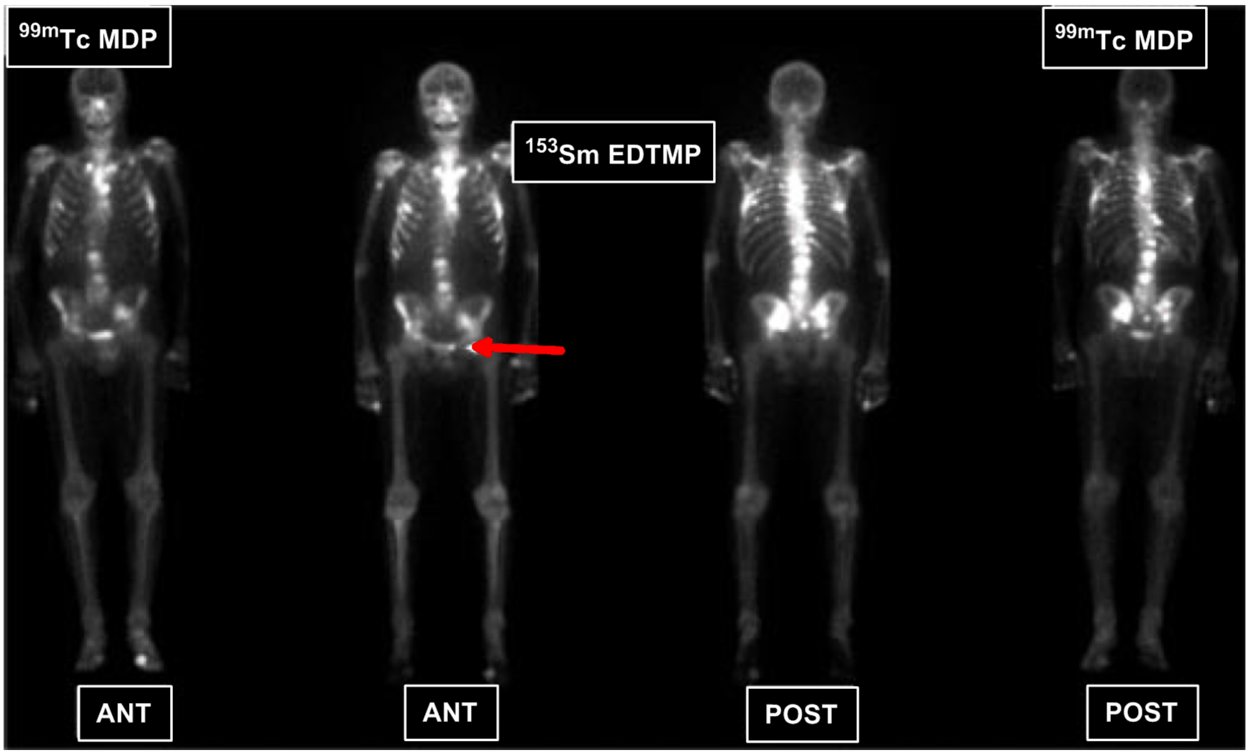



**Fig. 4.62.2:** Targeting of bone **metastases** with $^{153}Sm$-**EDTMP** in a prostate cancer patient. ANT indicates the anterior view of the patient; POST indicates the posterior view of the patient; arrow represents uptake in the pubic bone of the patient. (Image Source: Pandit-Taskar, Batraki, and Divgi, 2004) [442].

### 4.62.4 Samarium isotopes used as a source of radioactive isotope(s)

$^{147}Sm$ bombarded with $^{40}Ca$ produces the radioisotope $^{182}Pb$ [443].