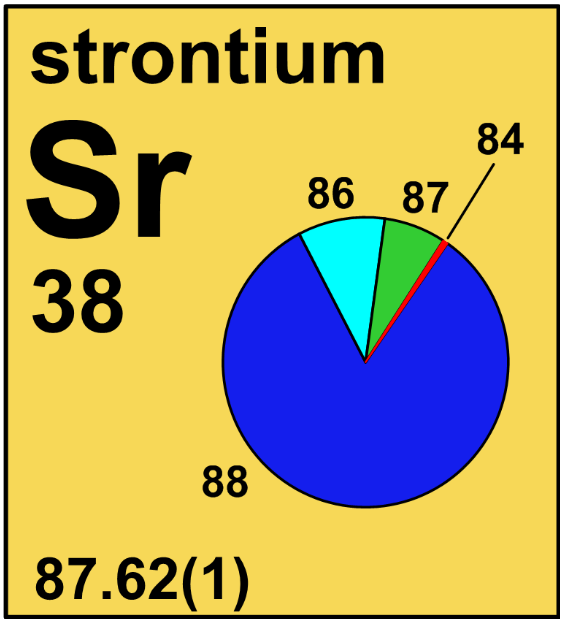
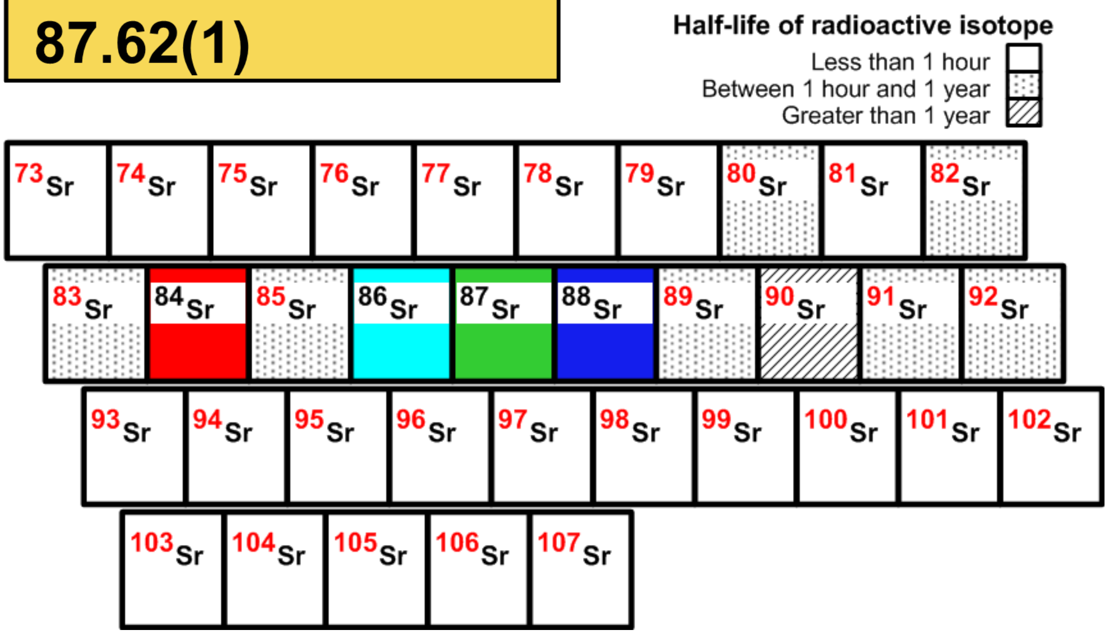
4.38 strontium



Stable isotope	Relative atomic mass	Mole fraction
^{84}Sr	83.913 419	0.0056
^{86}Sr	85.909 261	0.0986
^{87}Sr	86.908 878	0.0700
^{88}Sr	87.905 613	0.8258



4.38.1 Strontium isotopes in Earth/planetary science

Stable **isotopic fractionation** of strontium is small because the relative differences between the masses of strontium **stable isotopes** are small (**mass numbers** are 86, 87, and 88 for the most abundant stable isotopes). Also, strontium is not subject to **reduction-oxidation** reactions in normal terrestrial environments, which would cause **isotopic fractionation** to be more evident. Nevertheless, current studies are exploring potential applications of stable strontium isotopic fractionation; for example, it has been used as a **proxy** for temperature during coral growth and for insights into the diets of ancient populations [292, 293].

The relative abundance of natural **radiogenic** ^{87}Sr in seawater is related to the relative rates of processes that add or remove strontium in the ocean (seafloor spreading, mid-ocean-ridge hydrothermal activity, and continental weathering). Over geologic time, these processes have fluctuated and the **isotope-amount ratio** $n(^{87}Sr)/n(^{86}Sr)$ has changed systematically. By measuring the $n(^{87}Sr)/n(^{86}Sr)$ ratio in marine fossils of known age, it is possible to identify when such environmental changes occurred. Conversely, it is possible to estimate the ages of marine deposits by comparing measured $n(^{87}Sr)/n(^{86}Sr)$ ratios with the global time chart; this process is known as strontium isotope stratigraphy [294].

4.38.2 Strontium isotopes in forensic science and anthropology

The isotope-amount ratio $n(^{87}Sr)/n(^{86}Sr)$ is highly variable in rocks, minerals, soils, and waters, and it can be transmitted to plants (Figure 4.38.1), animals, and manufactured materials. Measurements of $n(^{87}Sr)/n(^{86}Sr)$ ratios are used for forensic applications in food authentication (determining where food came from), archaeology, crime-scene investigation, and human migration [295, 296].

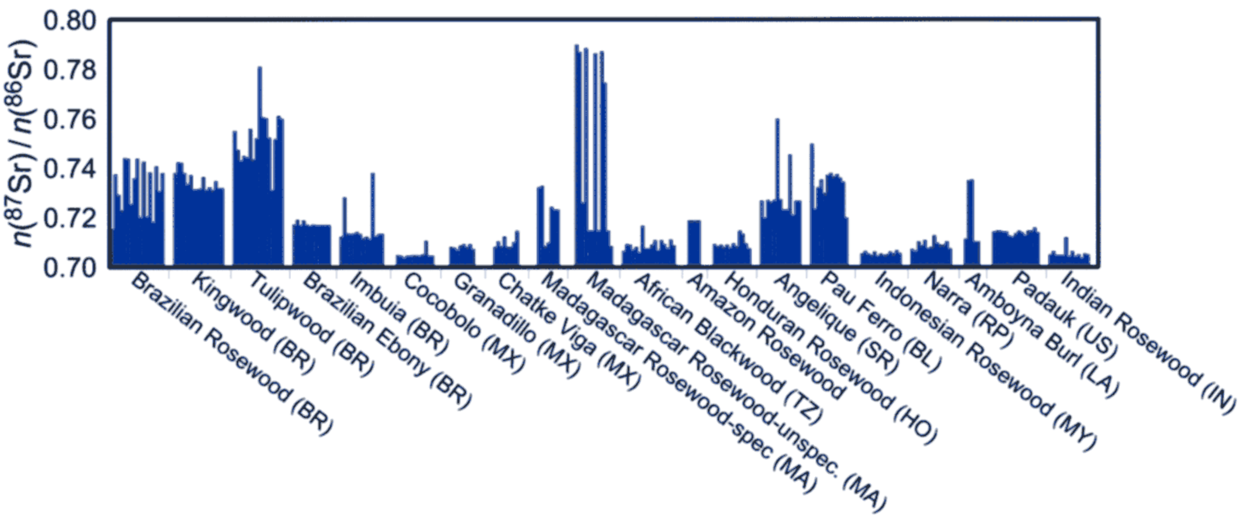


Fig. 4.38.1: Variation in strontium **isotope-amount ratios** of twenty species of exotic wood from thirteen countries (modified from [297]).

4.38.3 Strontium isotopes in geochronology

The ^{87}Rb-^{87}Sr dating technique utilizes the fact that ^{87}Sr is a product of radioactive ^{87}Rb decay (**half-life** = 4.97×10^{10} years) and is a useful tool for determining ages of rocks and minerals spanning the age of the Earth (Figure 4.38.2) [298].

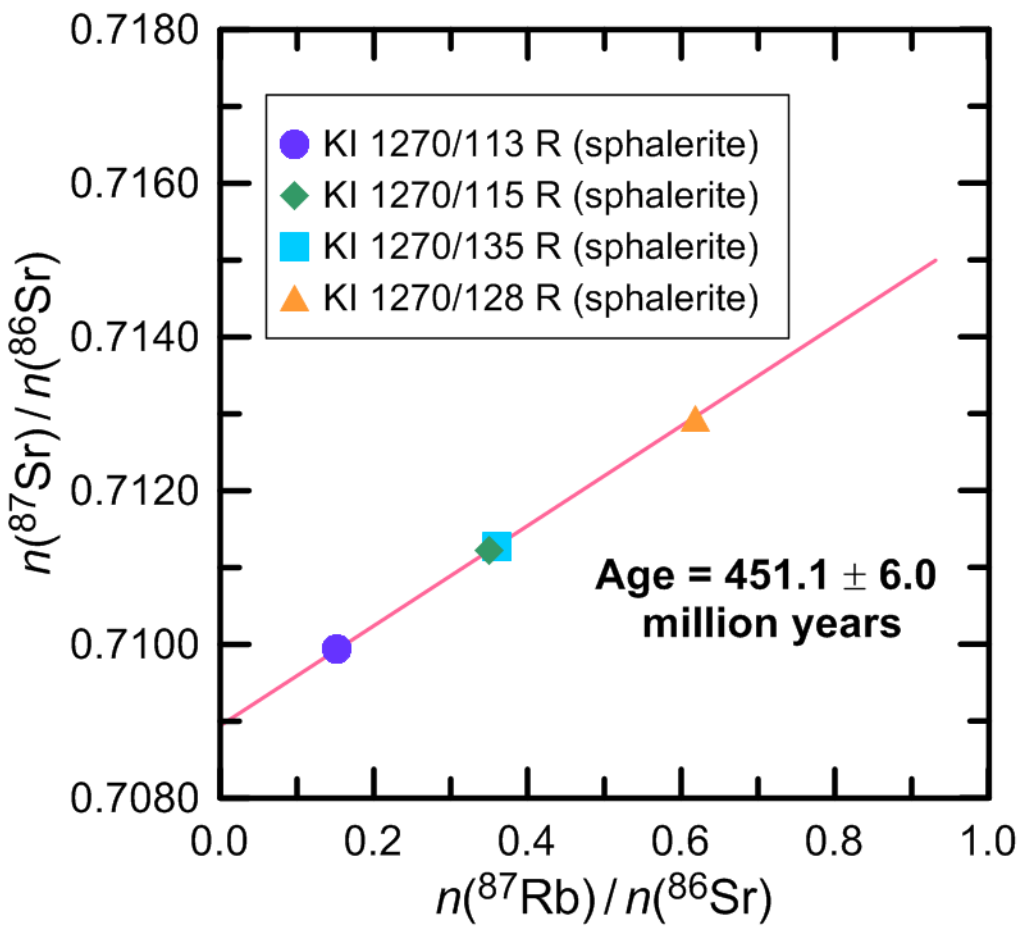


Fig. 4.38.2: Cross plot of $n(^{87}\mathrm{Sr})/n(^{86}\mathrm{Sr})$ **isotope-amount ratio** and $n(^{87}\mathrm{Rb})/n(^{86}\mathrm{Sr})$ **mole ratio** of sphalerites (zinc sulfide mineral) from the Kipushi base metal deposit, Democratic Republic of Congo (modified from [299]). ^{87}Sr is produced by decay of radioactive ^{87}Rb. Rock containing higher amounts of ^{87}Rb will over time produce higher amounts of ^{87}Sr, for example sample KI 1270/128 R. Rock containing lower amounts of ^{87}Rb will over time produce smaller amounts of ^{87}Sr, for example sample KI 1270/113 R. Assuming all the sphalerites in this figure were formed at the same time, one can determine the age of formation of the sulfides from the slope of the line through the data points (here $451.1 \pm 6.0 \times 10^6$ years), and this line is called an **isochron**.