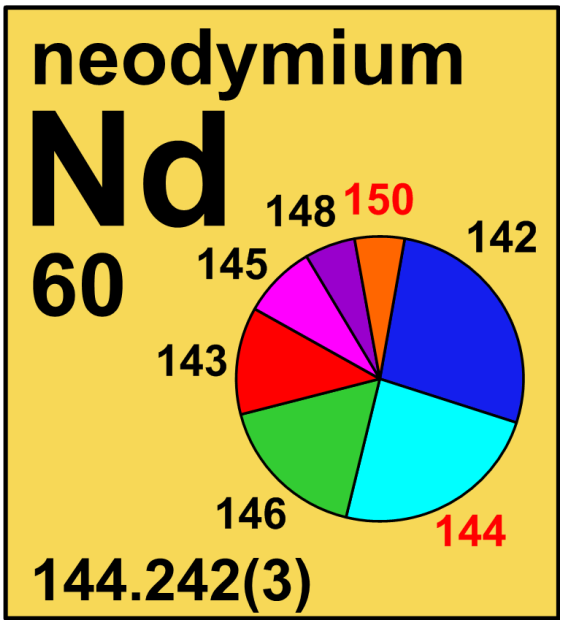
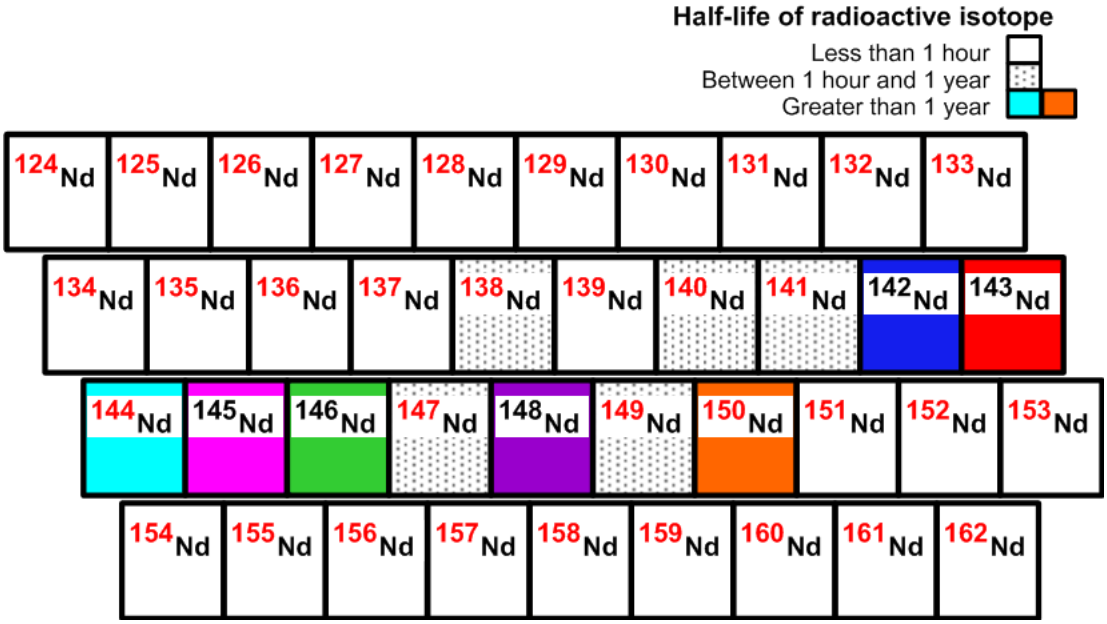
4.60 neodymium



Stable isotope	Relative atomic mass	Mole fraction
^{142}Nd	141.907 73	0.271 53
^{143}Nd	142.909 82	0.121 73
^{144}Nd†	143.910 09	0.237 98
^{145}Nd	144.912 58	0.082 93
^{146}Nd	145.913 12	0.171 89
^{148}Nd	147.916 90	0.057 56
^{150}Nd†	149.920 90	0.056 38

† **Radioactive isotope** having a relatively long **half-life** and a characteristic terrestrial **isotopic abundance** that contributes significantly and reproducibly to the determination of the **standard atomic weight** of the **element** in **normal materials**. The half-lives of ^{144}Nd and ^{150}Nd are 2.1×10^{15} years and 1.3×10^{20} years, respectively.



4.60.1 Neodymium isotopes in geochronology

^{143}Nd is a **radiogenic isotope** produced by decay of ^{147}Sm, with a **half-life** of 1.06×10^{11} years. Thus, the **isotope-amount ratio** $n(^{143}\text{Nd})/n(^{144}\text{Nd})$ can be used for dating rocks on long time

scales and as a chemical **tracer** in geochemistry (Figure 4.60.1) [424, 425]. The very small accumulation of ^{142}Nd in billion-year-old metamorphosed rocks from Greenland [from the

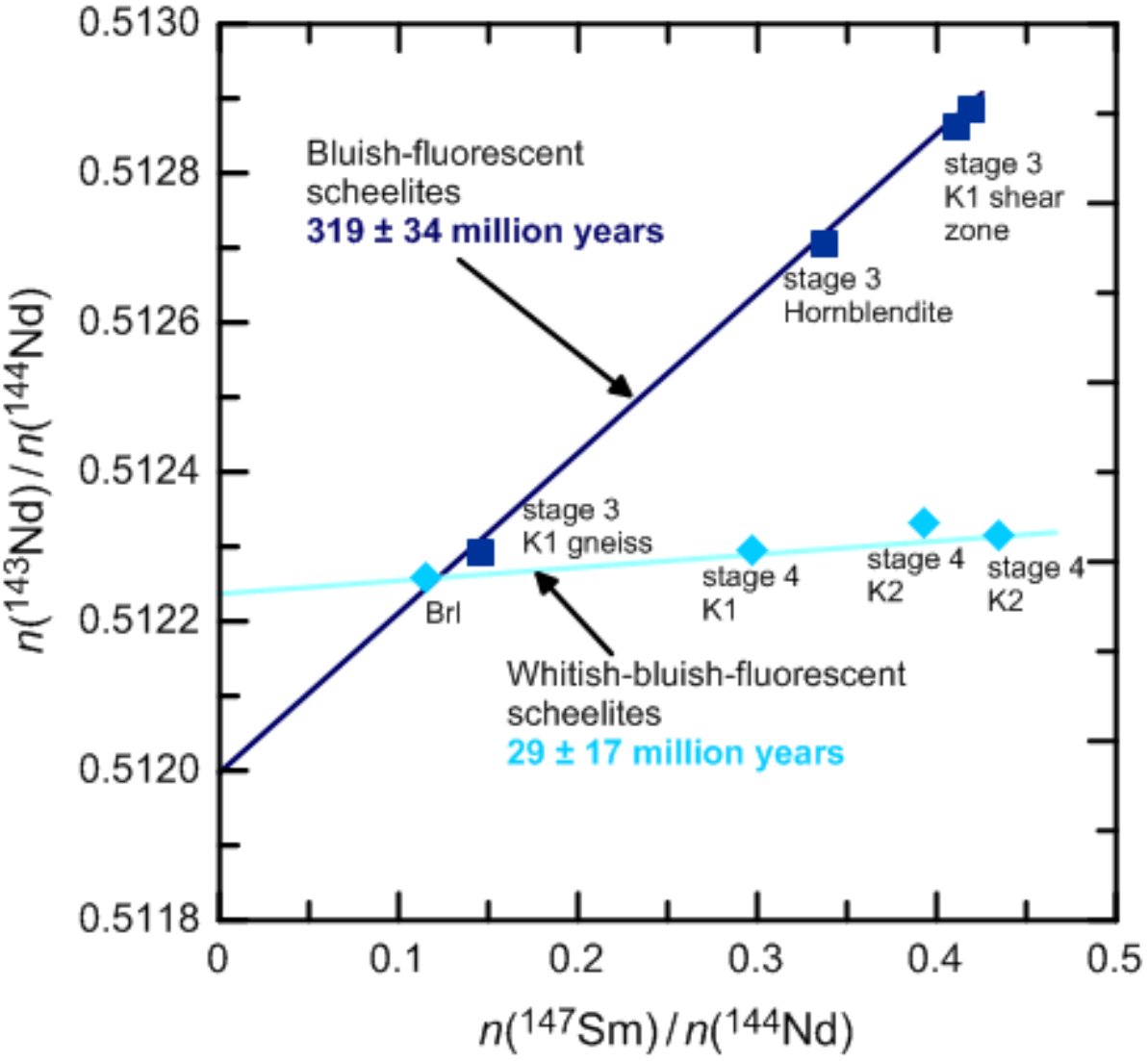


Fig. 4.60.1: Cross plot of $n(^{143}\text{Nd})/n(^{144}\text{Nd})$ **isotope-amount ratio** and $n(^{147}\text{Sm})/n(^{144}\text{Nd})$ **mole ratio** for two periods of scheelite (calcium tungstate; ore of tungsten) mineralization (metamorphism) (modified from [425]). ^{143}Nd is produced by decay of ^{147}Sm. Rock containing higher amounts of ^{147}Sm at time of mineralization will over time produce higher amounts of ^{143}Nd (e.g., sample stage 3 K1 shear zone and sample stage 4 K2). Alternatively, rocks containing lower amounts of ^{147}Sm at time of mineralization will over time produce lower amounts of ^{143}Nd (e.g., sample stage 3 K1 gneiss and sample Brl). Samples from an older mineralization event will have proportionally more ^{143}Nd because of the longer accumulation time for ^{143}Nd; thus, the line through the bluish-fluorescent scheelites with an age of 319 ± 34 × 10^6 years has a substantially higher slope than the line through the whitish-bluish-fluorescent scheelites with an age of 29 ± 17 × 10^6 years. These lines from which age of mineralization (crystallization) can be determined are called **isochrons**.

relatively short-lived (~68 × 10^6 years) **alpha decay** of ^{146}Sm] provided evidence that the crust of the Earth formed before the young planet was more than 100 × 10^6 years old. This is because only a short amount of time could have elapse to incorporate the ^{146}Sm **parent radionuclide** into the ancient Greenland minerals before it decayed [426, 427].

4.60.2 Neodymium isotopes used as a source of radioactive isotope(s)

^{146}Nd has been used in the production of ^{147}Pm (with a half-life of 2.6 years), via the ^{146}Nd (n, γ) ^{147}Nd → ^{147}Pm reaction, which is a radioisotopic power-generation source [428].