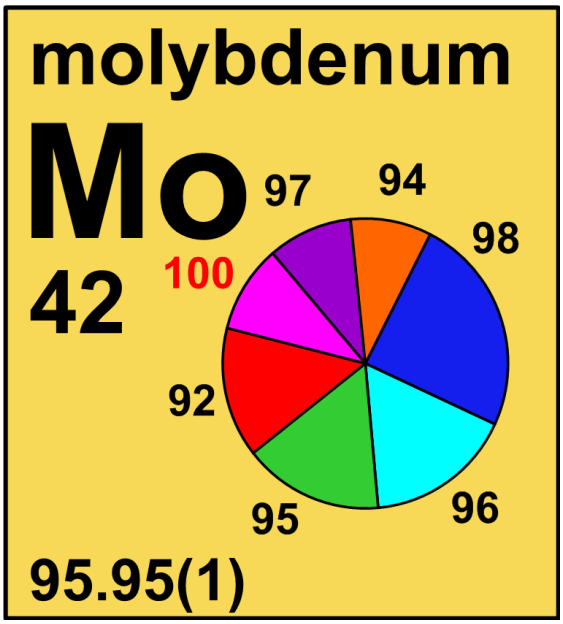
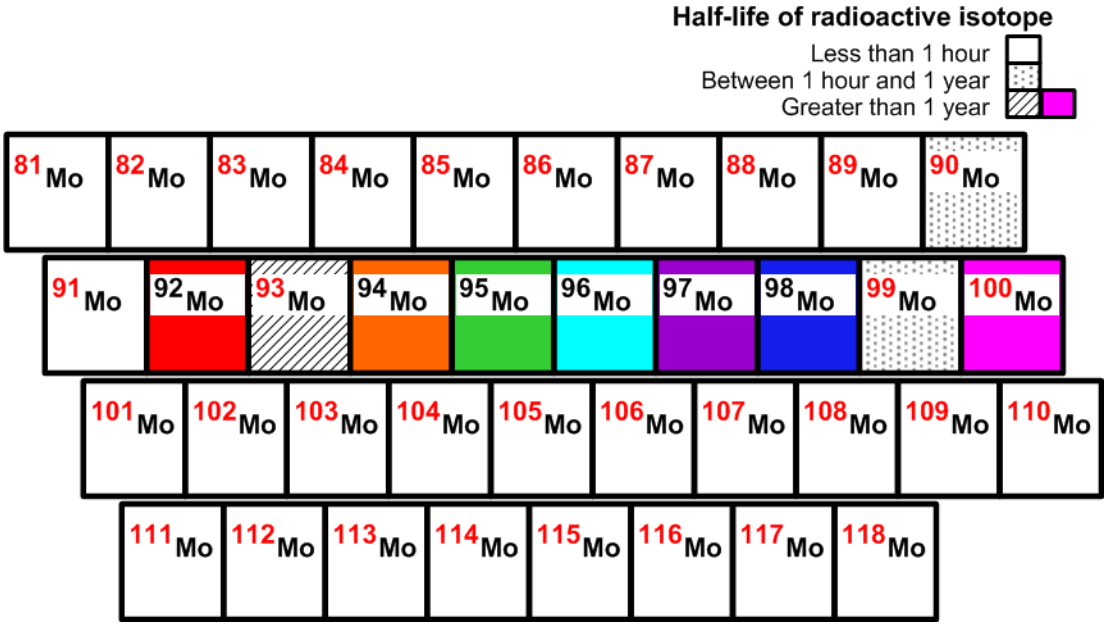
4.42 molybdenum



Stable isotope	Relative atomic mass	Mole fraction
^{92}Mo	91.906 808	0.146 49
^{94}Mo	93.905 085	0.091 87
^{95}Mo	94.905 839	0.158 73
^{96}Mo	95.904 676	0.166 73
^{97}Mo	96.906 018	0.095 82
^{98}Mo	97.905 405	0.242 92
^{100}Mo†	99.907 472	0.097 44

† **Radioactive isotope** having a relatively long **half-life** (7.1×10^{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**.



4.42.1 Molybdenum isotopes in Earth/planetary science

Molybdenites display a variation in **isotopic composition** (Fig. 42.1) [313]. The isotopic composition of molybdenum in ocean sediments depends on oxygen levels in the ocean. When oxygen levels are high, the lighter **isotopes** of molybdenum are scavenged by iron and manganese oxides into sediments. However, when oxygen levels are low, the mechanism for molybdenum removal becomes more efficient and more of the heavier isotopes of molybdenum

are found in iron and manganese oxides. Thus, the molybdenum isotopic composition of these sediments can be used as a **proxy** for oxygen levels in the paleo oceans (history of the oceans in the geological past) to gain insights into mechanisms that may have been responsible for mass-extinction events in the Earth's history [314].

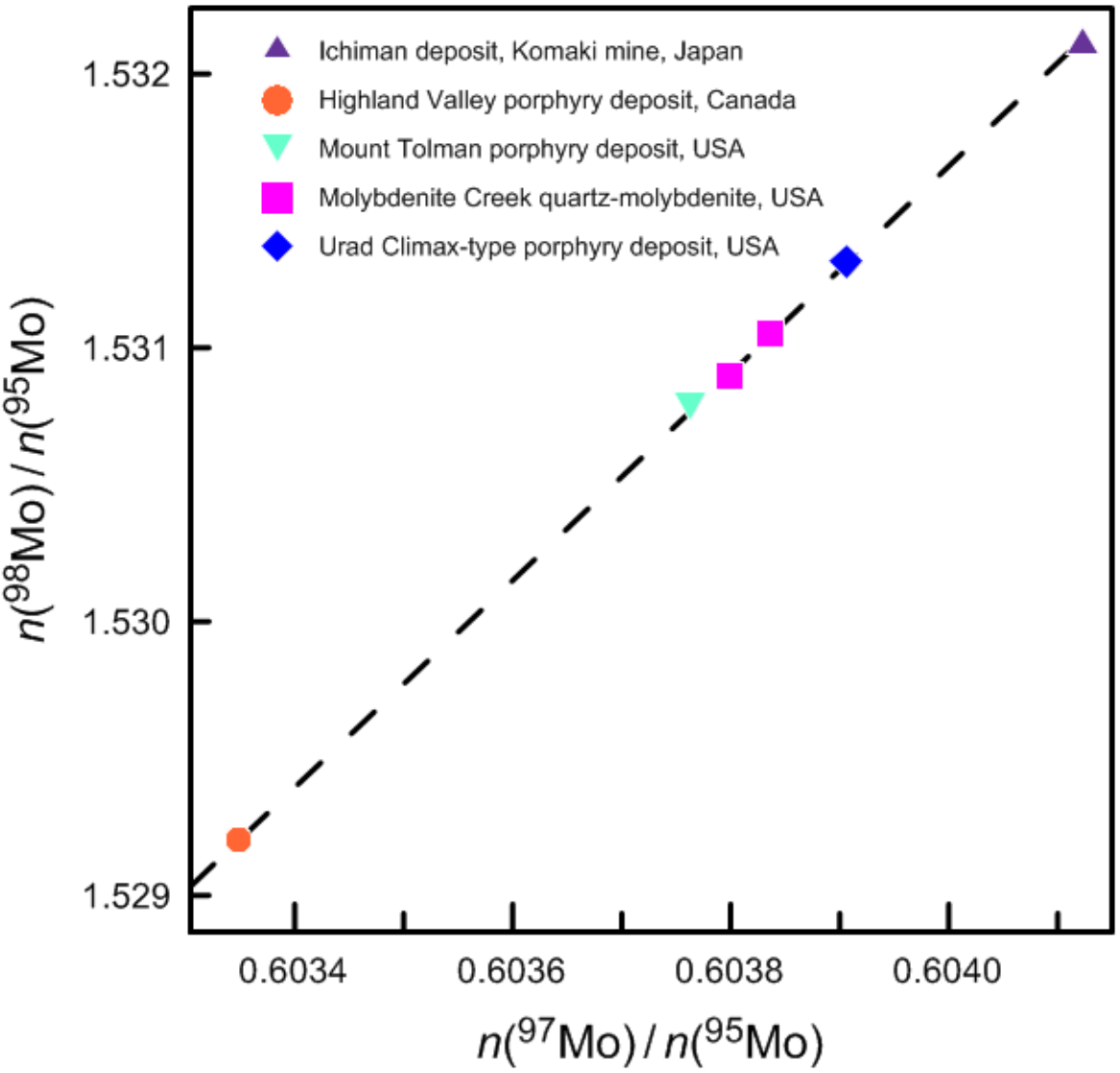


Fig. 4.42.1: Cross plot of $n(^{98}\mathrm{Mo})/n(^{95}\mathrm{Mo})$ **isotope-amount ratio** and $n(^{97}\mathrm{Mo})/n(^{95}\mathrm{Mo})$ isotope-amount ratio of selected molybdenum-bearing materials (modified from [313], assuming a measured $n(^{98}\mathrm{Mo})/n(^{95}\mathrm{Mo})$ isotope-amount ratio of 1.530 40 and a measured $n(^{97}\mathrm{Mo})/n(^{95}\mathrm{Mo})$ isotope-amount ratio of 0.603 67 [315].

4.42.2 Molybdenum isotopes in industry

Depleted ^{95}Mo has been used in the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (Tennessee, USA). The use of U-10Mo fuel elements (90 percent uranium, 10 percent molybdenum) would allow the conversion from high-enrichment uranium (HEU) fuel, 92 percent, to low-enrichment uranium (LEU) fuel, < 20 percent, for nuclear non-proliferation purposes [316].

4.42.3 Molybdenum isotopes used as a source of radioactive isotope(s)

^{95}Mo is used to produce medical **radioisotope** ^{97}Ru via the ^{95}Mo (^{4}He, 2n) ^{97}Ru reaction. The isotope ^{99}Mo is commercially produced by the **fission** of ^{235}U and is the **parent radionuclide** of ^{99m}Tc, which is the most widely used **radiopharmaceutical** in the world. The much longer **half-life** of ^{99}Mo (about 66 hours) enables the **radionuclide** to be transported more easily than the short-lived (6-hour half-life) ^{99m}Tc. The $n(^{99}\text{Mo})/n(^{99m}\text{Tc})$ mole-ratio generator was originally developed at Brookhaven National Laboratory (Figure 4.42.2) in the early 1960s and is now a patented system [317].

Fig. 4.42.2: Pictured above is Brookhaven National Laboratory where the $n(^{99}\text{Mo})/n(^{99m}\text{Tc})$ mole-ratio generator was originally developed in the early 1960s. (Picture Source: Brookhaven National Laboratory) [318].