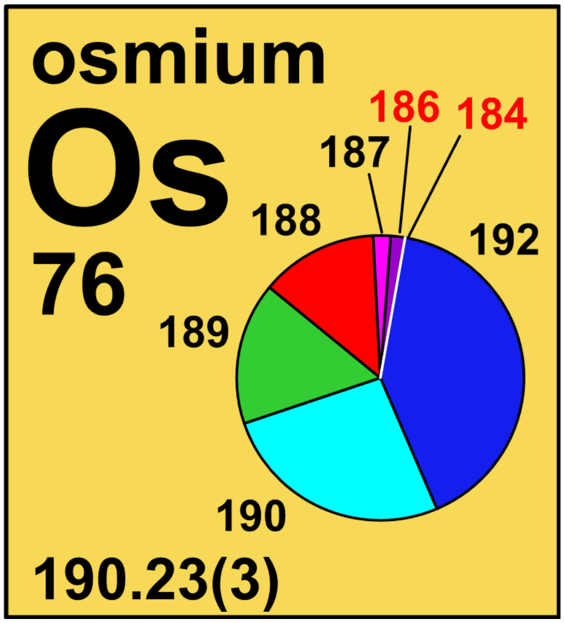
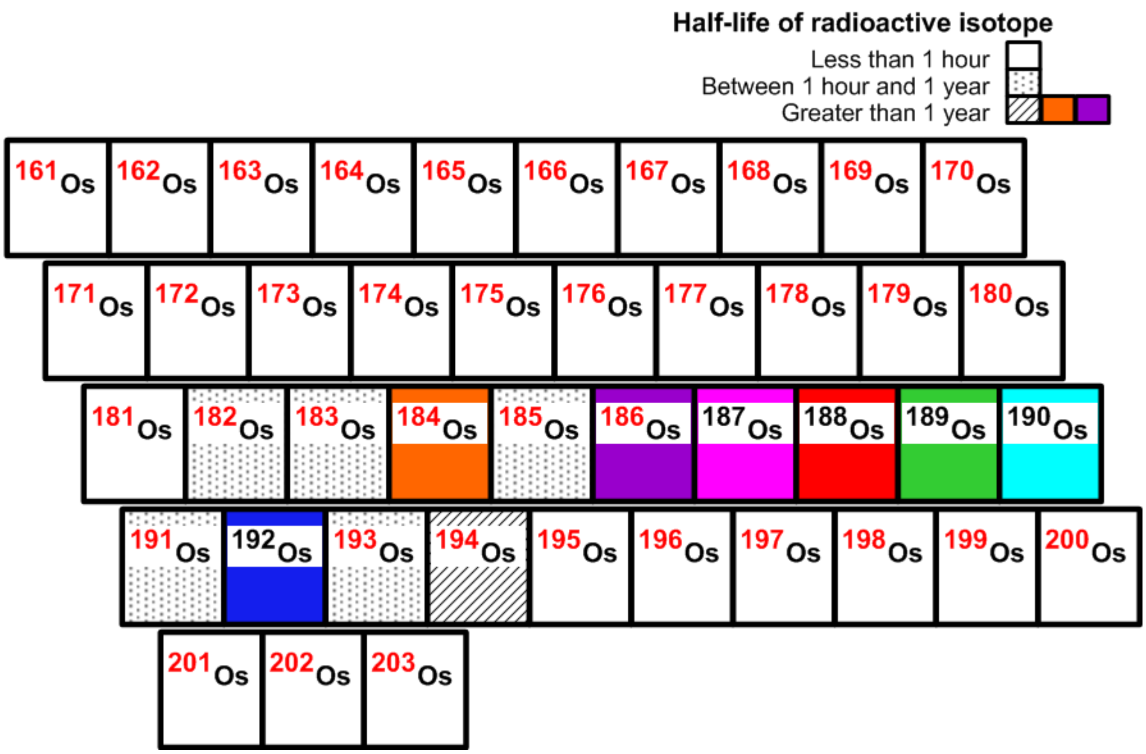
4.76 osmium



Stable isotope	Relative atomic mass	Mole fraction
$^{184}Os^{\dagger}$	183.952 489	0.0002
$^{186}Os^{\dagger}$	185.953 84	0.0159
^{187}Os	186.955 75	0.0196
^{188}Os	187.955 84	0.1324
^{189}Os	188.958 14	0.1615
^{190}Os	189.958 44	0.2626
^{192}Os	191.961 48	0.4078

† **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 ^{184}Os and ^{186}Os are 1.1×10^{13} years and 2×10^{15} years, respectively.



4.76.1 Osmium isotopes in Earth/planetary science

The **isotope-amount ratio** $n(^{187}\text{Os})/n(^{186}\text{Os})$ in rocks can be transferred to fluids, such as magmas, groundwaters, rivers, and oceans. Variations in the inherited $n(^{187}\text{Os})/n(^{186}\text{Os})$ ratios can provide a useful **tracer** for fluid sources and migration paths including different layers of the Earth [298, 501, 513, 514]. **Meteorites** and meteorite dust impacting the Earth have different osmium **isotopic compositions** than terrestrial rocks and sediments. As a result, $n(^{187}\text{Os})/n(^{186}\text{Os})$-ratio studies provide evidence of continuing extraterrestrial additions to the Earth over geologic time, as well as providing a method for prospecting in the sedimentary record for large meteorite impact events that may have affected life on Earth [515].

4.76.2 Osmium isotopes in geochronology

Some ^{187}Os is **radiogenic** as a result of being formed by **beta decay** of radioactive ^{187}Re, which has a **half-life** of 4.16×10^{10} years. Variations in the isotope-amount ratio $n(^{187}\text{Os})/n(^{186}\text{Os})$ and **mole ratio** $n(^{187}\text{Re})/n(^{186}\text{Os})$ are used for geochronology; for example, variations in these ratios have been used to determine the ages of the Earth, Moon, and meteorites [298]. Kirk *et al.* [516] measured rhenium-osmium **isotopic abundances** in gold and pyrites from conglomerates of the Central Rand Group of South Africa (Figure 4.76.1), which have produced over 48,000 metric tons of gold and have accounted for 40 percent of the world's total historic production [517]. The gold and rounded pyrites from the conglomerates yield an age of ~3.0×10^9 years. Kirk *et al.* find that this age is much older than that of conglomerate, and they conclude that the gold is detrital (material wearing away by weathering or erosion) and was not deposited by later hydrothermal fluids.

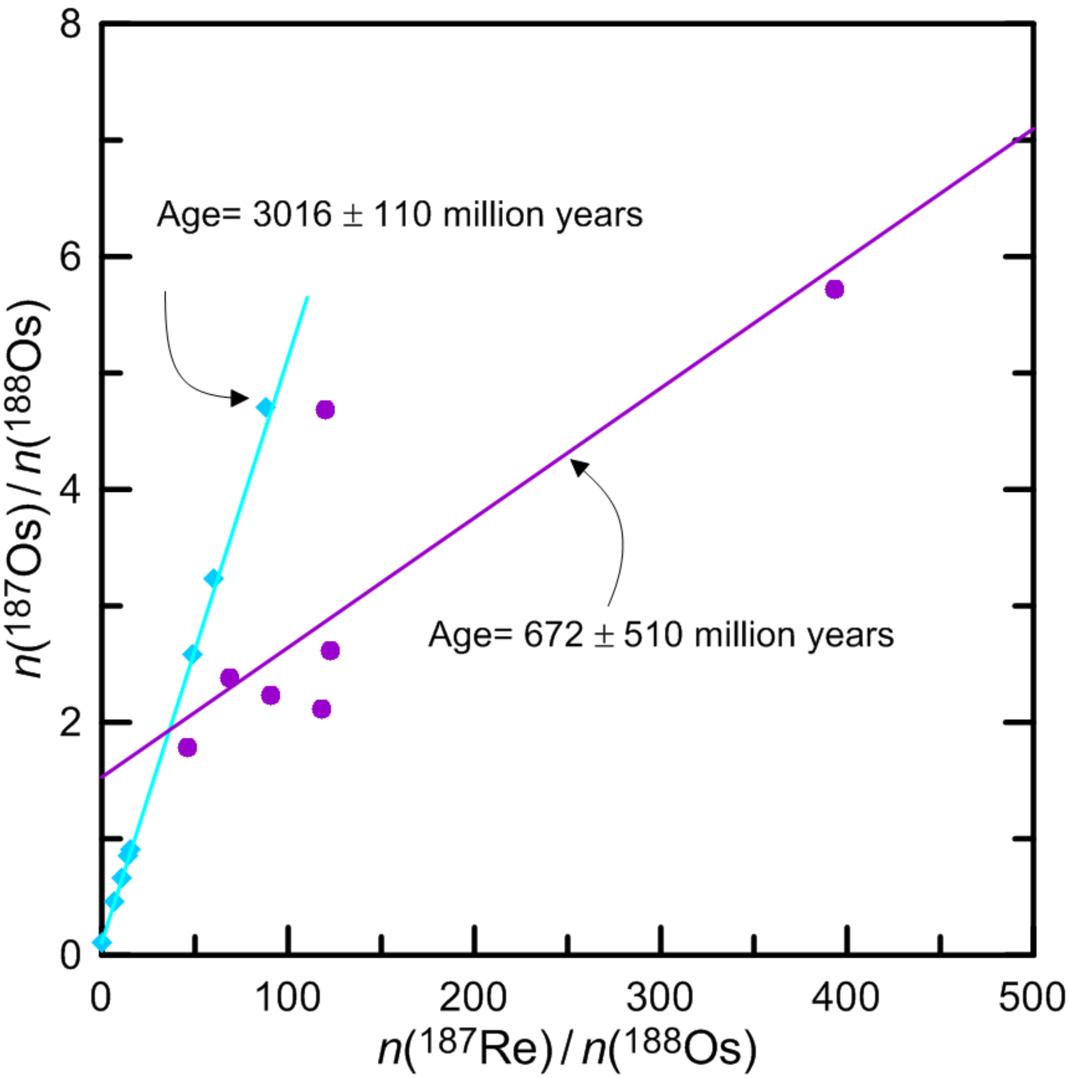


Fig. 4.76.1: Cross plot of $n(^{187}Os)/n(^{188}Os)$ **isotope-amount ratio** and $n(^{187}Re)/n(^{188}Os)$ **mole ratio** of gold and pyrite from South Africa's Witwatersrand Supergoup gold deposits (modified from [516]). The turquoise diamonds are gold-bearing samples from Vaal Reef, and they form an **isochron** with an age of ~3.0×10^9 years. The purple filled circles are euhedral pyrites (crystals having a flat surface and sharp angles) from the Venterdorp Contact Reef, and they have a much younger age of $672 \pm 510 \times 10^6$ years.

4.76.3 Osmium isotopes used as a source of radioactive isotope(s)

^{192}Os can be used for the production of the medical **radioisotope** ^{195m}Pt via the ^{192}Os (α, n) ^{195m}Pt reaction.