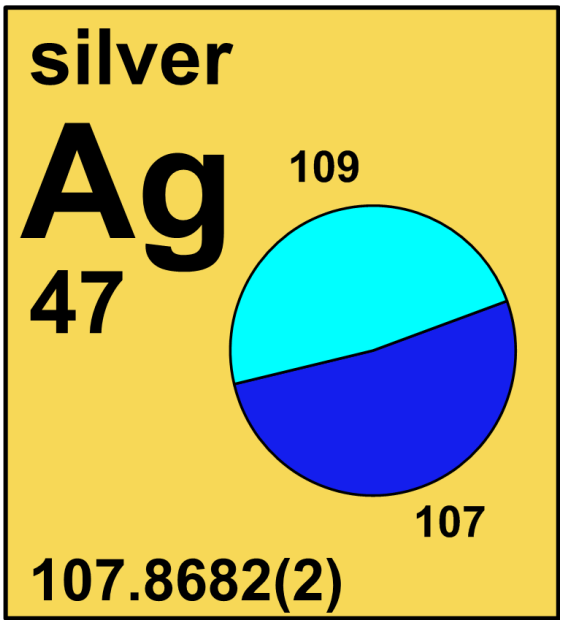
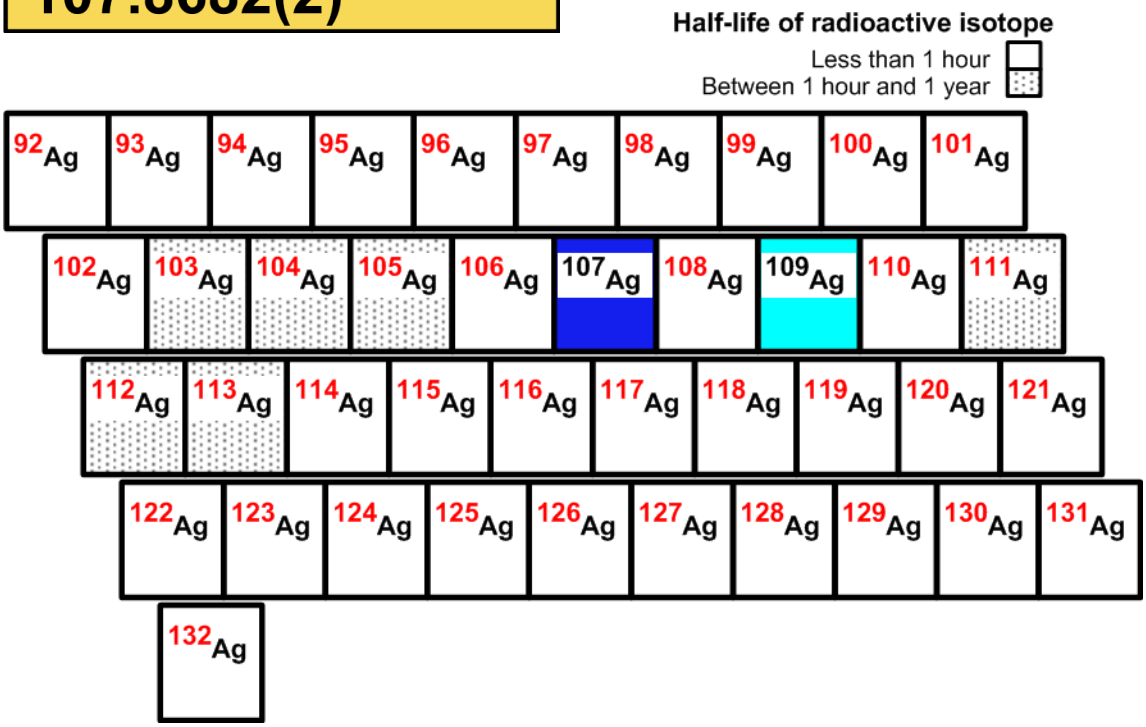
4.47 silver



Stable isotope	Relative atomic mass	Mole fraction
^{107}Ag	106.905 09	0.518 39
^{109}Ag	108.904 755	0.481 61



4.47.1 Silver isotopes in Earth/planetary science

The measurement of relative amounts of ^{107}Ag and ^{109}Ag is used to study the processes responsible for the **isotopic fractionation** of silver **isotopes** in ore deposits, which depends on the specific minerals and environmental conditions. This is currently an area of active research

and it is thought that the relative amounts of the isotopes of silver are altered during the formation of the ore [348, 349].

4.47.2 Silver isotopes in forensic science and anthropology

Silver **isotope-amount ratios** ($n(^{107}Ag)/n(^{109}Ag)$) along with isotope-amount ratios of copper ($n(^{65}Cu)/n(^{63}Cu)$), and isotope-amount ratios of lead ($n(^{206}Pb)/n(^{204}Pb)$, $n(^{207}Pb)/n(^{204}Pb)$ and $n(^{208}Pb)/n(^{204}Pb)$) have been used to determine origins of European coins and information on the flow of goods in the world market over time (Figure 4.47.1). Metals from Peru and Mexico and those from European mining have distinct isotopic signatures that enable the origin of the metal to be determined by examining the **isotopic compositions** of silver, copper, and lead in the coins. Abundant silver sources, mined in Mexico and Peru in the 16th century, were used to mint coins, but they were not a major influence in the European coin market until the 18th century (Figure 4.47.1) [234].

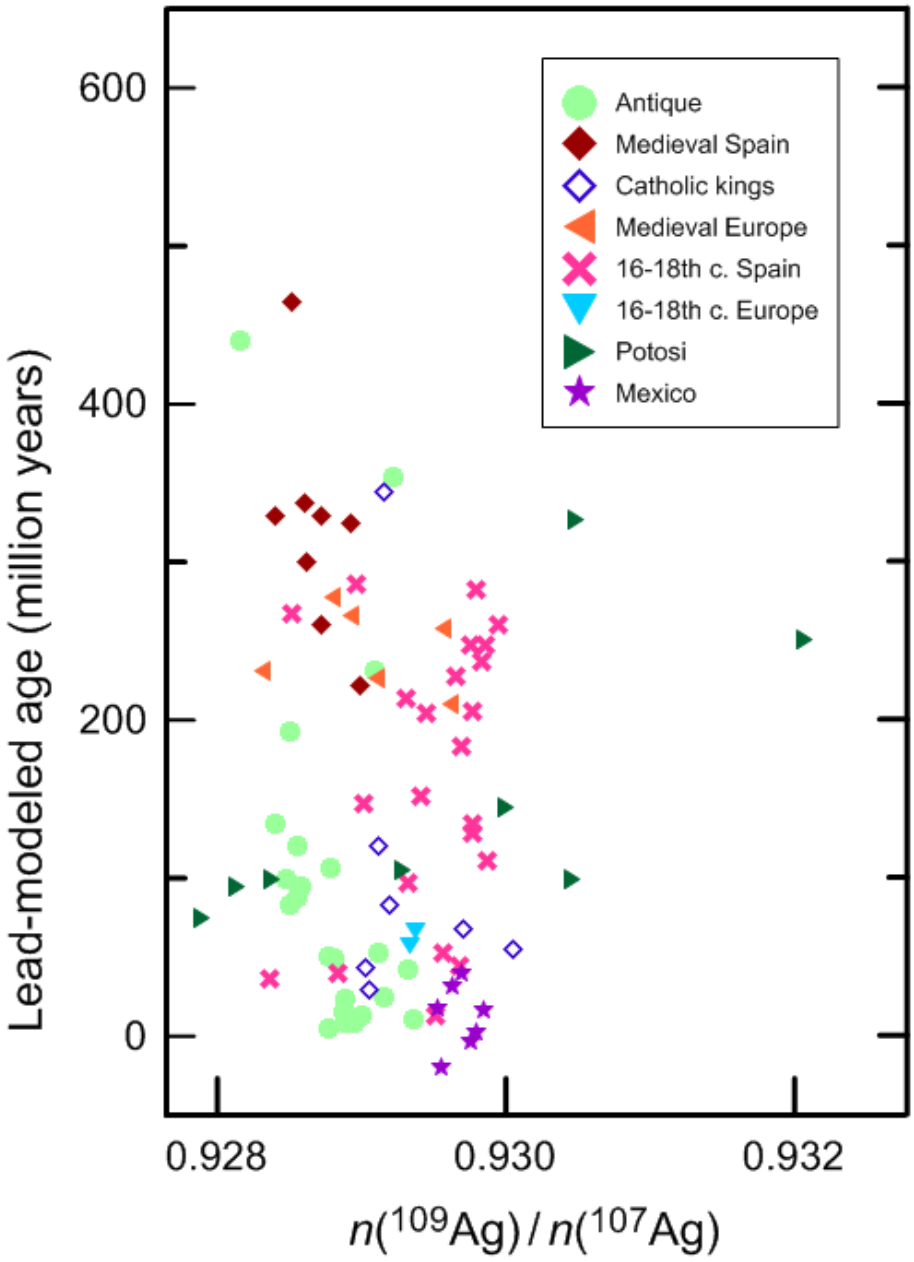


Fig. 4.47.1: Cross plot of lead model age and $n(^{109}Ag)/n(^{107}Ag)$ **isotope-amount ratio** of *selected* coins (modified from [234]) assuming a $n(^{109}Ag)/n(^{107}Ag)$ value of 0.929 04 for the isotopic reference material SRM 981a silver nitrate [234]. The isotopic signatures of the silver, copper, and lead in the metals used to make Spanish coins have been used to trace (see **tracer**) the origin of the metals to help determine the flow of metal in the global market during the 16thcentury. The Mexico coins show little variation in the silver mole fraction, although the observed range of isotopic variation is about 30 times the analytical uncertainty. The antique coins have two groups, the oldest on the right and the younger on the left. They are statistically different at the 99-percent confidence level. The Catholic Kings coins are distinct from the rest of the medieval coins.

4.47.3 Silver isotopes in geochronology

The **mole ratio** $n(^{107}Pd)/n(^{107}Ag)$ is used in geochronology to date major events in the Solar System [341-345, 350]. Although ^{107}Ag is naturally occurring, it is also the **daughter product** by **beta decay** of ^{107}Pd. If both excess ^{107}Ag and ^{107}Pd are present in a sample of extraterrestrial origin, then the material would have formed sometime after ^{107}Pd decayed (i.e. sometime after the 6.5-million-year **half-life** of ^{107}Pd). The $n(^{107}Pd)/n(^{107}Ag)$ mole ratio can be measured to help determine when the ^{107}Pd decay process began and determine how much time has elapsed since the material was formed.

4.47.4 Silver isotopes in industry

^{107}Ag is being studied as a possible target for **cyclotron** production of ^{103}Pd (with a half-life of 17 days) via the ^{107}Ag (p, α n) ^{103}Pd reaction. ^{103}Pd releases **X-rays** and **Auger electrons** at the rate of about 80 X-rays and 186 Auger electrons per 100 decays of ^{103}Pd, which makes this **isotope** an ideal candidate for internal **radiotherapy** for the treatment of cancers. The production of this isotope in a no-carrier form (not formed in another solution) is important for its medical uses. By using **neutrons**, **photons**, and charged particles to force reactions with isotopes of a higher **mass number** than 103, ^{103}Pd will occur in a fraction of those reactions. The most common methods of ^{103}Pd production use targets of rhodium or other isotopes of palladium. However, ^{107}Ag has also been studied as a feasible option [346, 351]. ^{109}Ag is used to produce the gamma reference source ^{110m}Ag to help calibrate gamma detectors [346, 351].