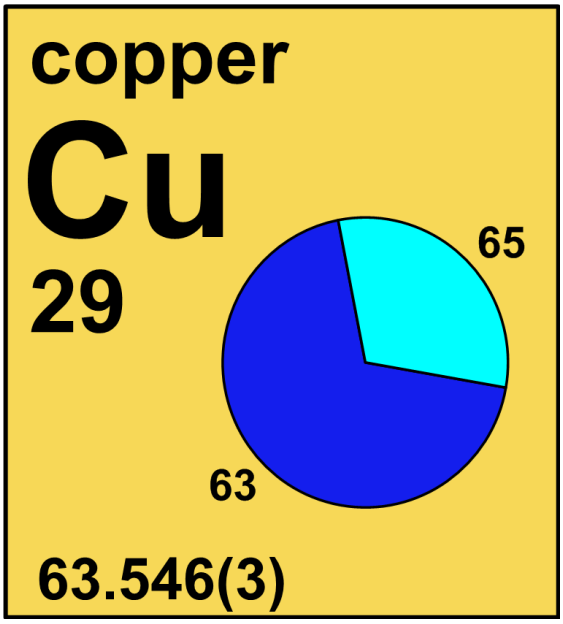
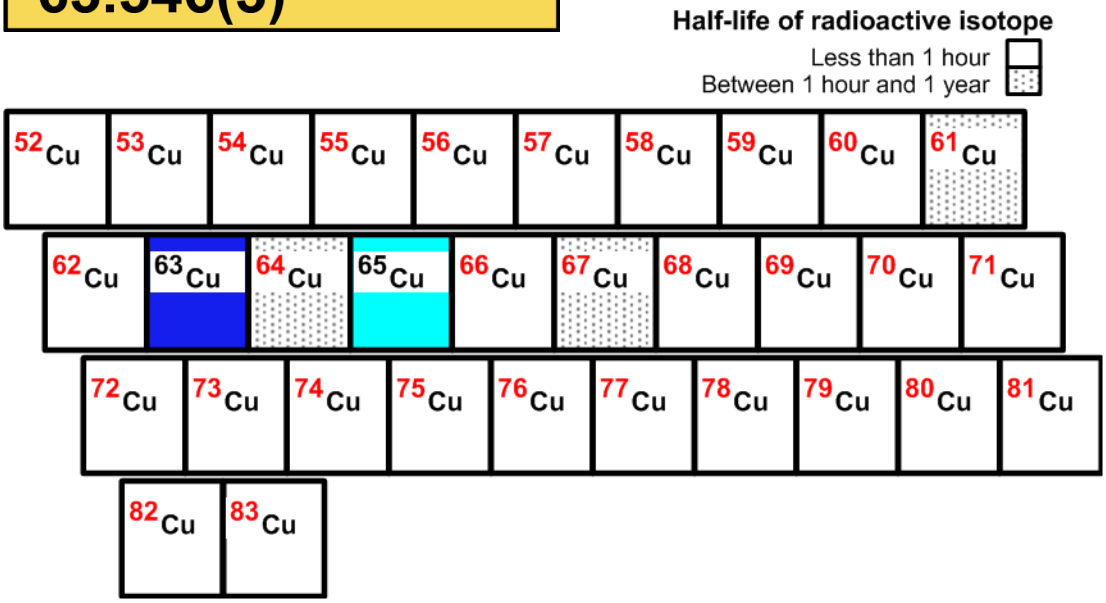
4.29 copper



Stable isotope	Relative atomic mass	Mole fraction
^{63}Cu	62.929 598	0.6915
^{65}Cu	64.927 790	0.3085



4.29.1 Copper isotopes in Earth/planetary science

Molecules, atoms, and ions of the **stable isotopes** of copper possess slightly different physical and chemical properties, and they commonly will be fractionated during physical, chemical, and biological processes, giving rise to variations in **isotopic abundances** and in **atomic weights**. There are measureable variations in the isotopic abundances of copper in natural terrestrial materials (Figure 4.29.1). ^{63}Cu and ^{65}Cu have been used to study copper isotope science of supergene (formed by descending solutions) copper minerals for potential use as an indicator of the paleohydraulic (ancient hydraulic) gradient, and for potential to provide a vector toward unrecognized copper source regions [233]. Copper **isotope ratios** of iron oxides and supergene

copper sulfides in surface samples or fossil leached caps of ore deposits are being used in prospecting to rank prospects and focus on drilling areas that have the greatest potential for mature enrichment profiles [233].

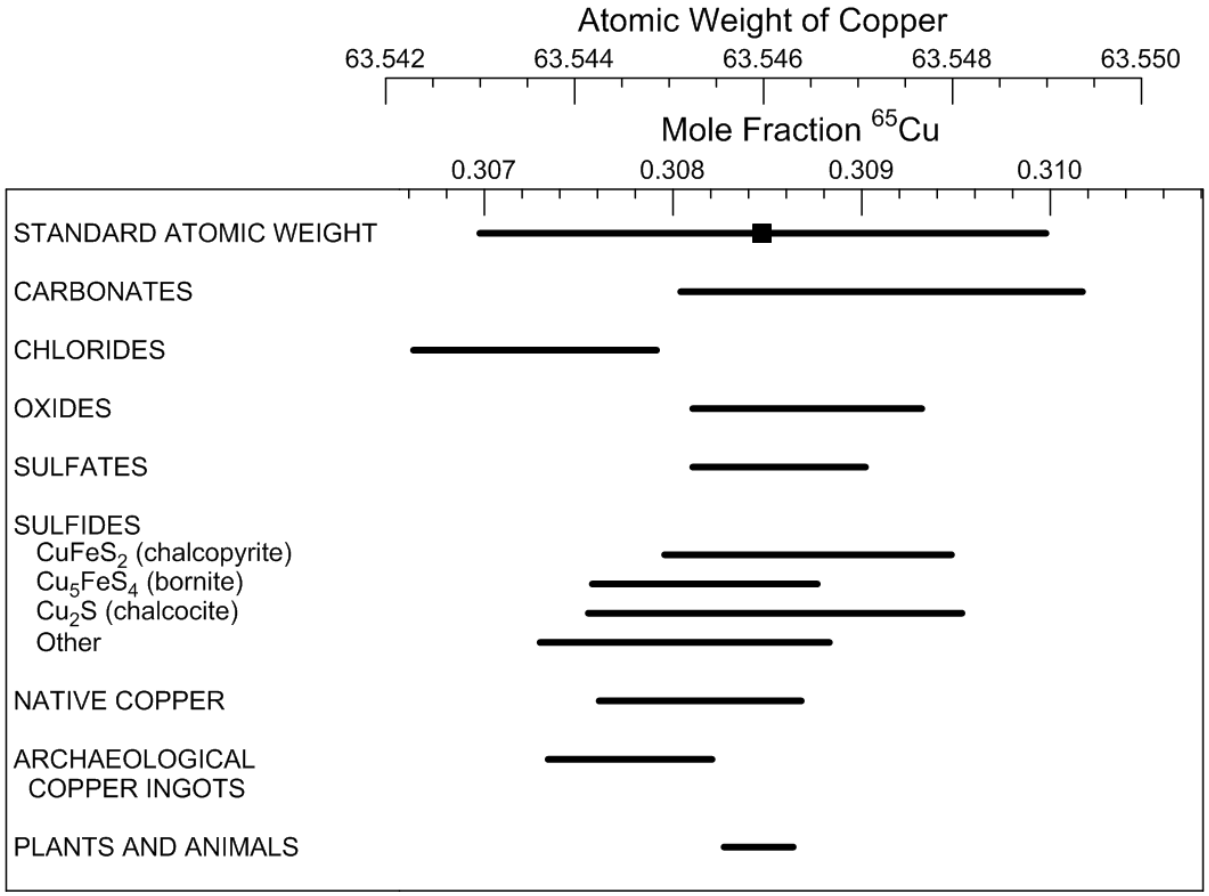


Fig. 4.29.1: Variation in **atomic weight** with **isotopic composition** of selected copper-bearing materials (modified from [14]).

4.29.2 Copper isotopes in forensic science and anthropology

The copper **isotope-amount ratio** $n(^{65}Cu)/n(^{63}Cu)$ along with the silver isotope-amount ratio $n(^{109}Ag)/n(^{107}Ag)$ and lead isotope-amount ratios $n(^{206}Pb)/n(^{204}Pb)$, $n(^{207}Pb)/n(^{204}Pb)$, and $n(^{208}Pb)/n(^{204}Pb)$ have been used to determine the origin of European coins and the flow of goods in the historical world market. Metals from Peru and Mexico and those from European mining sites have distinct isotopic signatures that enable the origin of the metal to be determined based on the **isotopic compositions** of silver, copper, and lead in the coins. Silver from mines in Mexico and Peru in the 16th century was used to mint coins but did not influence the European coin market until the 18th century [234].

4.29.3 Copper isotopes in medicine

The **radiopharmaceutical** ^{62}Cu-PTSM, which contains radioactive ^{62}Cu (with a half-life of 9.7 minutes), is used as a **tracer** in **positron emission tomography** (**PET**) to quantify myocardial perfusion (heart blood-flow measurements) [235, 236]. The **radioisotope** ^{64}Cu (with a half-life of 12.7 hours) is used for PET imaging and **radiotherapy** to diagnose, understand, and monitor disease (Figure 4.29.2) [235, 237]. The stable **isotope** ^{65}Cu has been used as a tracer to study copper absorption, utilization, and **excretion** in humans [238, 239].

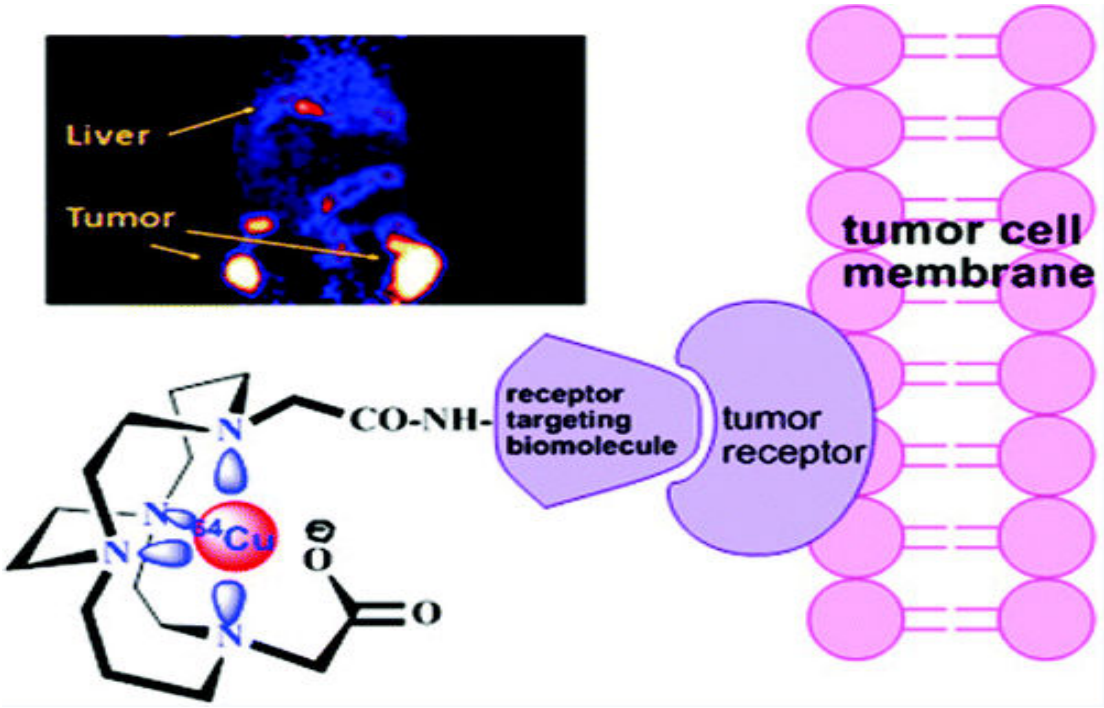


Fig. 4.29.2: An illustration of a small-animal **positron emission tomography** (**PET**) system that uses the ^{64}Cu **radioisotope** to generate a reconstructed image of the animal in a noninvasive manner. (Diagram Source: Monica, S. & Anderson, C.J., 2009, © American Chemical Society) [237].(Copyright permission will be purchased through Copyright Clearance Center once publication is approved.)