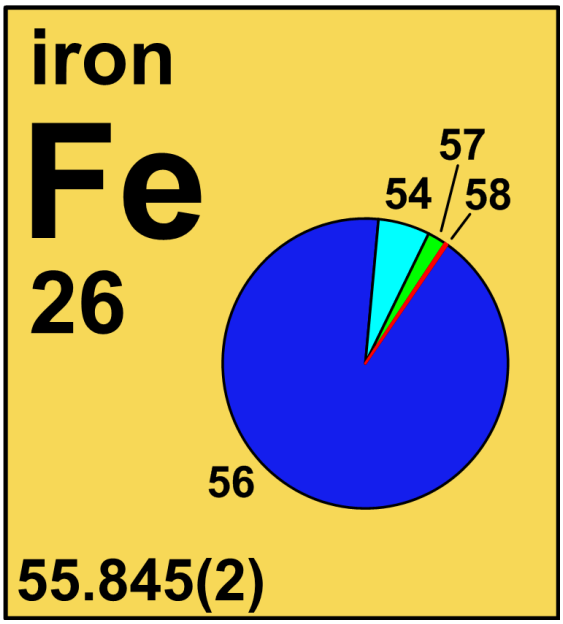
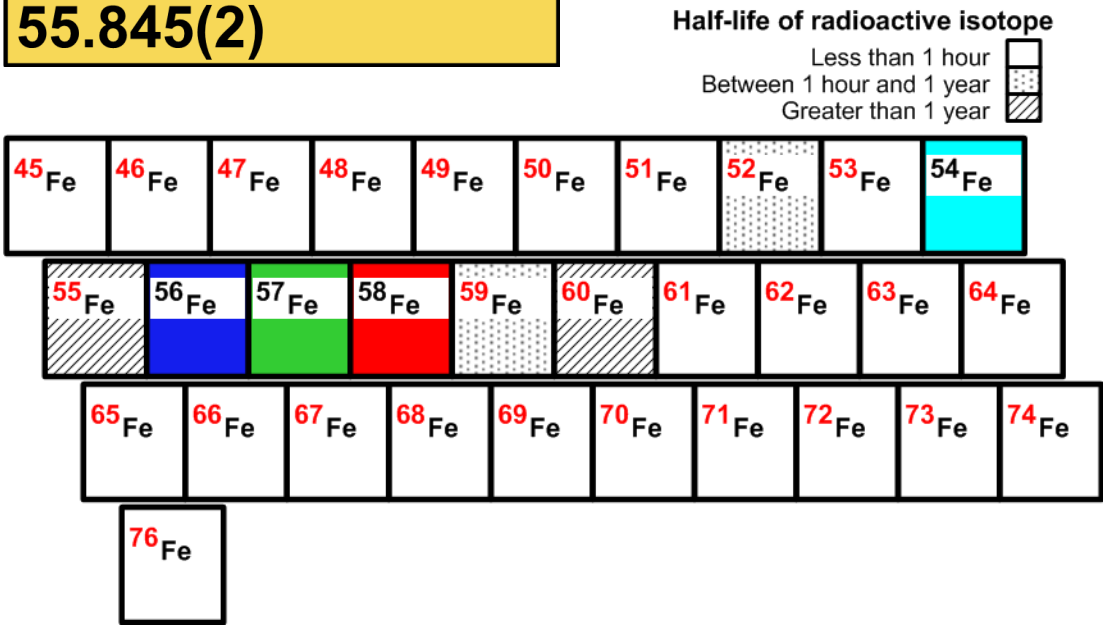
4.26 iron



Stable isotope	Relative atomic mass	Mole fraction
^{54}Fe	53.939 609	0.058 45
^{56}Fe	55.934 936	0.917 54
^{57}Fe	56.935 393	0.021 19
^{58}Fe	57.933 274	0.002 82



4.26.1 Iron isotopes in biology

Natural iron enriched in its least abundant **stable isotopes**, ^{57}Fe and ^{58}Fe, are used as a **tracer** in human studies to assess absorption, **excretion**, distribution, and utilization of iron in basic and applied research [105-107, 211-213]. The two **radioisotopes**, ^{55}Fe and ^{59}Fe, have sufficiently long **half-lives** of 2.75 years and 44.5 days, respectively, to be used as tracers, but potential health and environmental hazards limit their use to diagnostic applications in patient care (i.e. disorders of blood and of iron **metabolism**) [107, 212, 213].

4.26.2 Iron isotopes in Earth/planetary science

^{60}Fe is an extinct **radionuclide** with a half-life of 2.6×10^6 years that has fully decayed to ^{60}Ni since formation of the Solar System. The distribution of the product (**radiogenic**) ^{60}Ni in extraterrestrial material, such as **meteorites**, has been used to gain insight into the early history of the Solar System [213]. Because molecules, atoms, and ions of the stable isotopes of iron possess slightly different physical and chemical properties, 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 iron in natural terrestrial materials (Figure 4.26.1). Small variations in stable iron **isotopic compositions** caused by physical and chemical **isotopic fractionation** processes have been used to study mass transfer processes in nature and chemical equilibria [14, 213, 214].

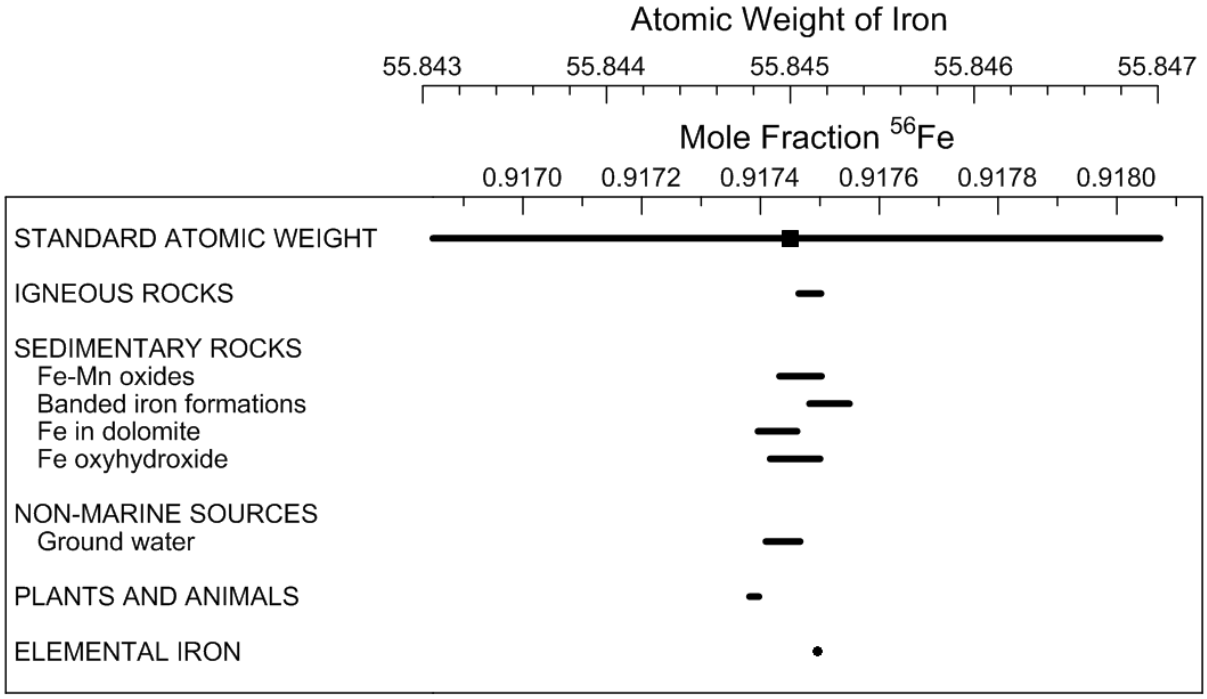


Fig. 4.26.1: Variation in **atomic weight** with **isotopic composition** of selected iron-bearing materials (modified from [14]).

4.26.3 Iron isotopes in industry

^{55}Fe is a beta emitting nuclide that serves as an **electron** source together with ^{63}Ni (with a half-life of 99 years) in **electron-capture detectors**. Electron capture detectors are used as thickness gauges or as detectors for organic **analytes** in **gas chromatography** [215].

4.26.4 Iron isotopes in medicine

^{52}Fe, with a half-life of 8.3 hours, emits **positrons** and is used in **positron emission tomography** (**PET**) studies. It can be produced in a **cyclotron** from stable ^{50}Cr by **alpha particle capture** [96, 216, 217].

4.26.5 Iron isotopes used as a source of radioactive isotope(s)

Stable ^{56}Fe is used for production of radioactive ^{55}Co (with a half-life of about 18 hours), as an emitter of positrons for PET applications using the reaction ^{56}Fe (p, 2n) ^{55}Co [218, 219].