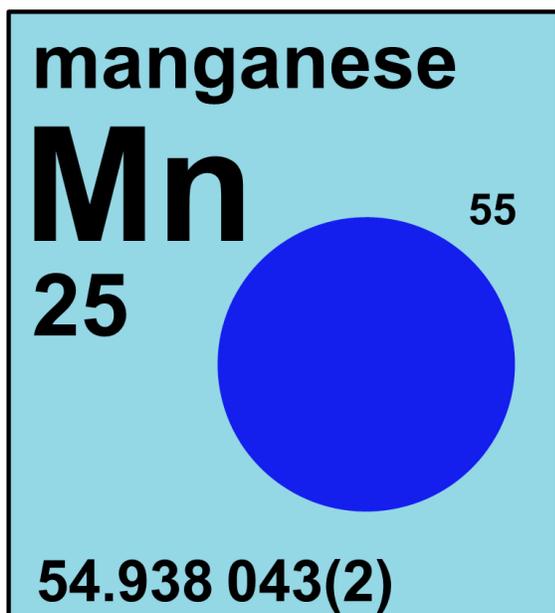


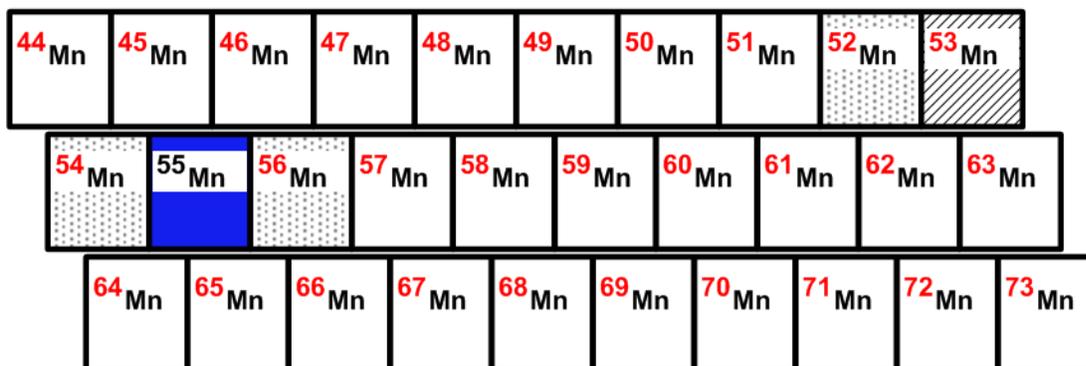
4.25 manganese



Stable isotope	Relative atomic mass	Mole fraction
⁵⁵ Mn	54.938 044	1

Half-life of radioactive isotope

Less than 1 hour	
Between 1 hour and 1 year	
Greater than 1 year	



4.25.1 Manganese isotopes in Earth/planetary science

Radioactive ⁵⁴Mn has been used as a **tracer** to study migration of heavy metals in effluents (flowing out) from mining waste [106, 107].

4.25.2 Manganese isotopes in geochronology

The **radioactive isotope** ⁵³Mn is formed by the interaction of **protons**, produced by **cosmic rays**, on iron in rocks. The accumulation of ⁵³Mn, having a **half-life** of 3.7×10^6 years, at the Earth's surface enables determination of exposure ages of landforms to cosmic rays and quantification of erosion rates. For example, Schaefer *et al.* [208] measured 13 samples from nine dolerite (**igneous** rock containing plagioclase, pyroxene, and olivine) surfaces in the Dry Valleys,

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Antarctica. They found that the terrestrial ^{53}Mn concentrations correlate well with cosmic-ray-produced ^3He and ^{21}Ne concentrations in the same samples (Figure 4.25.1), which suggests that ^{53}Mn is produced continuously in place and retained over millions of years without loss. Their results suggest that ^{53}Mn concentrations in rocks can be used to monitor Earth-surface processes on time scales exceeding 10×10^6 years.

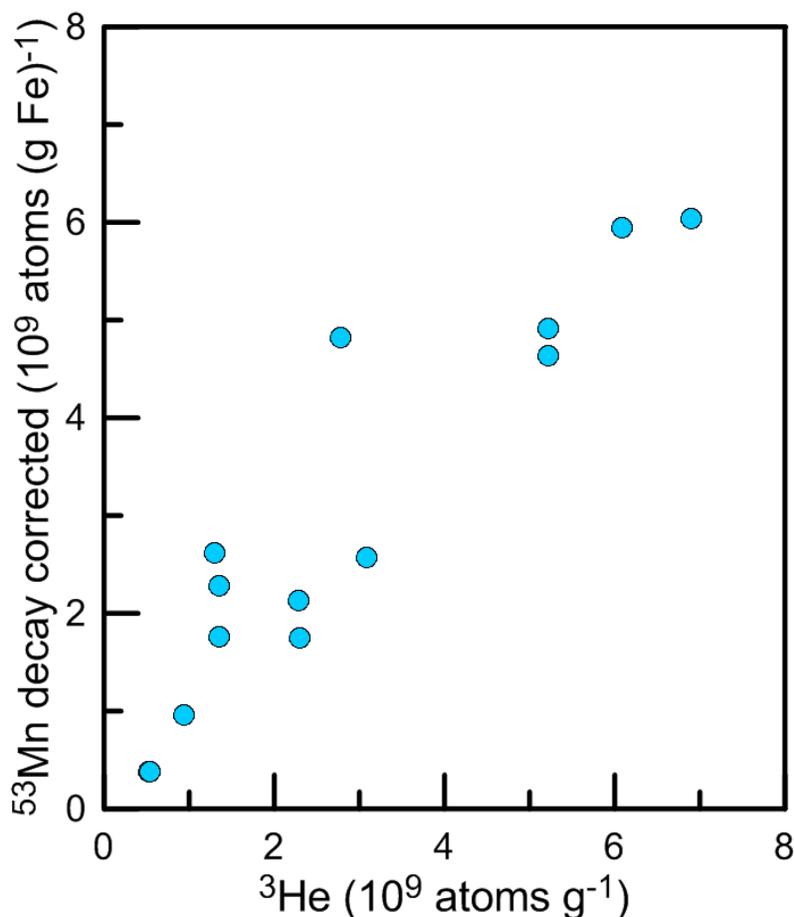


Fig. 4.25.1: Cross plot of **cosmic-ray** produced radioactive ^{53}Mn and ^3He from 13 **igneous-rock** samples collected from land surface at the Dry Valleys, Antarctica (modified from [208]). The correlation between ^{53}Mn and ^3He indicates that ^{53}Mn is produced continuously in place and has been used to monitor Earth-surface processes.

4.25.3 Manganese isotopes in medicine

^{51}Mn , ^{52}Mn and $^{52\text{m}}\text{Mn}$ (with half-lives of 46 minutes, 5.6 days, and 21 minutes, respectively) are radioactive isotopes that emit **positrons** that are used in **positron emission tomography (PET)** imaging [209, 210]. The m in the superscript of $^{52\text{m}}\text{Mn}$ indicates a **metastable** (excited state) of the **isotope**.