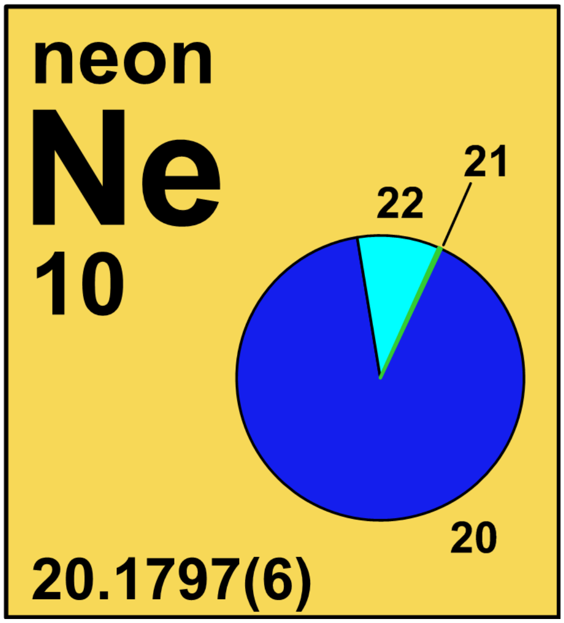
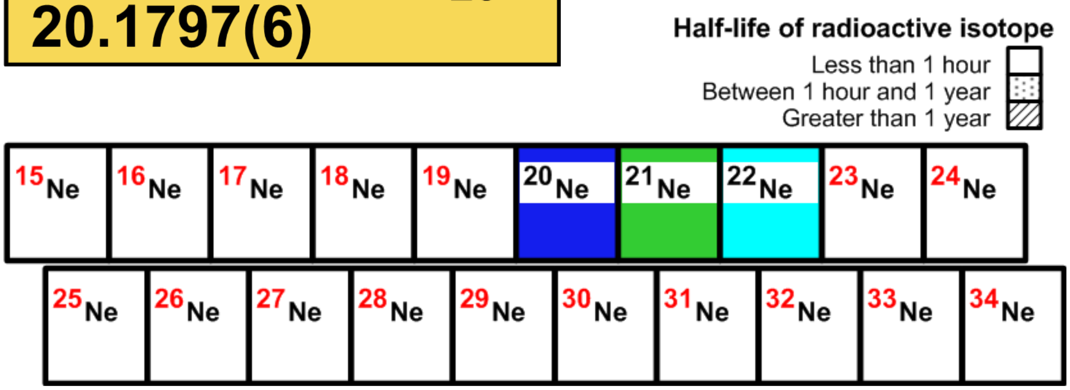
4.10 neon



Stable isotope	Relative atomic mass	Mole fraction
^{20}Ne	19.992 440 18	0.9048
^{21}Ne	20.993 8467	0.0027
^{22}Ne	21.991 3851	0.0925



4.10.1 Neon isotopes in Earth/planetary science

Neon is subject to stable **isotopic fractionation** by physical processes such as exchange between gas, liquid, and solid phases. Small variations in the **isotope-amount ratio** $n(^{22}\text{Ne})/n(^{20}\text{Ne})$ have been used to examine gas-liquid exchange processes during groundwater recharge (water moving downward from the surface) and discharge [26, 98, 99].

4.10.2 Neon isotopes in geochronology

Some ^{21}Ne and ^{22}Ne form naturally in the Earth's crust largely by reactions of ^{18}O and ^{19}F in minerals with **neutrons** and **alpha particles** emitted from uranium and thorium decay, called nucleogenic neon isotopes [26, 98]. In addition, neon **isotopes** can form at the surface of the Earth and in extraterrestrial bodies by cosmic-ray-induced **spallation** reactions on magnesium, silicon, aluminum, and sodium [100, 101]. Analyses of all three stable neon isotopes may be used to distinguish these sources from **primordial** neon. The relative amounts of atmospheric neon and crustal nucleogenic neon isotopes in deep groundwaters and natural gases have been used in studies of solid-water-gas interactions and migration (Figure 4.10.1). The **cosmogenic** component is mainly detected in ^{21}Ne and can be used to determine cosmic-ray exposure ages of rock samples, including **meteorites** exposed during travel through space and boulders exposed by melting of glacial ice (Figure 4.10.1).

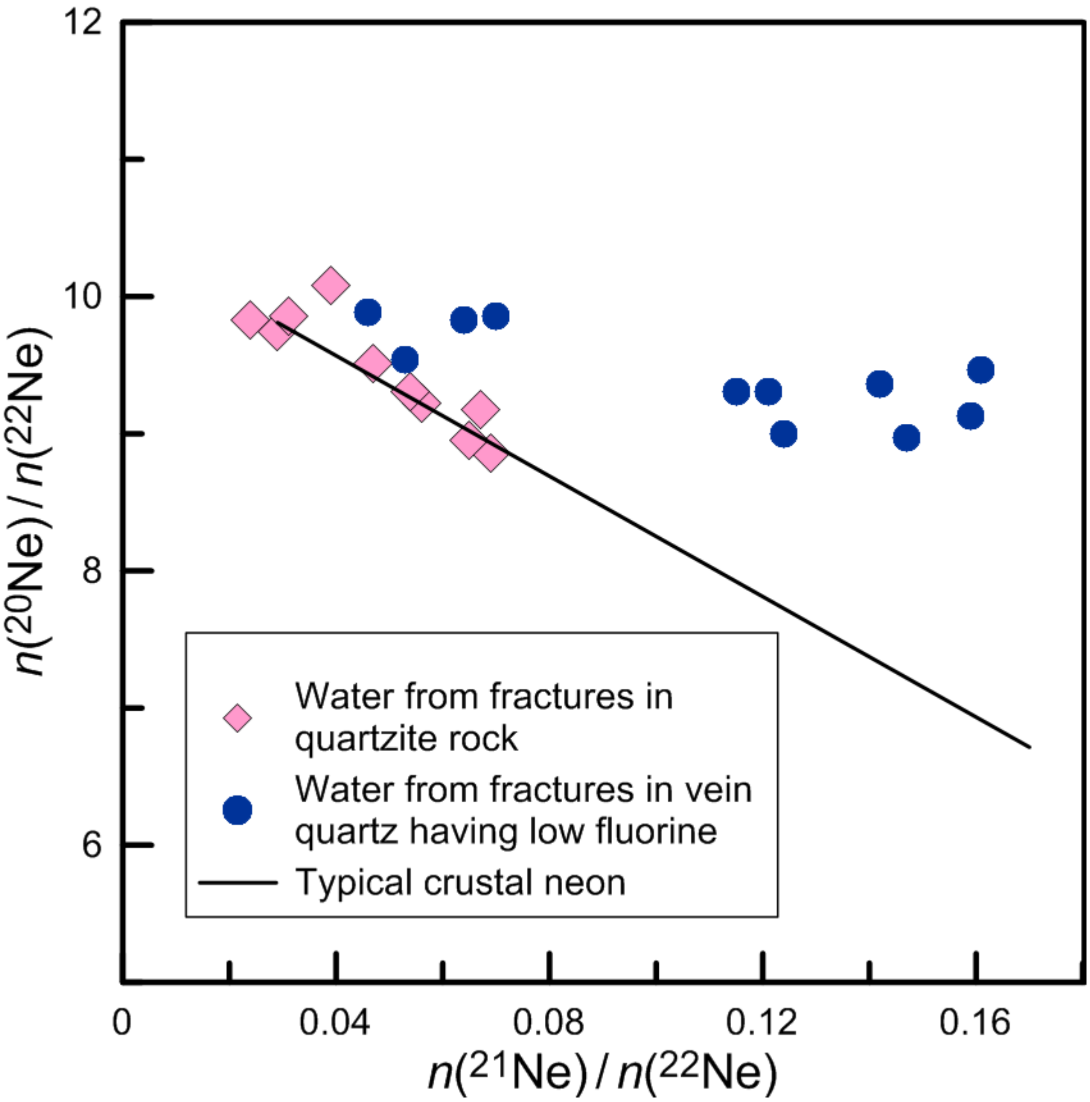


Fig. 4.10.1: Neon-**isotope ratios** of water from fractures in quartzite (open diamonds) and water from fractures in vein quartz (solid circles) from the deep gold mines of the Witwatersrand Basin, South Africa [102]. The **isotope-amount ratio** $n(^{21}\text{Ne})/n^{22}\text{Ne})$ depends upon the **mole ratio** of oxygen to fluorine in the ~40-µm reaction range of **alpha particles** from uranium and thorium. Lippmann-Pipke *et al.* [102] show that the neon end-member represents a fluorine-depleted fluid component that was trapped in fluid inclusions in vein quartz more than 2×10^9 years ago.

4.10.3 Neon isotopes in industry

Masers (Microwave Amplification by Stimulated Emission of Radiation) containing ^{20}Ne have been used to study quantum physics. ^{21}Ne may also play a role in maser studies of quantum physics [103].

4.10.4 Neon isotopes used as a source of radioactive isotope(s)

^{22}Ne is used to produce the **radioisotope** ^{22}Na via the reaction ^{22}Ne (p, n) ^{22}Na [104]. ^{20}Ne has been used to produce the radioisotope ^{18}F via the reaction ^{20}Ne (d, ^{4}He) ^{18}F [104].