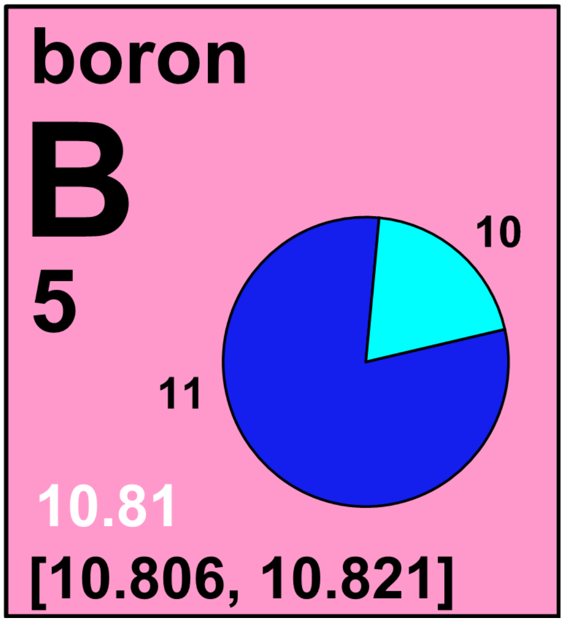
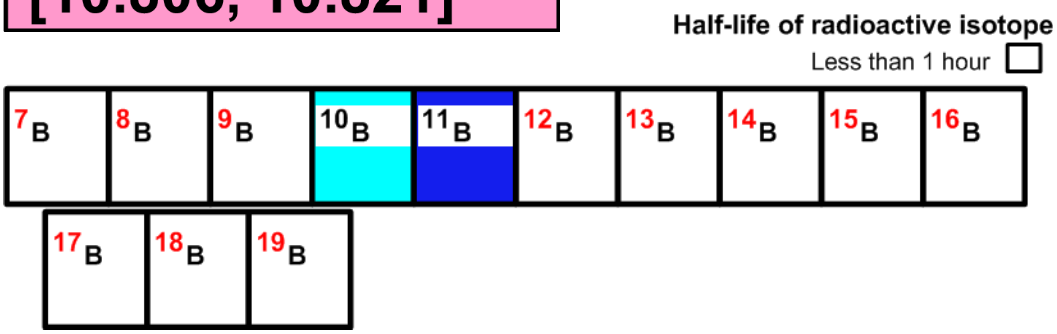
4.5 boron



Stable isotope	Relative atomic mass	Mole fraction
^{10}B	10.012 937	[0.189, 0.204]
^{11}B	11.009 305	[0.796, 0.811]



4.5.1 Boron isotopes in Earth/planetary science

Molecules, atoms, and ions of the **stable isotopes** of boron 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**. Natural terrestrial materials show a substantial variation in boron isotopic abundance (Figure 4.5.1). The relative abundances of ^{10}B and ^{11}B have been used in a variety of environmental **tracer** applications [48, 49]. The **isotope-amount ratio** $n(^{11}B)/n(^{10}B)$ of boron in a water sample depends on the source of the water and region through which the water flows, and it may also be affected by some types of contamination such as dissolved borate in domestic wastewater. Different water sources may have their own distinct boron isotopic composition, for example seawater versus continental sources (Figure 4.5.1).

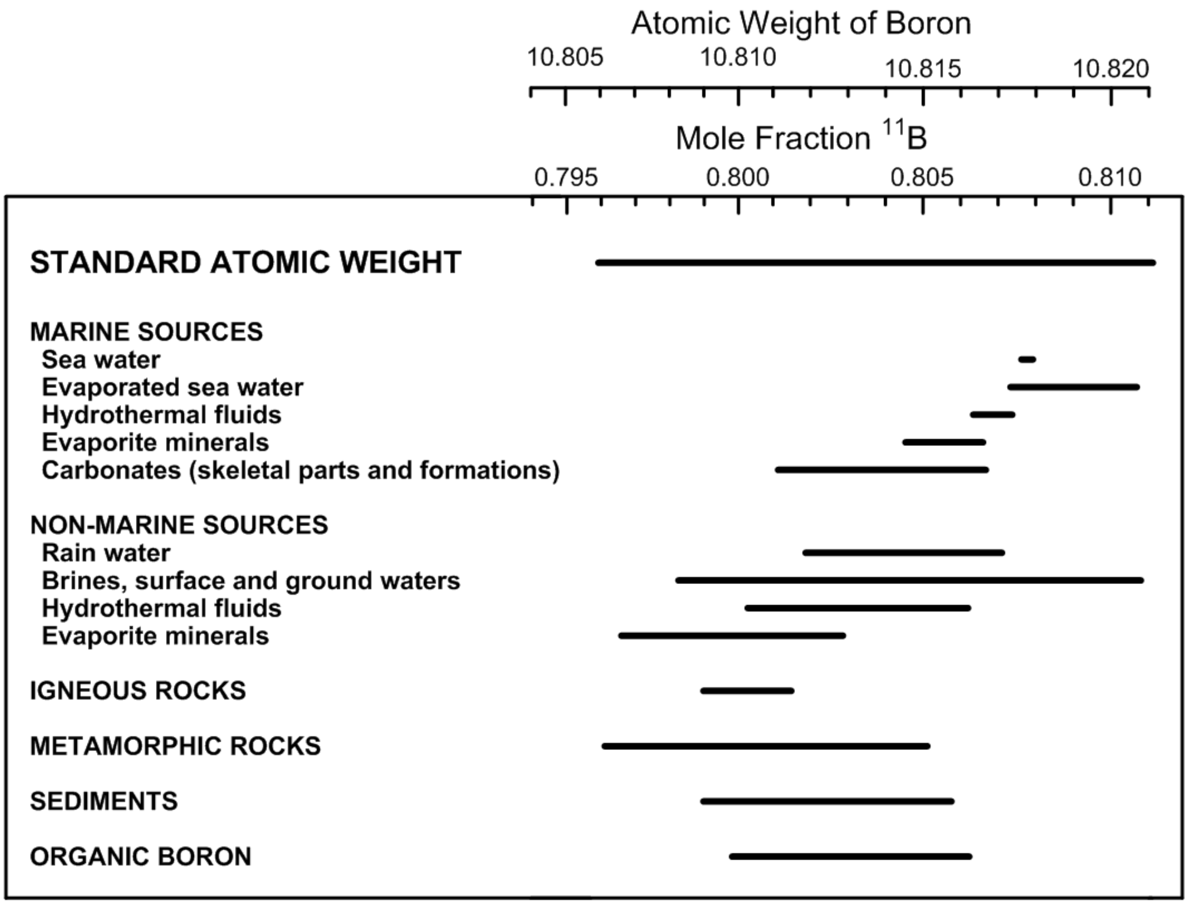


Fig. 4.5.1: Variations in **atomic weight** with **isotopic composition** of selected boron-bearing materials (modified from [10]).

4.5.2 Boron isotopes in industry

The large value of the **absorption cross section** of ^{10}B for **thermal neutrons** makes this **isotope** useful for counting **neutrons**; ^{10}B is being studied as a potential replacement for ^{3}He in radiation detectors [29, 50, 51]. The large thermal absorption cross section of ^{10}B makes the isotope useful in **control rods** (Figure 4.5.2) [52].

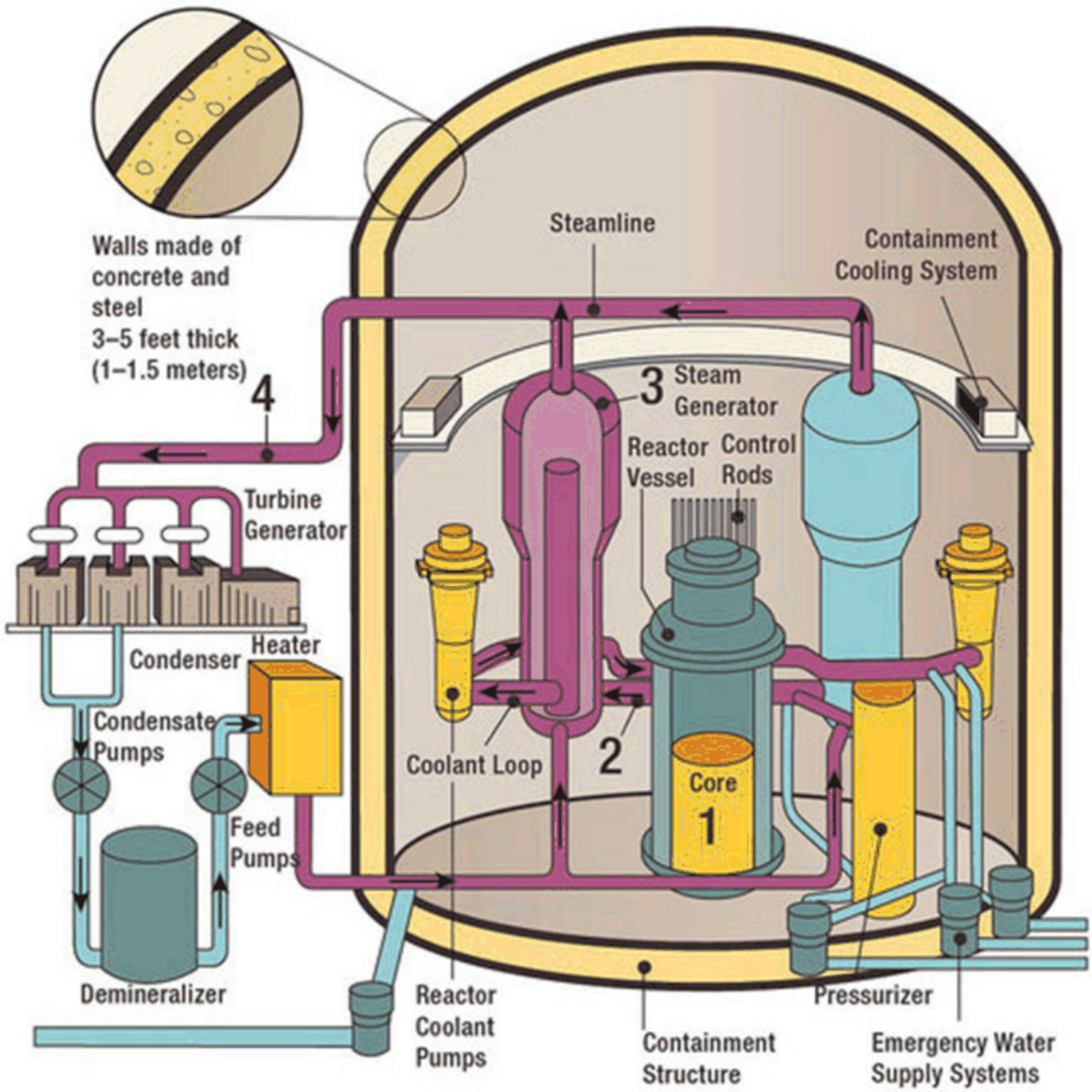


Fig. 4.5.2: Diagram of a typical pressurized water reactor, which shows where the boron **control rods** can be inserted or withdrawn from the core (1). (Diagram Source: U.S. Nuclear Regulatory Commission) [52].

4.5.3 Boron isotopes in medicine

^{10}B has a high thermal neutron absorption cross section, and it can readily absorb neutrons via the reaction $^{10}B + n \rightarrow {}^{7}Li + \alpha$. The resulting **alpha particles** from this reaction carry away relatively large kinetic energy, and they are useful for the treatment of malignant (tendency of a medical condition to become progressively worse) tumors in cancer patients [53-55].