Schweitenkirchen, May 2015

Isotope of the month – $\delta^{37/35}Cl$

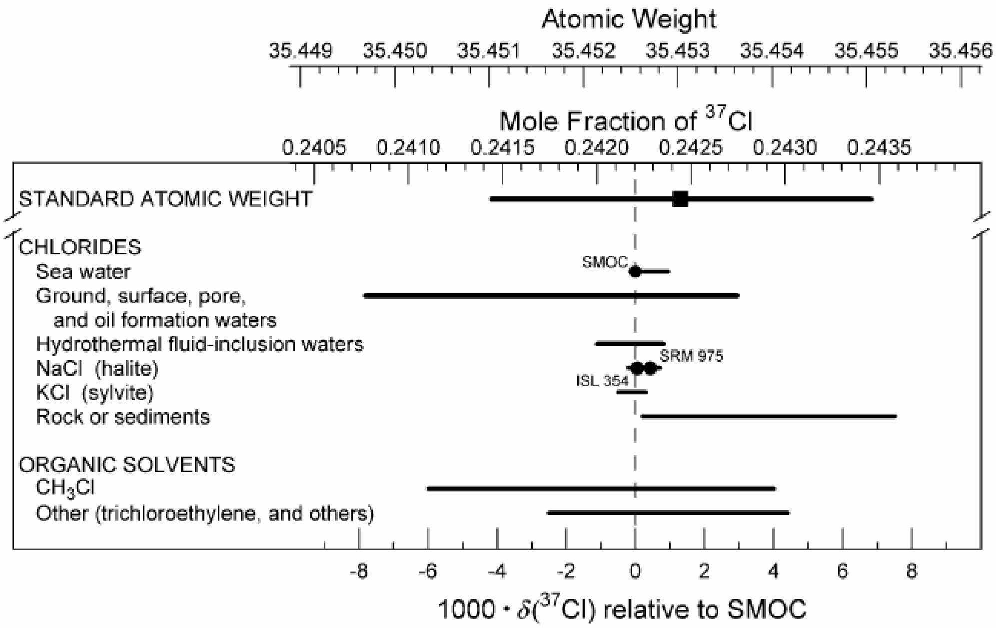
Chlorine does not naturally appear in its elementary form, but as anion Cl^- (Chloride). Chemically, chlorine belongs to the halogens. It forms, together with a kation, salts like NaCl and KCl. These deposits result from evaporation. Accordingly, chloride is found in salt deposits all over the world. The largest part of globally existing Chlorine is dissolved in ocean water (ca. 2 masspercent Chloride). Its name, originating from the greek meaning “bright green”, refers to its poisonous green coloured gas.
Chloride is a conservative ion and therefore of great interest within the field of hydrology. Its high solubility and its high distribution in the environment are further advantages when applying the $^{37/35}Cl$-method.

The element Chlorine has, beside a high number of radioactive, instable isotopes, two naturally occurring stable isotopes, ^{35}Cl and ^{37}Cl. ^{35}Cl and ^{37}Cl are abandont with a frequency of 75.8 % and 24.2 %, respectively. The generally used $\delta^{37}Cl$-term describes the ratio R between the „heavy“ ^{37}Cl and the “light” ^{35}Cl of a sample in relation to the ratio R of an international standard. For $\delta^{37}Cl$ this standard is the “standard mean ocean chloride” (SMOC) and is noted in ‰.

$$\delta^{37}Cl = [R_{Sample}/R_{SMOC} - 1] * 1000\ (‰)$$

The natural fractionation between ^{37}Cl and ^{35}Cl, based on the physically different behaviour of the isotopes, is used to retrace the **development of saline waters**. As depicted in Figure 1 the different isotopic signatures give evidence for possible **origin and genesis of dissolved Chloride** and its **transport in water**. The isotopic signature of chlorine can also be altered through **diffusion processes** within the groundwater as well as through **interaction of water and rock** under high temperatures. These variations in the natural distribution of Chloride make the $\delta^{37}Cl$-value a useful tracer in hydrologic analysis. Thereby, **flowpaths of groundwater** can be better comprehended and modelled.
In addition, the stable isotopes of Chlorine can help to evaluate the **sources and degradation of organic matter** like chlorinated hydrocarbons. Due to the different isotopic signatures of the starting material, different inputs of for example PCE and TCE can be differentiated. As the isotopic fractionation during biological degradation depends on the redox condition, the degradation of the chlorinated hydrocarbons can be classified by evaluating their $\delta^{37}Cl$-values.

For analysis of $\delta^{37}Cl$ a mass spectrometer is used.



Graph 1: Range of δ^{37}Cl-values as well as atomic weight and mole fraction of several inorganic and organic Chloride compounds (Coplen, 2002).