The triple oxygen isotope composition of the Earth and mass-dependent variations in $\Delta^{17}O$ in mantle and crustal rocks

ANDREAS PACK[1], DANIEL HERWARTZ[1,2]
AND SUKANYA SENGUPTA[1]

[1]Universität Göttingen, Geowissenschaftliches Zentrum, Abteilung Isotopengeologie, Göttingen (Germany)

[2]Universität Köln, Institut für Geologie und Mineralogie, Köln (Germany)

It is commonly assumed that the terrestrial fractionation line (TFL) passes through the origin in $\delta'^{18}O_{VSMOW}$ vs. $\delta'^{17}O_{VSMOW}$ space. Two independent studies have recently shown that this assumption is invalid and that the $\Delta^{17}O$ of the Earth mantle is negative [1,2]. Thus SMOW and the Earth mantle do not lie on a common TFL. This variation can be well explained by low- and high-T exchange between seawater and oceanic crust [1].

With our improved analytical technique, we are able to resolve ppm variations in $\Delta^{17}O$. On this small scale, the concept of a single terrestrial fractionation line (TFL) is invalid [1]. The Earth mantle is homogenous on the ppm scale and has a negative $\Delta^{17}O$. The variations we observe in $\delta^{18}O$ and $\Delta^{17}O$ of crustal rocks and minerals bear information not only about the fractionation in $\delta^{18}O$, but also about the process that caused the fractionation (kinetic vs. equilibrium). A temperature effect is resolved for equilibrium fractionation [1].

The minerals in high-T equilibrated rocks (lherzolite, granite, high-grade metamorphic qz-px-mt rock) fall on MF lines with a slope close to the high-T approximation of 0.5305. Low-T solids (cherts, sponge silica, bioapatite, altered oceanic crust) define fractionation lines with shallow slopes of ~ 0.51 – 0.52.

In a first application, the triple isotope composition of marine chemical sediments is used as a single-phase geothermometer; assuming that changes in $\delta^{18}O$ and $\Delta^{17}O$ of seawater are closely coupled. A further application is presented in [Sengupta *et al*., this conference].

[1] Pack & Herwartz (2014) *EPSL* **390**, 138-145. [2] Tanaka & Nakamura, *RCM* **27**, 285-297.