Natural Fractionation of Stable and Radiogenic Strontium Isotope Ratios - Implications for Continental Chemical Weathering and Seawater History

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The stable $^{88}Sr/^{86}Sr$-ratio has traditionally been considered to be a constant value in order to correct instrumental mass fractionation during measurement of the radiogenic strontium ratio ($^{87}Sr/^{86}Sr$). However, recent high precision measurements (Fietzke and Eisenhauer, (2006)) showed that the natural $^{88}Sr/^{86}Sr$ ratio is not stable, but rather variable and temperature dependent. Variations of the $^{88}Sr/^{86}Sr$-ratios are expressed in the usual δ-notation: $\delta^{88/86}Sr=((^{88}Sr/^{86}Sr)_{sample}/(^{88}Sr/^{86}Sr)_{NBS987}-1)*1000$, where $\delta^{88/86}Sr_{NBS987}=0$. The recent measurements also showed that the presently accepted ($^{88}Sr/^{86}Sr$)-value for seawater is off by about 0.4 ‰ from the $\delta^{88/86}Sr_{NBS987}$ value. This in turn implies that the $^{87}Sr/^{86}Sr$ isotopic ratio in seawater not corrected for natural isotope fractionation is also significantly different from its normalized value ($^{87}Sr/^{86}Sr= 0.70916$). With regard to the $\delta^{88/86}Sr_{seawater}$ value, the not normalized $^{87}Sr/^{86}Sr$ is estimated to be around 0.70930. First studies on continental rocks and minerals indicate that they are significantly lighter than seawater by about 0.3 ‰ and presumably become fractionated due to dissolution, precipitation of secondary mineral phases and biological utilization ((deSouza et al., 2007), (Halicz et al., 2007)). Together the observation of natural $^{88}Sr/^{86}Sr$ and $^{87}Sr/^{86}Sr$ fractionation has major implications on the existing models for continental weathering and the seawater history. For further studies the combination of $\delta^{88/86}Sr$ an $^{87}Sr/^{86}Sr$ data may provide a unique solution for three-component mixing processes and a way of distinguishing fractionated sources ans sinks that balance the supply of Sr to seawater. This may help to elucidate the link between continental weathering and atmospheric pCO_2 on geological time scales.

References

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