Resolving changes in silicate and carbonate weathering with radiogenic and stable Sr isotopes

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Changes in the radiogenic strontium isotope composition (^{87}Sr/^{86}Sr) of seawater over the Cenozoic (the past 65 Myr) reflect variations in both the flux and composition of weathered material from the continents (e.g. [1-3]. At the present-day the Sr in rivers reflects a balance from the weathering of carbonates and silicates, where carbonates are considered to be the dominant source (e.g. [1,2]). Nevertheless, variations in carbonate weathering are difficult to resolve because the ^{87}Sr/^{86}Sr of carbonates lies so close to that of seawater itself [4]. However, recent stable strontium isotope (^{88}Sr/^{86}Sr) data suggests that carbonate weathering yields a signal distinct from that of both silicate weathering and seawater itself [5,6]. In particular, carbonates may have similar ^{87}Sr/^{86}Sr ratios but will tend to possess light ^{88}Sr/^{86}Sr ratios. In contrast, will often silicates possess radiogenic ^{87}Sr/^{86}Sr ratios, and heavy ^{88}Sr/^{86}Sr ratios, and this difference can be used to resolve when the inputs are dominated by either silicate or carbonates. Therefore, coupled variations in radiogenic and stable Sr preserved in marine records can potentially be used to reconstruct changes in the balance of carbonate versus silicate weathering over time.

This study presents high-precision stable and radiogenic Sr isotope data (obtained using double-spike TIMs) for rivers draining both carbonate and silicate terrains, mid-ocean ridge hydrothermal fluids, and seawater from the Atlantic, Indian and Pacific Oceans. These data can be used to balance the major present-day Sr inputs to and outputs from the Oceans. Coupled marine records of both ^{87}Sr/^{86}Sr and ^{88}Sr/^{86}Sr for both glacial-interglacial and Quaternary timescales have also been obtained. These results will be discussed and used to place limits on changes in the balance of carbonate and silicate weathering on both short and long timescales.

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Partitioning and diffusion of noble gases in olivine at mantle pressures

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We have developed a new experimental method for measuring the partitioning and diffusion of noble gases in mantle minerals at high pressures and temperatures. Wafers of gem quality mineral (in this case, San Carlos olivine, 250-1000 microns thick, 3-4 mm diameter) are surrounded by diamond powder (or vitreous carbon spheres) and a layer of melt is placed at the bottom of the capsule. The capsule is graphite, surrounded by Pt. Prior to welding, 1-50 bars of noble gases are loaded and sealed into the capsule. This method has a number of desireable qualities: 1) it avoids producing melt inclusions in the olivine, 2) it yields large areas of olivine to analyze by laser-ablation and 3) it has both melt and crystals present and in contact. Due to the large size of the wafers and the lack of melt inclusions, the new noble gas partitioning data are significantly more reproducible than previous studies.

The experimental glasses and olivine wafers were analyzed by laser-ablation noble gas mass spectrometry at the Open University, UK. Both depth profiles and cross-sections were analyzed on the olivine wafers. Helium concentrations are nearly uniform across the wafers, indicating diffusive equilibrium and diffusion rates $>10^{-14}$ m^2/s.

The olivine-melt partition coefficient for He at 20 kbar and 1450°C is $5*10^{-4}$ for He, with estimated errors of 25% relative. The D^{He} value is similar to that measured at lower pressures [1, 2, 3], suggesting a minimal pressure effect on noble gas partitioning, at least in the upper mantle. The results confirm that He is more compatible than its radioactive parents U and Th during mantle melting. The experiments also contained Ne and Ar, and these data will also be presented.

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