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Linking isotope fractionation and secondary mineral formation in field and laboratory settings

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Chemical weathering mediates Earth's carbon cycle and hence global climate over geological time-scales. Ca and Mg from silicate minerals are released to the solute phase during dissolution with carbonic acid and subsequenty buried as marine carbonate. This mechanism has provided the climatic feedback that has maintained Earth's climate equable over geological history. Quantitative models of contemporary silicate weathering processes coupled to estimates of modern day carbon fluxes associated with silicate weathering are therefore fundamental to understanding Earth's carbon cycle, and the feedbacks between the carbon cycle, climate and chemical weathering. However, such quantitative models have proved elusive in part because of the many controlling parameters. Isotope ratios, both radiogenic and stable, of many different elements have provided invaluable contraints on both weathering sources and processes.

Over the last 15 years ir has become apparent that stable isotope ratios of elements such as Mg and Li may provide promise to better fingerprint the weathering reactions taking place and to provide valuable quantitative constraints. Several studies have made links between the isotope ratios sand secondary minerals such as clays. This fractionation could be related to both mineral surfaces (cation exchange processes) or structural incorporation into the clays. Here we will discuss Mg and Li isotope analyses on dissolved, exchangeable and structural Mg and Li from field settings and compare them to data on synthetic clays synthesised in a laboratory. In field settings it has been known for some time that river waters are enriched in ^{7}Li over ^{6}Li compared to the silicate rocks they drain. For Mg isotopes, there would appear to be a more significant source control than for Li isotopes with most river waters having intermediate ^{26}Mg/^{24}Mg ratios between the carbonate and silicate rocks that contribute to the solute load. However, small rivers draining only silicate rock have typically shown an enrichment in the ^{24}Mg relative to the silicate rock. Also seawater is enriched in ^{24}Mg relative to silcate rocks leading to the suggestion that ^{26}Mg is retained by secondary minerals on the continents such as clays. These field observations will be contrasted with new experimental data on clays in an attempt to better understand the controlling processes at a global scale.