Sulphur isotopes of alkaline igenous suites: new insights into magmatic fluid evolution and crustal recycling

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Some of the most important constraints on ancient subduction and crustal recycling on Earth come from studying the sulphur isotopes of ocean island basalts (OIBs). The key limitation is that the oceanic record only extends back 200 Ma and thus, OIBs cannot reveal temporal variations in crustal recycling over the vast majority of Earth history. However, alkaline magmas erupted in continental settings could solve this problem because they are commonly associated with recycled crustal sources and, crucially, are found throughout the geological record. Here we undertake a detailed study of sulphur isotopes ($\delta^{34}S$) in a Mesoproterozoic alkaline province in Greenland to evaluate whether evolved alkaline magmatic suites constrain the mantle source $\delta^{34}S$. We show that while crustal contamination and changes in oxidation state at low temperature generate large $\delta^{34}S$ fluctuations, all our samples from Greenland can be reconstructed to a mantle source with an enriched signature ($\delta^{34}S$ of +1 to +5 ‰). A comprehensive global compilation of sulphur isotopes in alkaline suites shows both positive and negative sulphur isotope signatures, akin to OIB mantle sources. Thus, alkaline magmas represent a powerful yet underutilised repository for interrogating crustal recycling and mantle evolution through geological time.