S isotopes in Archean & Proterozoic strongly peraluminous granites

C.E. BUCHOLZ[1], J.A. BIASI[1], P. BEAUDRY[2], S. ONO[2], J. LIEBMANN[3], C.J. SPENCER[4]

[1] California Institute of Technology (Caltech), USA
[2] Massachusetts Institute of Technology (MIT), USA
[3] The Insitute for Geoscience Research (TIGeR), Curtin University, Western Australia
[4] Queens University, Canada

The sulfur isotope system is a powerful tool to track incorporation of surface-derived S in magmas. In particular, observation of S mass-independent fractionation (S-MIF) in an igneous rock or mineral indicates a contribution of Archean atmospheric-derived S, which in turn can be used to trace crustal recycling throughout Earth's history. However, relatively few studies of multiple S isotopes in igneous materials exist and those focusing on Archean igneous rocks are even fewer. Further, S transfer from sedimentary rocks to melts through metamorphism & devolatilization and/or partial melting is not well understood. Here we present results from S isotope studies of Archean and Proterozoic strongly peraluminous granites (SPGs) which are predominantly (if not fully) derived from partial melting of metasedimentary rocks. We first present a study of the Archean (~2685 Ma) Ghost Lake batholith (GLB) and its host metasedimentary rocks (Ontario, Canada). The GLB comprises SPGs which are thought to represent partial melts of greywackes/mudstones similar to its host metasedimentary rocks. The metamorphic grade of the metasedimentary rocks increases from biotite-chlorite (5 km from the GLB) to sillimanite-K-feldspar (in contact with the GLB), thus providing a natural experiment to understand S mobility/transformation during metamorphism and partial melting of metasedimentary rocks. We find that pyrrhotite $\delta^{34}S$ values increase with progressive metamorphism at most 2-3‰, which can be explained through fractionation via pyrite desulfidation and loss of S from the system. Pyrite of the granites preserve $\delta^{34}S$ values similar to that of the high grade metasedimentary rocks, suggesting limited isotope fractionation during partial melting. Small (several tenths of a permil) mostly positive $\Delta^{33}S$ are observed in both the metasedimentary rocks and granites, likely reflecting the $\Delta^{33}S$ of their Archean source rocks that (1) was either originally small, or (2) homogenized and/or diluted, obscuring potentially larger original values. We explore the utility of multiple S isotopes of SPGs further using data from a globably distributed suite of Archean and Proterozoic SPGs.