Multiple sulfur isotope signatures of Archean continental crust from the Superior craton

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Multiple isotope evidence of sulfur mass independent fractionation (S-MIF) in Archean, ca. 2.5 to 4.0 Ga, rocks is primary evidence that the Earth's early atmosphere contained less than 0.001% of the present level of atmospheric oxygen [1]. However, the timing and controls on the loss of S-MIF signals during the Great Oxidation Event, ca. 2.5 to 2.3 Ga could be attributed to an anomalous sulfide reservoir (e.g., with $\Delta^{33}S$ >0.4‰) that may have taken millions of years to exhaust during weathering under an oxygenated atmosphere, or due to low oxygen levels that could maintain generation of small primary S-MIF signals[2]. Both hypotheses are subject to recent tests [3-5]. An important constraint for these tests is the multiple sulfur isotope compositions of Archean continental sulfur reservoirs, of which we measured sulfides from 19 samples from drill cores of Archean magmatic rocks of the Superior Craton, of Canada.

We report that Superior magmatic continental crust contain average sulfur contents are 341 ppm within a significant range of 0 ppm to 2263 ppm, with multiple sulfur isotope results of $\Delta^{33}S$ with an average of +0.01‰ within a range from –0.11‰ to +0.11‰, and average $\delta^{34}S$ of +2.2‰ within a range of –1.1‰ to +11.6‰. The average sulfur contents are close to those of the estimated bulk continental crust at 404 ppm [6]. The average $\Delta^{33}S$ is the expected 0‰ value for igneous materials, in comparison to Archean sedimentary rocks at the Earth surface that may sum to ~+1‰ [3]. These results demonstrate that Archean magmatic continental crust is not likely to be a source of isotopically anomalous sulfur during its weathering.

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