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Sedimentary sulfur mobilization during sill emplacement at Ellesmere Island, Canadian High Arctic Large Igneous Province

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The Canadian portion of the Cretaceous High Arctic Large Igneous Province (HALIP) contains an extensive network of sills and dikes emplaced into carbon- and sulfur-bearing mudstones (shale) of the Sverdrup Basin. These intrusions advected heat into the surrounding host rocks, leading to the release of large amounts of carbon-bearing greenhouse gases [1]. Moreover, petrological experiments have shown that entrainment of Sverdrup Basin shale xenoliths in HALIP magma could have mobilized not only carbon, but sulfur too [2]. We investigated magma-shale interaction by performing sulfur and oxygen isotope analyses on whole-rock samples collected in a traverse through and around a spectacularly exposed shale-hosted sill (the "Hare sill") at South Hare Fiord on Ellesmere Island. As the sill margins contain conspicuous sulfide, we also carried out secondary ion mass spectrometry (SIMS) $\delta^{34}S$ analysis of sulfide from the sill's contacts. The sill interior possesses relatively undisturbed magmatic whole-rock $\delta^{34}S$ and $\delta^{18}O$ values of ca. -1 and +6 ‰, respectively, in contrast to the sill margins which record perturbation of $\delta^{34}S$ and $\delta^{18}O$ values by several per mil. Contact zone sulfides have $\delta^{34}S$ values as low as -19 ‰, commensurate with negative whole-rock $\delta^{34}S$ values of the surrounding shale (as low as -37). The SIMS data thus point to sulfide in the sill as a sink for shale-derived sulfur. Our combined data provide evidence for coeval sulfur assimilation and sulfide precipitation by a HALIP sill that intersected shale host-rocks. On a basin scale, this process may have led to significant mobilization of sedimentary sulfur with implications for sulfide ore formation in shale-hosted intrusions.

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