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Impact of basaltic sills on sedimentary host rocks in the High Arctic Large Igneous Province

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The voluminous basalts of continental large igneous provinces are typically associated with abundant sill-like intrusions. In the Canadian Arctic Islands, a complex network of dykes and sills are exposed that belong to the High Arctic Large Igneous Province (HALIP). The HALIP is a Mesozoic continental basalt suite, which intruded volatile-rich sedimentary rocks of the Sverdrup Basin (shale, limestone, sandstone, and evaporite) some 130 to 120 million years ago. There is thus great potential in the HALIP to learn how volatile-rich sedimentary rocks respond to magmatic heating events during LIP emplacement. The HALIP remains, however, one of the least well studied LIPs on the planet due to its remote location, short field season, and harsh climate. In this study, we document how the thin (mostly <20m) sills of the HALIP have affected shaly host rocks (some organic-rich) on Axel Heiberg and Ellesmere Islands in the Canadian Arctic Archipelago. These magmatic intrusions can advect considerable amounts of heat into the crust, potentially generating large amounts of greenhouse gases from carbon- and sulphur-rich host rocks. We recently sampled HALIP sills and their sedimentary host rocks, including igneous and meta-sedimentary rocks for subsequent geochemical and stable isotopic analysis as well as magma-sediment interaction experiments. In general, the studied HALIP intrusive rocks are relatively evolved tholeiitic basalts. Complex mineral textures, such as internal zoning patterns and sieved zones indicate a multi-stranded plumbing system with complex replenishment-fractionation histories. Here we focus on a specific narrow sill (17m) that experienced limited extents of internal differentiation after emplacement, as shown by the near-absence of internal bulk chemical evolution. A detailed traverse of this sill revealed variable magmatic d34S and d18O values, which is evidence for incorporation of crustal material. To gain insights into the actual processes involved in crustal digestion by sills, we carried out magma-shale interaction experiments at magmatic temperature of 1250 ºC for 600 s. The experiments document break-down of shale into magma and vigorous crustal degassing. Our initial results thus provide fresh insights into the actual processes and time-scales of magma-sediment interaction, which has been hypothesised to be a key factor in modulating the environmental impact of LIPs.