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Geochemical evolution of the 2021 and 2022 Fagradalsfjall eruptions

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Understanding Moho-level magmatic processes occurring beneath volcanoes is difficult because volcanic eruptions that directly sample such deep sources are rare. The 2021 and 2022 eruptions of Fagradalsfjall volcano in SW Iceland were fed from Moho depth, providing a direct window to deep parts of the Fagradalsfjall magmatic system [1]. We sampled the eruption on a daily-to-weekly basis, generating a geochemical timeseries of the eruptive products. Data from the first 50 days of the 2021 eruption is published ([1]), and here we present additional major, trace, and radiogenic isotope data from the remainder of the 2021 eruption and from the 2022 eruption.

Analysis of the 2021 eruption products reveal dramatic geochemical changes that occur along well-defined binary mixing curves. In the first 50 days, the lava composition undergoes large changes in terms of enrichment in incompatible trace elements and radiogenic isotopes (i.e. K_2O/TiO_2 from 0.14 to 0.27, La/Sm from 1.9 to 3.1, $^{143}Nd/^{144}Nd$ from 0.513017 to 0.512949) [1]. Subsequently, smaller oscillatory changes to the lava composition continue for the duration of the eruption. However, not all chemical changes are gradual and on Day ~45, $^{143}Nd/^{144}Nd$ shifts suddenly in isotope composition and lava compositions begin falling along a new, near-parallel binary mixing trend. This combination of slow and sudden changes reveals eruption supply from a highly dynamic magma reservoir system.

The 2022 eruption lavas are compositionally indistinguishable from one another and are slightly more enriched than lavas from the 2021 eruption. They are not compositionally identical to any 2021 lava but lie along an extrapolation of the mixing curves defined by the 2021 eruption lavas. The 2022 lavas therefore are more similar to the enriched melt endmember than any 2021 lava. Given the diversity of melt compositions observed, the magma reservoir system beneath Fagradalsfjall is likely comprised of multiple, interconnected Moho-level sills. The rapid changes in erupted lava compositions are likely related to variations generated by melt transfer between sills and/or changes in supply to the eruption feeder dike.

[1]: Halldórsson et al. (2022) Nature. **609**, 529–534.