Timescales of crystal mush mobilization in the Bárðarbunga-Veiðivötn volcanic system based on olivine diffusion chronometry

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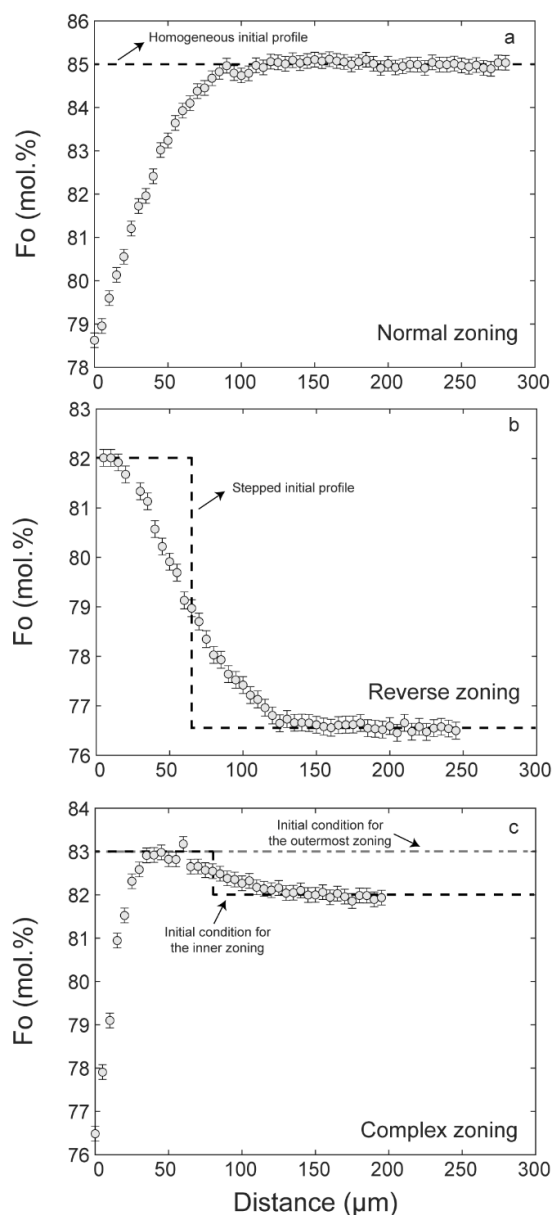
Supplementary material

Fig. S1.1. The types of olivine zoning patterns identified in the magmatic units. a) Normal zoning: the majority of olivine macrocrysts (n=82) are normally zoned, with homogeneous, high forsterite core plateaux, followed by decreasing forsterite contents towards the rim. b) Reverse zoning: only 3 olivine macrocrysts are reversely zoned with forsterite increasing from core to rim. c) Macrocrysts with complexly zoned patterns, with reversely zoned interiors followed by normally zoned outermost rims (n=15). Dotted lines indicate inferred initial profiles. Error bars indicate 2σ uncertainty.
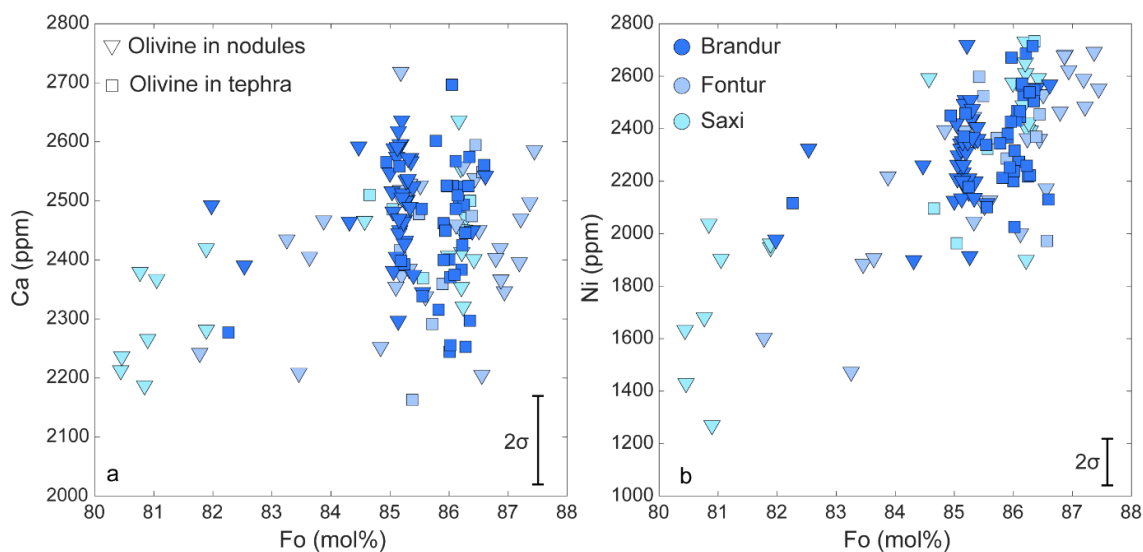
Fig. S1.2. Olivine variation diagrams showing a) Ca content and b) Ni content as a function of Fo in olivine macrocrysts from early-Holocene units only. In this figure, we distinguish between olivine crystals found in the nodules and olivine crystals found in the tephra using different symbols (inverted triangles and squares respectively). No significant differences are observed between the two groups, except that olivine macrocrysts from Brandur nodules plot at lower Fo content (Fo~85) compared to olivine macrocrysts from Brandur tephra samples (Fo~86). Analytical errors are representative of 2σ for multiple standard analyses.
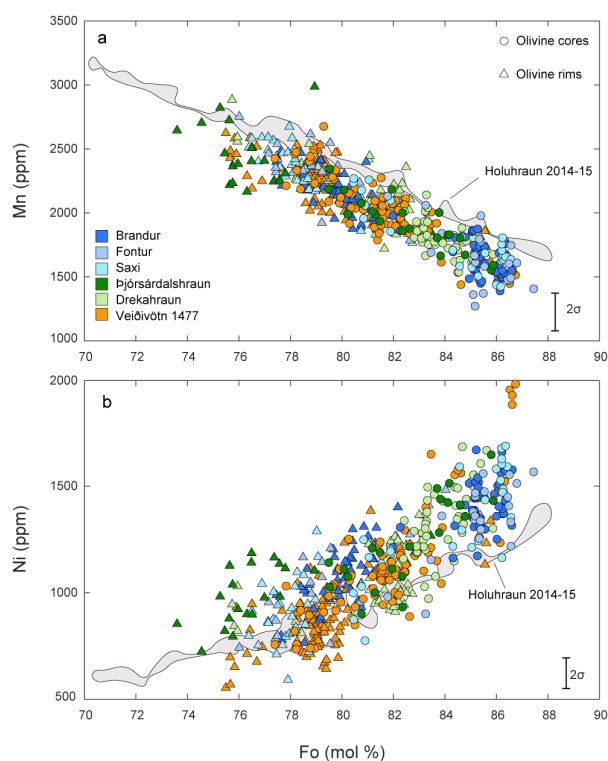
Fig. S1.3. Variation diagrams showing a) Mn content and b) Ni content as a function of Fo in olivine macrocrysts from all studied magmatic units. Circles represent olivine cores and triangles are olivine rims. High current analyses of 2014-15 Holuhraun olivines are reported for comparison (Halldórsson et al. 2018). Olivine macrocryst cores from historical units are more evolved with higher contents of Mn and lower contents of Ni compared to early-Holocene units. Analytical errors are representative of 2σ for multiple standard analyses.
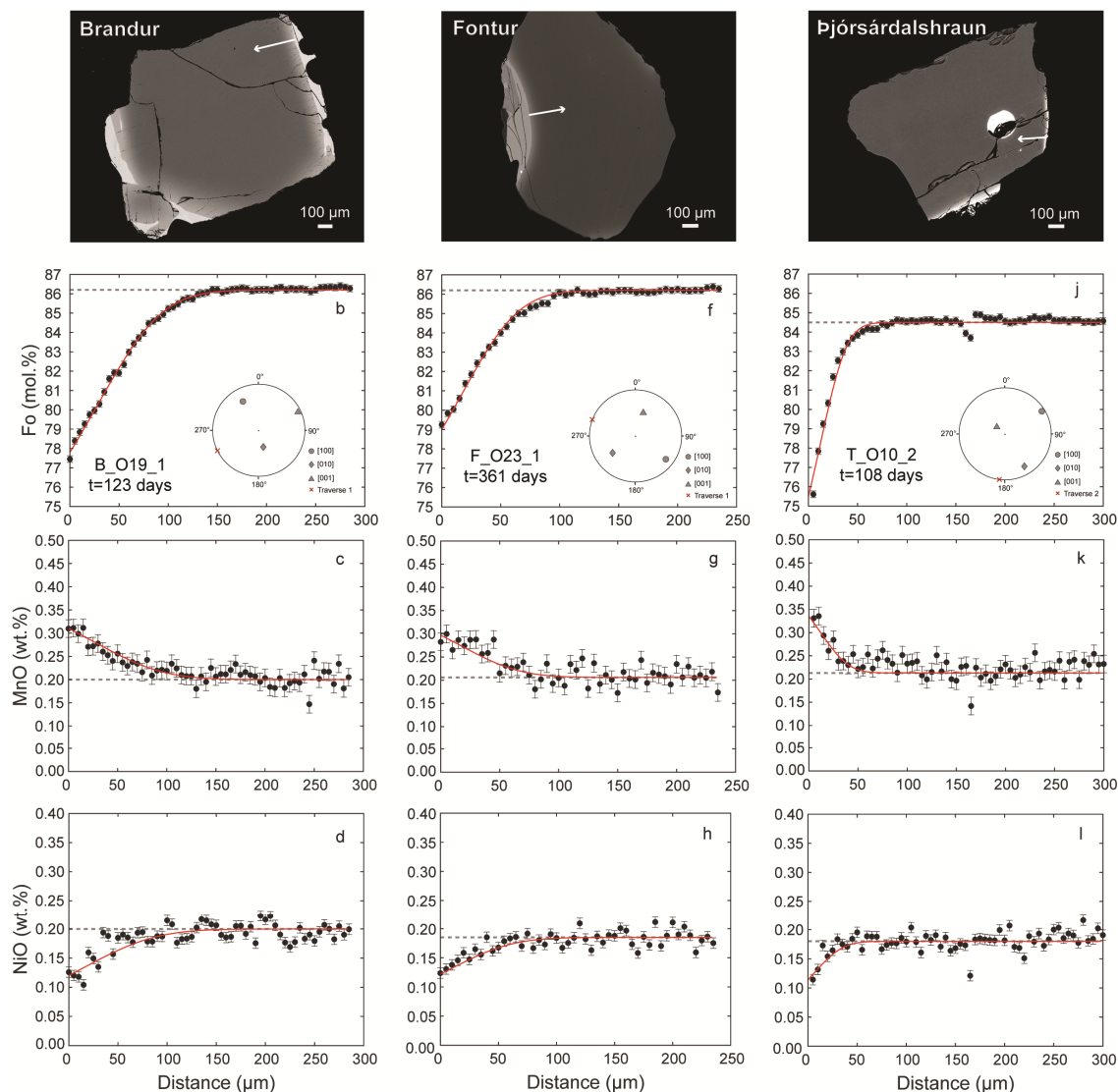
Fig. S1.4. Selected macrocrysts suitable for multi-element (Fe-Mg, Mn, Ni) diffusion modeling along the same EMP traverse (white line). a-d) Olivine macrocryst from Brandur, e-h) olivine macrocryst from Fontur, and i-l) olivine macrocryst from Þjórsárdalshraun. Red lines are best fit curves obtained for Fe-Mg, Mn and Ni using the same time steps and assuming the same initial conditions. Black dashed lines show inferred initial conditions. Analytical errors of the EMP data based on 2σ for multiple standard analyses.
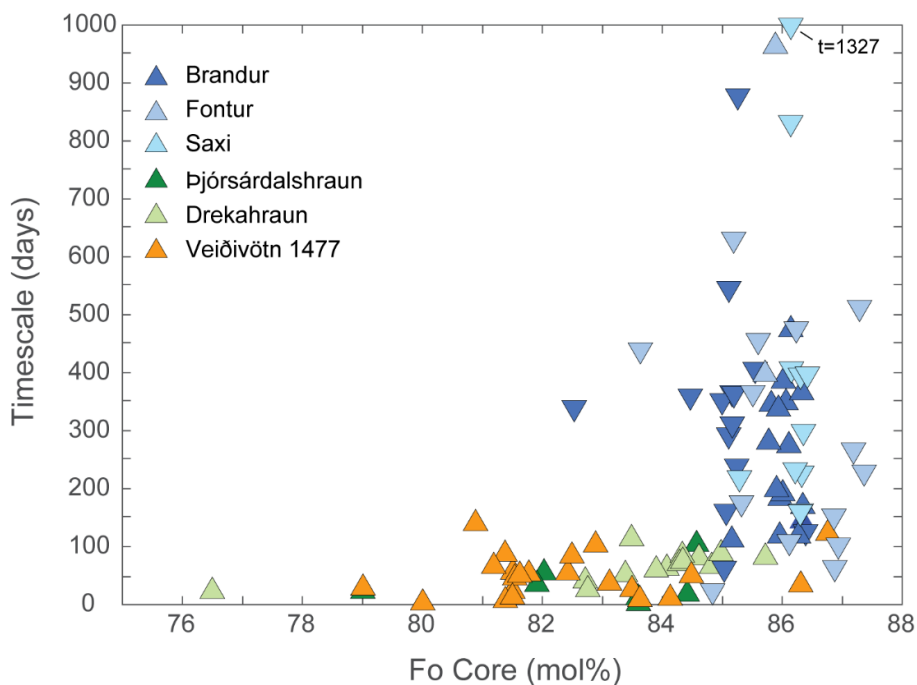
Fig. S1.5. Relationship between olivine Fo cores and calculated diffusion timescales. At any given Fo content, early-Holocene olivines register longer and more variable timescales compared to middle-Holocene and historical olivines. Furthermore, early-Holocene olivine cores are more primitive than middle-Holocene and historical olivine cores. Olivine crystals from tephra/lava and nodule samples are indicated with upwards pointing triangles and inverted triangles, respectively.