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What do silicate melt inclusions represent in the macrocrysts of the 2021 Fagradalsfjall eruption (Reykjanes Peninsula, Iceland)?

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The 2021 Fagradalsfjall eruption, lasted for six months and produced an olivine tholeiite lava with mean whole rock MgO and TiO_2 contents of 9.44 wt% and 1.05 wt%, respectively. In the first six weeks, the magma composition changed remarkably, with a factor of two increase in the K_2O/TiO_2 ratio (Halldórsson et al. 2022). Following this period and to the end of the eruption, incompatible element ratios fluctuated only slightly. The magma transported abundant silicate melt inclusion (SMI)-rich olivine, plagioclase and clinopyroxene macrocrysts to the surface. The composition of SMIs, corrected for post-entrapment processes, overlaps with groundmass glass and whole rock compositions, but covers a significantly larger range (MgO 7.6-12.3 wt%). The most primitive SMIs are trapped in primitive olivine (Fo>88) cores. Two groups can be distinguished among these; a K_2O-rich (K_2O/TiO_2 of ~0.35) and a K_2O-poor (K_2O/TiO_2 of ~0.02) group. With decreasing MgO content, the variability of incompatible element ratios in SMIs decreased, consistent with concurrent mixing and fractional crystallization (Maclennan 2008) in a near-Moho magma reservoir (0.55-0.65 GPa) (Halldórsson et al. 2022). The most primitive clinopyroxene- and plagioclase-hosted SMIs have MgO content close to 10 wt%, suggesting that these minerals start to crystallize almost simultaneously. However, whereas K_2O/TiO_2 ratios in the primitive clinopyroxene (mg#>87)-hosted SMIs are higher and more variable (0.12±0.06), plagioclase macrocrysts (with An>88) trapped primitive SMIs dominantly with low K_2O/TiO_2 (0.09±0.03). This is consistent with the results of recent phase equilibria and mixing experiments (Neave et al. 2019, 2021), showing that in the depleted (low K_2O/TiO_2), primitive melt end-member of the volcanic systems of Reykjanes Peninsula, plagioclase follows olivine on the liquidus, whereas in the enriched melt end-member (high K_2O/TiO_2) plagioclase stability is suppressed due to low Ca/Al in the melt. During mixing between the two end-member melts, An-rich plagioclase might be resorbed. Thus, the enriched melt component is less likely to be preserved in An-rich plagioclase as SMIs than in the other two primitive macrocryst phases.

References:
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