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Mantle melting processes, source characteristics and melt evolution at Jan Mayen volcano, North Atlantic, as recorded by olivine-hosted melt inclusions

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Jan Mayen, an oceanic island in the northern North Atlantic, lies on a transform fault that offsets the Mid-Atlantic Ridge north of Iceland. A suite of ankaramitic lavas from Jan Mayen was crushed to extract olivine (cores: Fo_{70-92}) phenocrysts, which were mounted and polished to reveal melt inclusions. Melt inclusions are trapped magma in their phenocryst host, protected from re-equilibration with the surrounding fractionating magma. High-Fo olivine, being an early crystallising phase, is an ideal host for preserving primitive magma compositions.

The melt inclusions are predominantly fine-grained and many show spinifex or glassy textures. Their incompatible trace element patterns analysed by EMPA and LA-ICP-MS are extremely homogeneous. Both the host rocks and melt inclusions show an identical alkaline trend on a TAS diagram and have trace element signatures consistent with being OIB magmas, confirming a mantle plume origin. Melt inclusions and bulk rocks show the same REE patterns, suggesting that the melts were derived from a homogeneous mantle source.

Modelling of REE in bulk rocks and melt inclusions using a Bulk Silicate Earth mantle composition reveals generation from a non-modal 4-5% partial melt of a mixture of spinel and garnet peridotite sources. Polybaric melting began in the garnet peridotite field (~3 GPa), i.e. at least 100 km depth, and ended in the spinel peridotite field. Comparison of melt inclusion REE and models suggest an enriched mantle composition.

Al-in-olivine thermometry was undertaken using Cr-spinel and olivine pairs from the host magmas. Preliminary results indicate that they crystallised at 1336-1157 °C, i.e., higher than those in Icelandic MORB.

Results indicate that Jan Mayen magmas originate from a hot, homogeneous, enriched mantle source. The homogeneity of their melt inclusions contrasts with the heterogeneity of similarly primitive inclusions from Iceland, suggesting a simpler mantle source for Jan Mayen.