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Peridotite-melt interactions in xenoliths from the Feuerberg volcanic complex, West Eifel, Germany.

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The Eifel region with its ~240 eruption centres is a well studied area in the western part of Germany. At a number of localities, mantle-derived xenoliths have been observed (e.g. Dreiser Weiher, Gees, Meerfelder Maar and Baarley). This study presents a suite of mantle-derived xenoliths from a lesser know locality, the Feuerberg volcanic complex. This complex is approximately in the middle of the West Eifel field, 5 km NE of Gerolstein and 4 km SW from Dreiser Weiher. No mantle-derived xenoliths have not been investigated from this locality before. The samples were collected from a single lapilli-tuff horizon located near the bottom of the exposed volcanic succession. A suite of 9 xenoliths were chosen for detailed investigation. The samples are dominantly wehrlites and were divided in 3 groups based upon mineral composition. A variety of textures are present even within a single sample, revealing a complex history involving mineral/melt interaction and/or mineral breakdown. The textures and chemistry of the minerals reveal important information regarding timing of mineral reactions and allow us to discern whether these processes happened in the mantle or during transport and emplacement.

One texture is expressed in different stages of interaction of large (1–5 mm) primary opx with a metasomatic melt. Opx-dissolution results in growth of Ca- and Ti-poor cpx and Ni-poor olivine (ol), together with small idiomorphic spinel (sp) and Si-rich (64-70 wt%) glass.

A second type of texture is locally developed in contact with opx grains. Here, a core of sieve-textured sp is surrounded by small (50–100 μm) ol and cpx grains together with bubbles caused by a volatile phase. Ol has an elevated Xfo (0.91-0.92) and is relatively rich in Ni and Ca. This secondary cpx has higher Ca than those directly associated with opx-breakdown.

An additional type of sieve-textured sp is not associated with opx, but contains biotite+cpx, without ol. In these domains, the newly formed cpx becomes increasingly enriched in Fe, Ti and Ca with increasing biotite content. Although ol doesn't occur in these clusters, the coarse ol in the peridotite matrix is particularly Mg-poor (down to Xfo=0.86), indicating a general Fe-metasomatism in the biotite-bearing samples.

Yet another texture involves clusters of intergrown cpx and ol (+minor sp and voids), with the cpx occurring in parallel prismatic crystals displaying optical continuity. The shape of these clusters suggests that they are pseudomorphs after an earlier mineral phase (maybe opx or amph). Here, ol is Mg-rich (Xfo=0.92-0.94), but has Ni contents like "normal" mantle olivine. Cpx has higher Na and Mg contents than in other textures, but low Ti. This texture is similar to that observed at Baarley by Shaw (2009).

Several other textures can be attributed to effects caused during transport to the surface. Clusters of cpx, ol, sp, and extensive glass and voids are interpreted to be due to amphibole breakdown during decompression (e.g. Shaw 2009). Cpx is not in optical continuity and has higher Al and Ti than in the other cluster texture.

Interaction with the host magma is restricted to the outer 1mm of the xenoliths. Here, primary ol is zoned with rims of Xfo ~0.86. Locally developed clusters of cpx+ol are present at the xenolith margins, but their compositions are distinct, being similar to phenocrysts in the lava.

In contrast to other Eifel localities (e.g. Dreiser Weiher, Witt-Eickschen et al. 1993) no amphibole or primary cpx was found and the occurrence of opx was limited. Our samples provide evidence for multiple types of peridotite-melt interaction under lithospheric conditions, as well as subsequent modification through changes in P and T.

References:

Shaw (2009) Lithos, 110, 215-228
Witt-Eickschen et al. (1993) J Petrol, 34, 1-22