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Timescales from mixing to eruption in alkaline volcanism in the Eifel volcanic fields obtained from sanidine and olivine diffusion modelling

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Diffusion profiles in sanidine (Ba) and olivine (Mg-Fe, Ca, Mn, and Ni) were used to track recharge events prior to the eruption of the Laacher See volcano, East Eifel volcanic field, western Germany (12.9 ka). Sanidine crystals were analyzed in samples from cumulates and mafic to intermediate phonolites. Olivine crystals occur only in the final mafic eruption products of the compositionally zoned tephra deposit and represent the hybrids of mixing between differentiated phonolite, crystal cumulates, and intruding basanitic magma at the bottom of the magma reservoir. This mixing event is likely related to the eruption triggering event. Additionally, olivine crystals from ten basanitic scoria and maar deposits in the East Eifel and two locations in the West Eifel (Pulvermaar melilith-nephelinite, Meerfelder Maar ol-nephelinite) were analyzed to represent Quaternary parent mafic magmas in Eifel volcanism.

Olivine from the mafic component that mixed with the Laacher See phonolite are always reversely zoned from cores of variable composition (Fo_{83-89}). Zoning of all crystals show trends to a common rim composition ($Fo_{87.5-89}$). Most crystals show additionally a narrow (<10 µm) normally zoned overgrowth at the outermost grain boundary ($Fo_{86.5-87.5}$). Olivine crystals from mafic cones in the East Eifel show similar zoning patterns and core compositions (Fo_{80-88}) as those from Laacher See hybrids, but their rims are more variable and always less forsteritic (Fo_{83-88}). The lack of olivine rims with >Fo_{88} indicates that East Eifel basanites are less primitive than the basanite that intruded into the Laacher See reservoir with olivine rim composition >Fo_{89}. However, olivine in samples from the West Eifel nephelinite maar deposits show rim compositions similar to the olivines from Laacher See ($Fo_{87.5-90}$), but are dominantly normal zoned and have high-Fo cores (Fo_{88-92}).

We interpret these observations to indicate that olivine crystals on Laacher See hybrids probably originate from a cumulate or crystal mush with low melt fraction that was disaggregated by the ascending basanite before hybridization. Diffusion modeling of olivine rims indicate a time scale between mixing and eruption of less than 49 days.

Diffusion times of the sanidine phenocrysts from the intermediate phonolite indicate older recharge events every 1500-3000 yrs that did not result in complete hybridization and eruption. Ba-diffusion times are much shorter for sanidines from the mafic phonolite (4-8 yrs) and the cumulates (months). The reactivation of crystals from cumulates, that can be related to the

eruption-triggering recharge event, occurred therefore only months prior to the eruption of Laacher See. These timescales between recharge and eruption are remarkably shorter than the diffusion times calculated for olivine from basanite erupted from scoria cones (up to 500 days).