First observation of nanolites and ultrananolites in alkaline volcanic glasses (Eifel, Germany)

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Nanolites are the smallest, less than <1 μm wide, crystals observed in groundmass of volcanic rocks. They are believed to be the last solid phases that crystallize from the melt during eruptions. Understanding mechanisms of nucleation and subsequent growth of nanolites could potentially provide information about the physiochemical conditions of magma just prior to eruption.

Since nanolite studies are scarce in literature and experimental observation of crystal nucleation and growth is challenging, few constraints on kinetics of nanolite crystallization are available at present. Furthermore, previous studies have investigated nanolites from exclusively calc-alkaline volcanic products. Since melt composition may have a significant effect on crystal nucleation and growth, detailed and systematic descriptions of nanolites occurring in eruptive products of different magma series are required.

The purpose of this study is to present a preliminary overview of nanolite nucleation and growth mechanisms in alkaline melts. Due to high concentrations of network modifying Na and K atoms and considerable volatile budgets, alkaline magmas have very low viscosities. As chemical diffusion is highly dependent on viscosity, nucleation and growth of nanolites in alkaline melts may be governed by different mechanisms from those observed in previous studies.

Variously differentiated samples produced by different eruption styles were collected from West and East Eifel Volcanic Fields (Germany). Samples were observed using a combination of polarized microscopy, FE-SEM and TEM.

Preliminary observation suggests that average nanolite nucleation density in mafic and ultramafic Eifel samples is noticeably higher in comparison to calc-alkaline rocks. In general, nanolites in alkaline eruptive products display a wide range of morphologies with a tendency towards acicular and dendritic habits. Examples of both homogeneous and heterogeneous nucleation were observed. The most abundant phase in the nanolite population of mafic and ultramafic samples is magnetite. The only highly differentiated sample, a phonolitic glass, contained very few nanolites.

In a recently published experimental study it was suggested that precipitation of magnetite nano-crystals may increase magma viscosity by modifying the melt composition. Considering the abundance of magnetite nanolites in Eifel scoria fragments, these magmas may have experienced a severe viscosity increase at shallow crustal levels. We suspect that the presence of extensive interconnected networks of acicular and dendritic magnetite nanolites may have mechanically impeded magma flow as well, contributing to the explosive nature of Eifel eruptions that was previously attributed to magma-water mixing.

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