Geophysical Research Abstracts
Vol. 14, EGU2012-5211, 2012
EGU General Assembly 2012

Magma ascent dynamics during highly explosive magmatic/phreatomagmatic eruptions of low-viscosity phonolitic magmas: Insights from textural studies on pumices from the 12.9 ka Laacher See eruption (Germany).

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The 12.9ka Laacher See eruption (Germany) is a unique example of a Plinian magmatic – phreatomagmatic eruption of low-viscosity phonolitic magma. In order to gain insights into the dynamics of magma vesiculation and fragmentation of phonolitic magmas during highly explosive eruptions, we study the textures of different pumice types erupted successively using an array of techniques, ranging from traditional 2D optical and scanning electron microscopy (SEM) to 3D laboratory density measurements and computerized X-ray microtomography (μCT). The use of different techniques for textural studies enables us to assess internal variability between different analysis techniques. In this study, we focus on a quantitative estimate of pumice vesicularity and vesicle size distributions, as well as qualitative studies of crystal-bubble relationships. Four different pumice types are examined: 1) aphyric white pumice, typical for the first and the start of the second Plinian phase of the eruption; 2) grey pumice erupted at the end of the second Plinian phase; 3) grey to greenish crystal-rich pumice erupted early in the final phreatomagmatic phase, and 4) cumulate pumice representing the crystal mush erupted during the final phreatomagmatic phase of the eruption. The white and grey pumice types (types 1 and 2) were both erupted during the dry magmatic Plinian phases of the eruption, and the decrease in both maximum and average vesicle size, as well as the increase in crystal content from type 1 to type 2 is related to a chemical composition zonation in the magma chamber. The change in eruptive style from a dry magmatic to a phreatomagmatic eruption does not seem to be reflected in a clear textural difference in terms of vesicle size distribution between the respective pumice types (1 and 2 vs. 3 and 4). The main difference between types 1-2 and 3-4 lies in the significantly higher phenocrysts abundance in the later, due to the fact that they have a deeper origin in the magma chamber. Especially in type 4, vesicle shape is highly irregular because of the high crystal content.