Melt Inclusion Textures and Volatile Compositions from Novarupta Dome, Katmai National Park, Alaska

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Novarupta Dome forms the extrusive portion of the 1912 eruption that produced the Valley of Ten Thousand Smokes ignmibrite, in what is now Katmai National Park. Our goal is to examine melt inclusion textures and compositions as a function of depth to constrain the cooling rate and degassing history of the upper 17 m of the 60 m thick dome. We collected samples from blocks along the perimeter of the dome, as well as at 1 m intervals over a 17 m thick vertical section within a crack face in the dome. This section provides samples ranging from almost instantaneously cooled lava at the top to slowly cooled lava in the interior.

We examined melt inclusion textures optically in both plagioclase and quartz phenocrysts from each sampled section, and compared them based upon their textures and their stratigraphic position. Three distinct textures are present: (1) clear inclusions with or without one shrinkage bubble, (2) partially crystalline melt inclusions, including those with clearly visible rod shaped microlites, and (3) rare inclusions containing a shrinkage bubble and sparsely aligned microlites. Both clear and microlite-rich melt inclusions are found throughout the dome, yet observable patterns in the relative abundance of these textures varies with stratigraphic position. Texture 3 is somewhat anomalous and has only been found in the glassy matrix areas. We are unable to explain the cause of this texture at this time. Ion probe analyses taken at Lawrence Livermore National Labratories of clear, uncracked melt inclusions from the outer glassy portion of the dome indicate that the pre-eruptive water content of the 1912 rhyolite may have contained up to 5.5 wt. % water, in agreement with previous work.

Lava blocks sampled from the perimeter contain an abundance of clear inclusions, with high volatile contents, reflecting much faster quench rates. The glassy matrix rock of the inner dome contains both clear and microlite-rich inclusions, the majority being partially crystalline and vesiculated. This trend continues through the glassy/crystalline contact to approximately 2 m below the contact. At this depth the majority of the melt inclusions are again completely crystal free. The clear inclusions in phenocrysts from the completely crystalline portion of the dome have visible cracks and capillaries indicating that decrepitation does occur much more readily in melt inclusions in slow cooling environments. This agrees with previous theoretical work. The abundance of glassy inclusions in the crystallized lava may indicate that matrix crystallization occurred in response to early water loss rather than slow cooling. However, we note that previous work on slowly cooled inclusions indicates that those retaining pre-eruptive volatiles are often crystalline, whereas the glassy inclusions are usually dry, indicating decrepitation. Water content of inclusions decrease regularly from ~5.5 wt% at the glass/crystalline boundary, to ~1wt% for the deepest samples, consistent with this possibility. Thus, future work is needed in order to conclusively address the integrity of the inclusions derived from the innermost portions of the dome.

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