Magma evolution during the latest Holocene activity at Mount Daisen volcano: A comprehensive analysis of phenocrysts.

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Physical conditions during magma storage, ascent, and eruption are reflected in the composition and textures of the erupted products. Phenocrysts in particular have the ability to preserve a detailed record of magmatic processes and physicochemical conditions that took place over time; these features include complex phenocryst zoning, resorption textures, intergrowths, and breakdown rims. This study analyzes phenocrysts from a recently discovered pyroclastic flow at Mount Daisen, named the Kirin Sawa Block and Ash flow deposit (BAF), from petrographic and geochemical perspectives to provide insights into magma evolution during the latest stage of the eruptive history of Mount Daisen.

Mount Daisen is the largest Quaternary volcano in the Southwest Japan Arc. The youngest, previously known eruptive products are dated at 20.8 ka; however, recent paleomagnetic analyses and radiocarbon dating confirmed a series of Holocene eruptions, suggesting that the youngest eruptive history is more complex than previously thought. One of these products is the Kirin Sawa BAF; this deposit contains angular blocks that are thought to be derived from dome collapse. A representative set of samples was collected, and petrographic analyses, mineral chemistry analyses of amphibole, plagioclase, biotite, and Fe-Ti oxides by EPMA, and whole-rock geochemistry by XRF were performed.

The studied lava blocks are porphyritic dacites with an adakitic trace element signature. Textural trends in the mineral phases were identified and analyzed separately. Plagioclase crystals exhibit three predominant textures: patchy zoning, sieve texture, and normal zoning; additionally, plagioclase rims exhibit higher Fe contents than the cores. Amphiboles exhibit breakdown rims, intergrowths, and strong zoning. Biotite phenocrysts exhibit oxide breakdown rims and pseudomorph replacement texture. Fe-Ti Oxides are present as uniform crystals and show exsolution textures between titano-hematite and titano-magnetite compositions. The temperature of the magma reservoir was determined using amphibole and orthopyroxene liquid geothermometers.

The disequilibrium textures collectively suggest crustal storage involving recharge, crystallization, and decompression prior to a dome-forming eruption. Destabilization of the magma chamber caused by the injection of discrete magma batches is proposed, based on the association between textural and geochemical features identified through cluster analysis of mineral phases. First, decompression with water under saturated conditions increased the melt temperature, leading to the occurrence of resorption (generating patchy and sieve textures in plagioclase crystals); evidence for heating generated by the injection can be found in the disequilibrium overgrowth preceding normal cooling zoning and in Fe-rich rims in plagioclases. We interpret the pyroclastic successions in Kirin Sawa as Block and Ash flow deposits formed during the collapse of an active lava dome in the eastern summit region of Mt. Daisen. This is shown by the presence of secondary oxides and exsolution textures in Fe-Ti oxides suggests post-emplacement oxidation compatible with dome-like cooling and degassing conditions. Our interpretation of magma storage and ascent provides a basis for assessing potential future eruptive scenarios at Mt. Daisen volcano in the event of renewed unrest.

Keywords: Phenocryst analysis, Magma evolution, Mt. Daisen, Magmatic processes