Vapor transport in shallow intruded magmas: insights from diktytaxitic texture

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Volcanic ashes from Vulcanian explosions derived from shallow-intruded magmas and dome lavas often include microporous and glass-free groundmass in which lath-shaped plagioclase microlites form angular voids. Such texture, generally described as diktytaxitic texture, is known to control the permeability of bulk rock significantly when the connected porosity of bubbles and cracks is small (Kushnir et al., 2016). How and under what conditions diktytaxitic texture is formed is, however, not precisely known. In this study we simulated the formation of diktytaxitic groundmass through a series of isobaric-isothermal (IBIT) crystallization experiments in order to clarify its formation kinetics. As a result, diktytaxitic texture was formed at 850 and 900℃ and at 10 and 20 MPa, and almost entire groundmass became diktytaxitic (i.e. glass-free) in the experiment kept at 850℃ and 20 MPa for 189 h. At 850℃ and 10 MPa for >24 h, interstitial melt completely disappeared to form the groundmass composed of feldspar microlites with angular voids. Cristobalite crystals were found in the groundmass and on the interior walls of capsules. The glass compositions form liner trends between the plagioclase microlites and the precipitated silica on the SiO_2-Al_2O_3 diagram. These observations indicate that evaporation of SiO_2-rich melt and condensation of cristobalite are the dominant process for the formation of microporous groundmass characteristic of dixtytaxitic texture. The wide range of K_2O contents in the glass can be explained as a result of vapor-phase growth of ~10 μm K-feldspar microlites in the diktytaxitic groundmass. Hence, we conclude that diktytaxitic texture is formed through (1) enrichment of silicon and potassium in the melt by microlite crystallization, (2) evaporation of SiO_2-rich constituents from the melt accompanied by breakage of Si-O covalent bond, and (3) precipitation of cristobalite and K-feldspar from vapor. The present study indicates that the late stage magma crystallization in shallow intrusions and lava domes proceeds dominantly through a vapor phase.

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