

Magma system and its eruption processes of the caldera-forming 10th century eruption of Changbaishan (Baitoushan) Volcano: Inferred from petrological and geochemical characteristics

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The 10th century eruption of Baitoushan volcano forming the summit caldera can be divided into three phases, Phase 1 to 3 in ascending order, with a short dormancy. Although previous studies have considered both Phase 2 and 3 as the 10th century eruption, pumice fall and pyroclastic flow deposits of the Phase 1 are newly recognized in the limited areas. The age of the Phase 1 might be several tens and hundreds years before the 10th century eruption, because there exists thin soil layer between Phase 1 and Phase 3. Juvenile ejecta widely ranges from comendite to shoshonite ($\text{SiO}_2=53-76$, $\text{Na}_2\text{O} + \text{K}_2\text{O}=6-13$). Major ejecta of the Phase 1 and 2 were comendite pumice, whereas those of Phase 3 were trachyte scoria. Based on the distribution of core compositions of phenocrystic minerals in a single sample, chemical trends on oxide-oxide diagrams and Nd isotope ratios, it can be concluded that five magmas were separately present before the eruption, two types of comendite magma with higher and lower Nd isotope ratio (high-Nd and low-Nd CM magmas), two types of trachyte magma with higher and lower SiO_2 content (high-Si and low-Si TR magmas) and shoshonite magmas. During the eruption of each phase, magma mingling and mixing of two or three magmas occurred. The 10th eruption began with the withdrawal from Low-Nd comendite (low-Nd CM) magma (Phase 1), and was followed by eruption from another comendite magma (high-Nd CM) after a dormancy (Phase 2). During the later of both phases, mixed magma of comendite magma (low-Nd CM in Phase 1 and high-Nd CM in Phase 2), high-Si TR and shoshonite magmas also erupted. Thus, it could be speculated that the high-Si TR magma associated with shoshonite magma had injected into each comendite magma. These two comendite magmas had been exhausted during the two eruption phases. Thus, low-Si TR magma mainly erupted in Phase 3. The magma was injected by the shoshonite magma to erupt with small amount of remnant comendite and high-TR magmas. It can be concluded that three eruption phases of the 10th eruption were related to withdrawal from isolated voluminous three magmas, two types of comendite and trachyte (low-Si) magmas, respectively. The genetic model of a large silicic magma system must explain the processes producing several distinct silicic intermediate magmas at the same time as in the case of the 10th century eruption of Baitoushan volcano.