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中国北東部・大陸内部火山におけるマグマ生成条件

Conditions of magma generation for intracontinental alkali basalt from the Longgang volcanic field, NE China

溝淵 文彦[1*], 栗谷 豪[1], 常 青[2], 木村 純一[2], 吉田 武義[1], 宮本 毅[3], 長橋 良隆[4], 谷口 宏充[3]

Fumihiko Mizobuchi[1*], Takeshi Kuritani[1], Qing Chang[2], Jun-Ichi Kimura[2], Takeyoshi Yoshida[1], Tsuyoshi Miyamoto[3], Yoshitaka Nagahashi[4], Hiromitsu Taniguchi[3]

[1]東北大学大学院理学研究科地学専攻, [2]海洋研究開発機構・地球内部変動研, [3]東北大学東北アジア研究センター, [4]福島大学

[1]Dep. Earth Sci., Tohoku Univ., [2]IFREE, JAMSTEC, [3]CNEAS, Tohoku Univ., [4]Fukushima Univ.

In northeastern China, intraplate magmatism has been active, and Cenozoic basalts are widely distributed. Beneath the area, the subducted Pacific slab is stagnant in the mantle transition zone. Previous studies have inferred that the magmatism has been caused mainly by decompression melting of the upwelling asthenospheric mantle, without significant contribution of materials derived from the stagnant slab. However, the magma generation conditions, such as temperature, pressure, degree of melting, and water content in the source mantle have not been estimated yet. In this study, therefore, these conditions were examined for primitive alkali basalt scoria samples from the Longgang area, NE China, using constraints of trace elements and multicomponent thermodynamics.

The alkali basalt samples contain spinel peridotite xenoliths, which is suggestive of rapid ascent of the magma from the upper mantle with minimal differentiation and interaction with the crust. Trace element compositions of the samples are characterized by enrichment of incompatible elements like OIB, and also by positive Ba and Pb anomalies in the trace element concentration pattern diagram. In particular, the samples have high MREE/HREE ratio, suggesting that the magmas were derived from the garnet stability field. The MREE/HREE ratios of the samples cannot be explained by melting of fertile mantle (Sun and McDonough, 1989), and they are rather explained by very low degree of melting (?1%) of the DMM-like source mantle (Salters and Stracke, 2004).

The eruption temperature of the magma has been estimated using the constraints of thermodynamic equilibria between microlites and the interstitial liquid by Mizobuchi et al. (2009, AGU). Given that the magma ascended adiabatically from the source mantle to the surface, the temperature is estimated as 1170 - 1190 degC at 80 - 120 km depths (i.e., the garnet stability field). Calculations using the Adiabat_1ph model (Smith and Asimow, 2005) show that high water content (?2000ppm) is required to induce 1%-melting of the DMM-like source mantle at this temperature condition. Instead, if the water content of the source mantle is ?100ppm (i.e., the DMM value), the degree of melting of 1% can be achieved at much higher temperatures of >1400 degC.

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中国北東部龍湾地域

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