パキスタン Muslim Bagh地域火山岩類の岩石学的・年代学的研究
Petrological and geochronological studies of the volcanic rocks in the Muslim Bagh area, Pakistan

*荒尾 眞成[1,2]、今山 武志[1]、八木 公史[3]、猪川 千晶[3]、澤田 順弘[4]、Rehanul Siddiqui[5]、Said Khan[5]
*Masanari Arao[1,2], Takeshi Imayama[1], Koshi Yagi[3], Chiaki Ikawa[3], Yoshihiro Sawada[4], Rehanul Haq Siddiqui[5], Said Rahim Khan[5]

1. 岡山理科大学　自然科学研究所、2. 岡山理科大学　生物地球学部、3. 蒜山地質年代学研究所、4. 島根大学　名誉教授、5. 地球科学研究所　パキスタン地質調査所
1. Research Institute of Natural Sciences, Okayama University of Science, 2. Faculty of Biosphere - Geosphere Science, Okayama University of Science, 3. Hiruzen Institute for Geology and Chronology, 4. Emeritus Professor of Shimane University, 5. Geoscience Laboratory, Geological Survey of Pakistan

Several type volcanic rocks occurred in the Muslim Bagh (MB) area, which were developed mainly in the Cretaceous period at a continental active margin of the northwestern India subcontinent: Bibai-basalt intruded into the sediment from the Indian subcontinent, Bagh Complex(BC) consisting of melange and basalt-chert unit, and metamorphosed basalts in the Muslim Bagh Ophiolite (MBO) sequence. However, the division among these volcanic rocks is insufficient in terms of whole rock composition, mineral composition, and mineral assemblage. Radiolarians age of the chart layer in the BC implies that tholeiitic basalt in the BC formed during late Jurassic (Sawada et al., 1995), but there are no direct geochronological data for tholeiitic basalt. In addition, hornblende K-Ar age 82-67 Ma reported from meta-dolerite and gabbro in the MBO (Sawada et al., 1995) is unclear whether formation or metamorphic ages. In this study, whole-rock composition, mineral composition, and K-Ar age were investigated to understand the origin and ages of volcanic rocks in the MB area. According to SiO_2-(Na_2O+K_2O) discrimination diagram, the Bibai-basalt and a part of BC-basalt belong to alkali rock series (Alk.), whereas the MBO basalt and the other BC-basalt belong to non-alkali rock series. The latter series were classified into tholeiitic rock series (Tho.) based on FeO*/MgO-SiO_2 diagram. The Harker diagram indicate that the Bibai and BC(Alk.) basalts were rich in Ti and Nb, whereas the BC(Tho.)-basalt was rich in Cr. Alkali series rocks include abundant alkali feldspar, in contrast to plagioclase in non-alkali series rocks. The more metamorphic grade in the MBO-basalt increases, the more anorthite content in plagioclase and Mg/(Mg+Fe^{2+})ratio in hornblende increase. The Bibai-basalt contains Ti-clinopyroxene and Ti-amphibole, and the BC-basalt includes Ca-clinopyroxene. Based on these occurrences, the volcanic rocks in this study area are divided into four types. The BC (Tho.)-basalt yielded the K-Ar feldspar ages of ca. 78 Ma and ca. 51 Ma, which is significantly younger than the late Jurassic previously considered. The former age represents the formation age, whereas the latter age from altered sample may represent the timing of accretion or an apparent age affected by argon loss. The MBO-basalt mainly yielded the K-Ar amphibole ages from 78 Ma to 71 Ma with one exceptional age of ca. 99 Ma. The ca. 78-71 Ma ages are interpreted as the formation age, because there are no clear differences between low-grade and high-grade metamorphosed samples. These ages are also similar with the U-Pb zircon age of ca. 80 Ma obtained from plagiogranite in the MBO (Kakar et al., 2012). The ca. 99 Ma age older than other samples may attribute to the influence by excess argon. The similarities in whole-rock composition and formation ages between the MBO-basalt and BC (Tho.)-basalt implies that the BC(Tho.)-basalt was originally formed with the MBO-basalt. Then, the MBO-basalt experienced the metamorphism during obduction of ophiolite, whereas the BC(Tho.)-basalt was accreted to Indian continent without the metamorphism.
Reference: Sawada et al., 1995, GSP, 12, 73-80; Kakar et al., 2012 Geology, 40, 1099-1102

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