

Volcanotectonic history of Shimabara Peninsula and the evolution of Unzen volcano in Southwest Japan

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Geologic, geochronological and geochemical studies are performed on Pliocene-Quaternary volcanic rocks in the back-arc region of SW Japan in order to verify the relationship between back-arc volcanism and regional tectonics. Shimabara Peninsula is located in the western Kyushu Island, and Pliocene-Quaternary volcanic rocks cover most of its surface. Active Unzen volcano sits in the middle of the peninsula, and is displaced by an E-W trending active Unzen graben. Volcanic products of Unzen subsided more than 1000 m beneath the sea level inside the graben. Two drillings at the northeastern and eastern flank of Unzen volcano and associated field research have revealed the detailed volcanic history in the Shimabara Peninsula. Even though the oldest volcanic rocks are ca. 4 Ma, volcanism widely occurred in the whole peninsula between 2.5 Ma and 0.5 Ma. Monogenetic volcanoes of olivine basalt and pyroxene andesite are major components. Major element chemical variations of pre-Unzen basalts and andesites are on a simple fractional crystallization trend with relatively constant trace element ratios (e.g. Zr/Y, Ba/Sr). At 0.5 Ma, monogenetic volcanism stopped and Unzen volcano started to grow in the central part of the peninsula. Formation of Unzen graben became significant after the birth of Unzen volcano. Except for the earliest eruptives, all Unzen products are hornblende andesites and dacites, and are characterized by abundant large phenocrysts of plagioclase and hornblende. Major and trace element variations are on a straight mixing line between basaltic and rhyolitic endmembers. Unzen volcanics thus have higher incompatible element contents but lower FeO^*/MgO ratios than pre-Unzen volcanics at given SiO_2 contents. Unzen volcanics also have higher Ba/Sr and Zr/Y ratios indicating the contamination of crustal materials. Younger Unzen particularly those with higher MgO, have lower Ba/Sr and Zr/Y ratios than older Unzen products suggesting more input of mantle-derived components. Spidergram of pre-Unzen basalts suggests that these basalts have similar geochemical characteristic with surrounding basalts in NW Kyushu but with a little Ta depletion. Sr and Pb isotopic ratios of Unzen and Pre-Unzen volcanics are offset from Quaternary volcanic rocks along the volcanic front of the Ryukyu Arc, but within the range of the Miocene-Quaternary alkalic basalts in NE Kyushu. They are on the mixing line between EM2 and N-MORB mantle components. Sr and Pb isotopic ratios of Unzen andesites are within the range of those of Pre-Unzen volcanics suggesting that all volcanics in Shimabara Peninsula have the common source materials. Upwelling asthenospheric mantle materials, chemically common in western Kyushu, have been heat and material source for volcanic rocks in Shimabara Peninsula in the past 2 million years. Crustal thinning and the consequent mantle uplift are synchronous with the graben formation becoming active after the birth of Unzen volcano, and this may have urged the magma formation and ascent to be centralized in the middle of the Unzen graben at 0.5 Ma. A steady-state magma chamber was formed to mix mafic and felsic magmas, and then have fed mixed magma to the surface and have formed the composite Unzen volcano.