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Petrology of Uracas and Anatahan volcanoes in the Northern Mariana Islands

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About 500 km-long volcanic arc, developed in front of the Mariana Back-Arc Basin, starts at Uracas (Farallon de Pajaros) in the northernmost land volcano and ends at Anatahan in the southernmost land volcano. The recent GPS study (Tabei et al., 2008) showed that the back-arc basin has opened like in the fun-shape with the pivot at N of Uracas, and the spreading rate is largest around Anatahan. Felsic volcanic rocks are only exposed in Anathan. Wade et al. (2005) suggested that the felsic rocks were products not by crustal melting/assimilation but by fractional crystallization, and that contribution of the pelagic sediments in the source mantle was highest in Anatahan. In this study, we compared chemically the Uracas and Anatahan volcanic rocks in order to check whether the different tectonic situation would influence the chemical behavior of magma or not.

Though Uracas is the most active volcano, the geological and petrological study hardly has been carried out due to its ill access condition. Uracas is basaltic to the andesite volcanic island of 2 km across and 360 m high, standing from 800 m below the sea surface. According to the detail sea beam map of MARGIN, the present form of Uracas has developed on the slope of the submarine height extending from NE to S of the island; a part of this old stratovolcano is exposed in the southern coast. Reflecting this, steep cliffs appear along the west coast and gentle slopes develop in the east and southern sectors. Collapsing occurs in the NNE direction from the summit, where the coastline is strongly retreated, when compared with the chart in 1940s. Eruptions with the magnitude as much as VEI 2 have occurred 16 times since the 19-th century, most of which issued lava flow from the summit and slopes being associated with the Strombolian explosions. Anatahan is volcanic islands of 9 km long in EW, 4 km wide in NS, and 788 m high. The most of central part is occupied by a caldera elongated in EW. The geological study was carried out by Lowland et al. (2005) and the eruption products in 2003 were investigated, for example, by Nakada et al. (2005). In this study, we used the samples taken from Uracas in 2008 and from Anatahan during 2003-2009. The Uracas volcanic rocks contain abundant phenocrysts and the SiO_2contents are in the range of 53-60 %. The old volcanic rocks are more abundant in phenocrysts and have the calc-alkaline affinity. The Anatahan volcanic rocks range from 49 to 66 % in SiO_2, showing slightly different trends for basaltic and other intermediate rocks. The intermediate rocks of Anatahan are enriched in TiO_2, Na_2O and K_2O in the SiO_2variation diagrams. However, it can be considered that magmas of the both volcanoes were originated from the similar source mantle, because of identical ratios of incompatible elements (Ze, K, Rb etc). In the Sr/Ca-Ba/Ca and Pearce diagrams, the two volcanoes show slightly different differentiation trends. It is likely that the degrees of melting in the source mantle were similar for the two volcanoes, though the fractional crystallization with higher plagioclase/clinopyroxene had operated in the Uracas magma.

In spite of a little different tectonic setting between the two volcanoes, the degrees of melting and the chemistries of the source mantles were similar, though a different mode of fractional crystallization seems to have generated different ranges in differentiation and chemical trends.

Keywords: petrology, island arc, Mariana