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The Geochemical and Tectonic Origin of Island Arcs Associated with the Caribbean Oceanic Plateau

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The Southern Caribbean margin bears close resemblance to a granite-greenstone belt, where an island arc-related sequence is found is close association with tonalitic batholiths and oceanic plateau fragments (which include outcrops of high-MgO rocks). Despite their close temporal association with the plateau, the origin of the arc sequence remains enigmatic and resolution of this problem could have important implications for the interpretation of granite-greenstone belts in the geological record and hence the formation and subsequent modification of continental crust. The Upper Cretaceous Caribbean oceanic plateau is generally believed to have formed as part of the Farallon plate, possibly representing the initial burst of plume magmatism from the Galápagos hotspot (e.g. Duncan & Hargraves, 1984). Whilst the majority of the plateau is not exposed, a series of fragments have been uplifted and obducted onto the margins of the South (and North) American plate. The Netherlands Antilles, in particular the islands of Curaçao and Aruba, represent fragments of mafic oceanic plateau crust that have been accreted to South America as the plateau was transported eastwards relative to the Americas along the southern Caribbean strike-slip plate boundary zone (Kerr et al., 1997). Upper Cretaceous rocks of island arc affinity are also associated with the margins of the plateau, and have been uplifted and accreted. On Aruba, a tonalitic batholith intrudes the plateau sequence no more than 3-9 m.y. after plateau formation (White et al., 1999), and an Upper Cretaceous island arc sequence is also found on the adjacent island of Bonaire. Despite their close temporal association, however, the relationship between the island arc rocks and the plateau is poorly known, and the aim of this study is to elucidate the nature of the association by concentrating on the island of Bonaire in the Netherlands Antilles. Cretaceous rocks of island arc affinity outcrop as two separate inliers on Bonaire (Klaver, 1987). The Northern Complex consists of a bimodal association of lavas, mafic and silicic intrusives and volcaniclastics, and field relations suggest a distal intra-oceanic island arc environment. The Southern Complex, however, is dominated by pillow basalts and rhyodacitic volcaniclastic sediments, which are intercalated on a scale of several metres, along with exogenous rhyodacite domes. The relationship between the two inliers is unclear, but the volcano-sedimentary environment of the two inliers is identical. Compositionally, the Northern Complex resembles a typical arc sequence, displaying a moderate negative Nb anomaly, low Ni (typically <25 ppm) and high levels of LILEs, along with a negative Sr anomaly. Primordial mantle normalised La/Nb ratios are consistently greater than 1.1. On a plot of Nb/Y against Zr/Y the mafic rocks plot sub-parallel to, but outside of, the Iceland neovolcanic array, in the MORB field. The Complex shows flat REE plots, typically enriched to ca. 30 times chondrite, with a slight relative enrichment in light REE (La/Yb ratios ~1.5-2.5). The bulk of the Northern Complex shows evidence for being comagmatic, with the more felsic rocks being related to the more mafic ones through fractionation processes. A series of intrusive dolerites found in the upper parts of the Northern Complex, however, is geochemically unrelated to the other dolerites, displaying lower levels of most immobile elements and a contrasting positive Sr anomaly. The Southern Complex is distinctly different in character: the rhyodacite domes form a discrete group characterised by no discernible Nb anomaly, generally higher trace element abundances (especially La, Ce, Nd, Zr), La/Yb ratios of >3 and produce separate trends on Harker diagrams, suggesting that an origin in a conventional island arc setting may not be the most appropriate interpretation. Some rhyodacite flows found within the Southern Complex, however, are identical in geochemical character to those of the Northern Complex. The relationship between the two Complexes and the origin of the arc-related sequence is so far unresolved. The highly evolved nature of the lithologies and partial alteration means that the interpretation of elemental data is not straightforward. The use of radiogenic isotopes (Sr, Pb, Nd and Hf), therefore, will be useful for distinguishing between various models for their origin and relating the Cretaceous volcanic sequence on Bonaire to the Caribbean plateau and neighbouring tonalitic batholiths.

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