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New geochemical and geochronological constraints on the Cretaceous volcanism from northeastern Cuba

C. Marchesi (1,2), D. Bosch (3), C.J. Garrido (1), J.A. Proenza (4), F. Gervilla (1,2), P. Monié (5), A. Rodríguez-Vega (6)

(1) Departamento de Mineralogía y Petrología, Universidad de Granada, Spain, (2) Instituto Andaluz de Ciencias de la Tierra, CSIC-Universidad de Granada, Spain, (3) Laboratoire de Tectonophysique, Institute des Sciences de la Terre de l'Environnement et de l'Espace de Montpellier, Université Montpellier II, France, (4) Departament de Cristal lografia, Mineralogia i Dipòsits Minerals, Universitat de Barcelona, Spain, (5) Laboratoire de Dynamique de la Lithosphère, Institute des Sciences de la Terre de l'Environnement et de l'Espace de Montpellier, Université Montpellier II, France, (6) Departamento de Geología, Instituto Superior Minero Metalúrgico de Moa, Cuba

In order to better understand the complex geodynamic evolution of the Caribbean realm, it is important to investigate the origin and temporal evolution of the Cretaceous volcanic activity occurring in the Greater Antilles, particularly in NE Cuba. Volcanic formations in this area are poorly mapped and lack a detailed geochemical characterization allowing their correlation with other Caribbean igneous suites. Here we report whole rock major and trace element compositions, as well as Sr, Nd and Pb radiogenic isotope ratios and geochronological data in a comprehensive sampling of volcanic rocks from this area. According to their geochemical signature, we have classified NE Cuba volcanic formations into three groups: (1) Island arc volcanics (Fm. Téneme and Fm. Quibiján) mainly constituted by basalts, basaltic andesites and andesites, with a subgroup of boninitic affinity (whole rock TiO2 $<$ 0.5 wt% and MgO $>$ 8 wt%) in Téneme volcanics. The chondrite-normalized REE patterns of these rocks are slightly enriched in LREE and flat to slightly depleted for MREE and HREE. They exhibit high Th/Nb (average value: 0.76) and La/Nb (average value: 5.97) ratios typical of arc lavas, and low LREE/Yb (e.g. La/Yb $<$ 5) and Th/Hf ($<$ 0.7) ratios as characteristic of Cretaceous IAT lavas in the Caribbean region. The Pb, Nd and Sr isotope compositions of these volcanics overlap those reported for rocks from various island arcs worldwide. Téneme volcanics are cut by small bodies of quarz-diorite intrusive

that were probably emplaced during the final stages of arc magmatism. Ar-Ar dating of hornblende separate from one of these bodies indicates an age of 89.7 (more or less 0.5) Ma that can be assumed as the minimum crystallization age of Téneme volcanics. (2) Back-arc basin subvolcanic rocks from Loma de la Bandera, Guamuta and Cerrajón areas. They are constituted by basalt and basaltic andesite dykes that intrude into mantle peridotites of the Mayarí-Baracoa ophiolitic belt. These rocks define a tholeiitic trend in terms of major elements (increasing FeOt with decreasing Mg#), and their chondrite-normalized REE patterns are LREE-depleted to relatively flat and overlap those commonly reported for the tholeiitic arc volcanics in the Caribbean realm. They exhibit Th/Nb (average value: 0.24) and La/Nb (average value: 3.36) ratios intermediate between MORB and typical arc volcanic values. The Pb, Nd and Sr isotope signature of these lavas is quite variable ranging from typical MORB values to more radiogenic compositions characteristic of arc volcanics, thus implying variable contribution of the slab to the mantle source. Ar-Ar dating of hornblende separate from one of these dykes indicates an age of 88.6 (more or less 3.5) Ma. (3) MOR-like tholeiitic basalts from Morel, La Melba and Centeno areas with REE patterns and low Th/Nb (average value: 0.06) and La/Nb (average value: 1.38) ratios typical of N-MORB. The Pb, Nd and Sr isotopic ratios of these volcanics coincide with those reported for N-MORB and they show variable influence of seawater alteration. Our results indicate that Cretaceous volcanics in northeastern Cuba record different igneous styles nowadays juxtaposed with complex field relations. Group 1 represents island arc volcanism at forearc or axial arc setting. On the other hand, we interpret Group 2 volcanics as back-arc tholeiites formed in the Late Cretaceous at an original setting relatively close to arc. Finally, Group 3 volcanics may have originated at spreading centre located either in a back-arc oceanic basin or in a mid-ocean setting.