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CENOZOIC VOLCANISM WITHIN THE NICARAGUAN GEOTRAVERSE

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Central America is an active continental margin, where subduction of the Cocos plate below the Caribbean plate has generated a segmented volcanic front. Nicaragua is the symmetry centrum of this front with regard to several features. For example, here the crustal thickness and SiO_2 content of the erupting basic lavas are at a minimum and the dip of the subducting oceanic slab is at a maximum (CARR, 1984). The Nicaraguan part of the volcanic front consists of two segments (QNW and QSE; Fig. 1), which are situated in a large tectonic depression and offset by a north-south line of basaltic cinder cones in the Managua area (MAN). The stratovolcanoes composing the segments contain a high proportion of basalts and basaltic andesites whereas rhyolitic rocks are scarce.

Compared to the Recent volcanic rocks (CARR et al., 1990, and references therein) very little has been published about the broad belt of Tertiary volcanics which covers most of Nicaragua. Following McBIRNEY & WILLIAMS (1965) the volcanic pile east of the Nicaraguan Depression (Fig. 1) is divided into two major units: the Oligocene - Miocene Matagalpa Group and the Upper Miocene - Pliocene Coyol Group. The former is dominated by intermediate to acid pyroclastic rocks, whereas the Coyol Group is characterized by basic lavas and dacitic to andesitic ignimbrites. The samples from these units (CC, JUI, MAT and BON; Fig. 1) are treated together here, because the basic lavas of both units have similar geochemistry (NYSTRÖM et al., 1988). Basic lavas and dacitic ignimbrites coeval with the lower part of the Coyol Group also occur west of the Nicaraguan Depression (the Tamarindo Formation; LEO in Fig. 1). Late Tertiary basaltic sequences outcrop both on and off the atlantic coast (BLU and CRN, respectively), but the stratigraphic correlation with central Nicaragua is not known in any detail.

This study is based on 123 samples of Tertiary-Recent volcanic rocks, the majority being basalts to andesites. All of them have been analyzed for mayor elements and Ba, Co, Cr, Cu, Nb, Ni, Rb, Sr, V and Zr, and many for REE, Y, Hf, Ta, Th, U and Au. The Sr, Nd, Pb and O isotope compositions were determined for 14 basic lavas representative of the different units in the geotraverse. The basic lavas are porphyritic, containing phenocrysts of olivine, augite, bronzite-hypersthene, highly calcic plagioclase with complex zoning, and titanomagnetite (intermediate plagioclase and ilmenite in CRN).

The lavas belong to the calc-alkaline series, although many samples are transitional to tholeiites. A tholeiitic affinity is shown by the following groups (in decreasing order): LEO, MAN, QNW, CC and JUI. The CRN basalts display a within-plate chemical signature, but all the other analyzed lavas have similar subduction-related trace element patterns. They are enriched

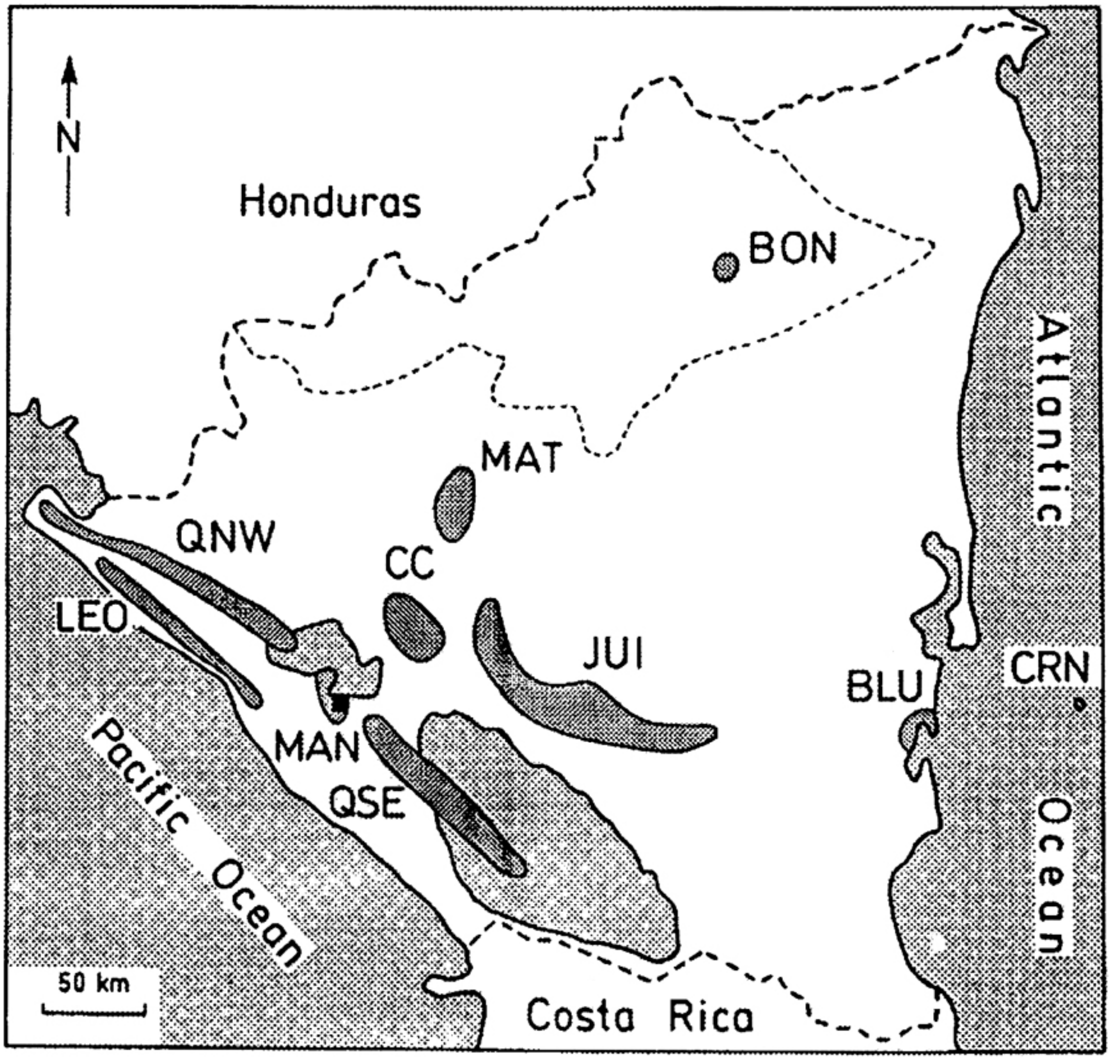

Fig. 1: Location of sample groups: QNW and QSE = two segments of the volcanic front in Nicaragua (the volcanoes occur in a partly lake-filled graben = the Nicaraguan Depression); MAN = cinder cones in the Managua area; the other groups are Tertiary, named after the area where they were sampled (LEOn, Cuesta Coyol, MATagalpa, JUIgalpa, BONanza, BLUefields and CORN island). The dotted line in northern Nicaragua marks the southern boundary of outcropping Paleozoic schists and Mesozoic sedimentary rocks.

in incompatible elements of low ionic potential (K, Rb, Sr and Ba) and have low contents of elements of high ionic potential (e.g. Nb, Zr, Ti and Y) compared to N-type MORB. Chemically, they resemble lavas from an oceanic island arc setting rather than an active continental margin. Island arc basalts generally have high Ba/La ratios, and many of our samples are remarkably high in this respect. The Nicaraguan rocks have a Ta/Yb ratio in the oceanic range, and most of them have a slightly negative Ce anomaly and show significant Eu anomaly. Such REE features seem to be common in oceanic arc lavas.

The samples define three populations in a Sr-Nd isotope diagram (Fig. 2): the Quaternary lavas, BON and all the remaining Tertiary lavas. The latter plot like oceanic island arc basalts, and their Sr-Nd compositions are inconsistent with

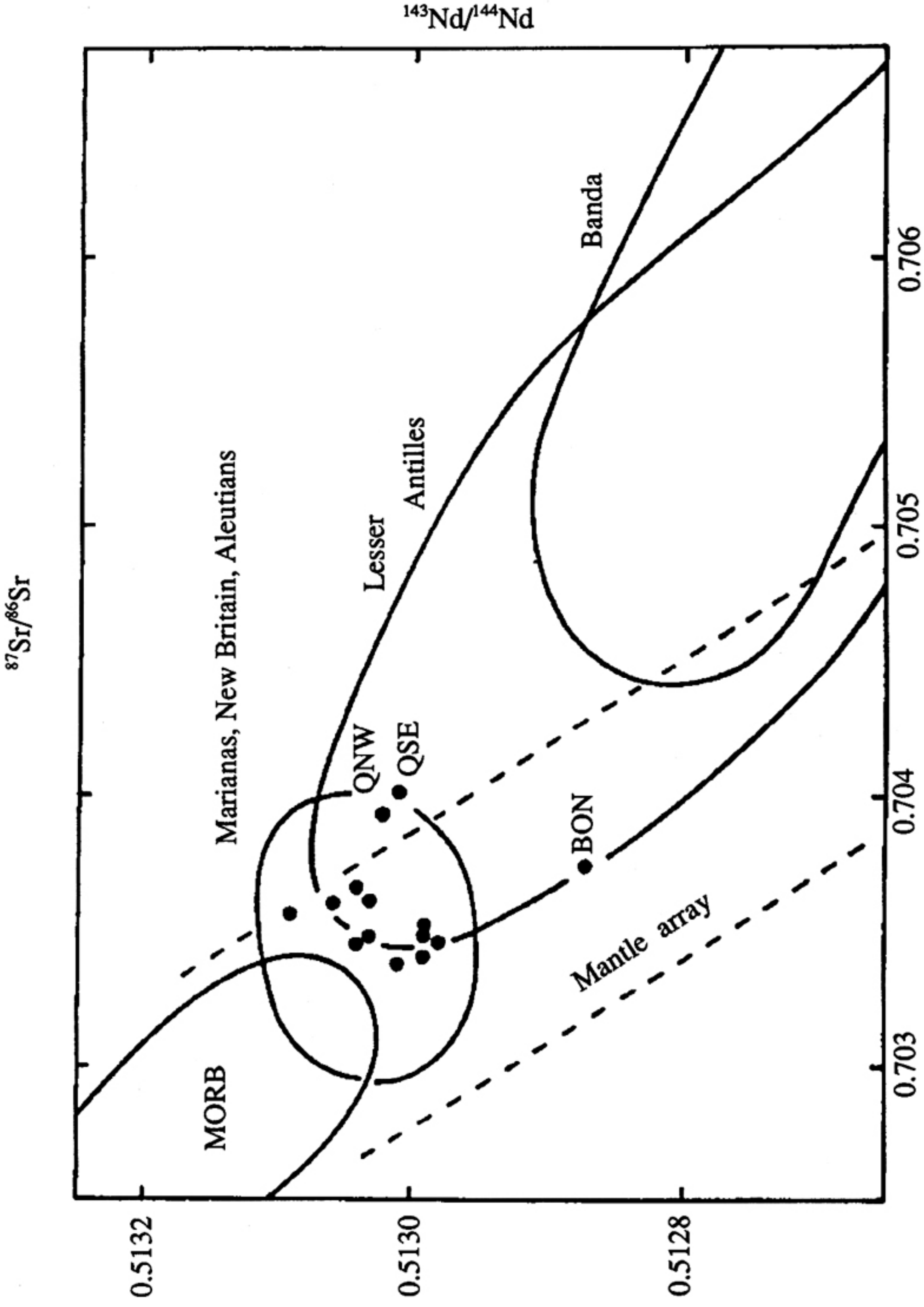

Fig. 2: Variation of $^{143}Nd/^{144}Nd$ versus $^{87}Sr/^{86}Sr$ for basalts from Nicaragua compared to MORB and island arc basalts (fields after ARCULUS & POWELL, 1986) The data for the Tertiary samples are corrected, assuming an age of 15 Ma.

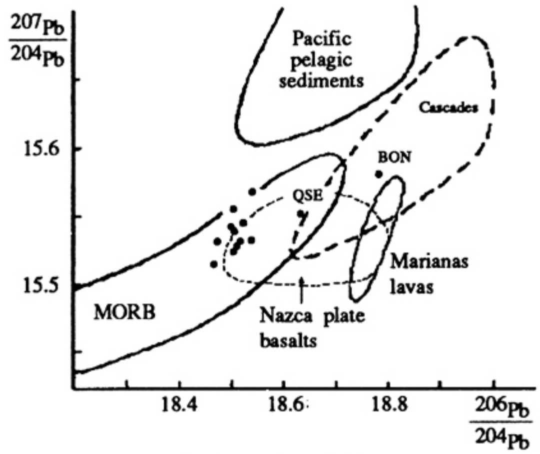

Fig. 3: Variation of ^{207}Pb vs. $^{206}Pb/^{204}Pb$ for basalts from Nicaragua (CRN not analyzed) compared to oceanic lavas, pelagic sediments, and an active continental margin (the Cascades, after Church, 1976' the other fields after Hole et al., 1984).

contamination by sialic crust during the petrogenesis. BON appears to have been influenced by crustal material during its formation, and a slight crustal influence cannot be ruled out for the Quaternary lavas. The $\partial^{18}O$ values of the Nicaraguan rocks (x = 5.3 ±0,5 $^{o}/oo$; 1σ) overlap and are somewhat lower than the MORB range, and coincide with the values for tholeiitic oceanic-island lavas (cf. KYSER, 1986). There are no substancial $\partial^{18}O$ enrichments such as might indicate a significant crustal contribution to the lavas.

According to the Pb isotope data most samples are quite primitive, plotting within and at the upper limit of the MORB field in a $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$ diagram (Fig. 3). A trend of steeply rising $^{207}Pb/^{204}Pb$ values with increasing $^{206}Pb/^{204}Pb$ for all the samples except BON and QSE might reflect assimilation of subducted pelagic sediments. This is supported by the selective enrichment in Ba compared to other incompatible elements in most Nicaraguan lavas, and consistent with the Sr-Nd-Pb isotope data and negative Ce anomaly of many samples. In fact, MORRIS & TERA (1989) presented strong evidence for involvement of pelagic sediments in the petrogenesis of Recent lavas from northwestern Nicaragua (see also CARR et al., 1990). According to them the $^{10}Be/^{9}Be$ ratio, considered as a measure of subducted oceanic sediments during the formation of young arc magmas, is extremely high here.

Chemically, the Recent basalts are less primitive than most of the Tertiary lavas. This is consistent with the idea that the development from an oceanic island arc to an active continental margin has only started in Nicaragua. QSE is also less primitive than QNW; a possible explanation is assimilation of sialic sediments at depth in the southeastern part of the Nicaraguan Depression. The Pb signature of BON (Fig. 3) suggests crustal contamination (cf. SUNDBLAD et al., 1991), in good agreement with the relatively high K and Rb contents of the BON lavas and their occurrence in an area with outcropping Paleozoic schists and Mesozoic sedimentary rocks. These older rocks belong to the Chortis Block, whose southward extension is unknown. Some geologists draw a boundary similar to that in figure 1, whereas others consider the Hess Escarpment at the border with Costa Rica to be the boundary. Our study indicates that the Chortis Block must end north of a line connecting QNW, CC, JUI and BLU in figure 1.

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