MAGMA GENESIS AND EVOLUTION OF CENOZOIC VOLCANIC ROCKS IN THE NORTHERN ANDES OF SOUTHERN COLOMBIA IN THE LIGHT OF REE AND ISOTOPIC DATA

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Résumé

Cenozoic volcanic rocks of southern Colombia form three petrographic groups. Group I consists of a typical calc-alkaline rock suite and is formed by wet partial melting of the oceanic crust, minor contamination by upper crustal material and crystallization differentiation. Group II (alkalirhyolitic volcanics) shows additionally a distinct plagioclase-dominant fractional crystallization. Group III (nephelinites-basalts) is the product of partial melting of the upper mantle in different depths.

Key Words: Northern Andes, Cenozoic volcanism, REE data, isotopic data, magma genesis.

Introduction

In spite of the wide range of Cenozoic volcanic rocks in the southern Colombian landscape, petrographical and geochemical papers (e.g. Kroonenberg et al. 1982, 1987; Murcia & Marin 1980; Murcia & Pichler 1987; Schmitt 1983), especially with REE and/or isotopic data (James 1982; Marriner & Millward 1984; Schmitt-Riegraf & Pichler 1989), are very rare. For the discussion of the magma genesis and evolution of these different rock groups, new REE and isotope analyses were made and combined with data from literature.

Geological setting

The rock samples were collected by the author, by H. Pichler, R. Kilian and S. Kroonenberg during several field trips which were partially supported by the Deutsche Forschungsgemeinschaft (DFG).
The samples are located in southern Colombia between 0°50'N - 2°46'N and 77°53'W - 76°13'W. The lavas and pyroclastic rocks of the three groups belong to the volcanoes Chiles, Nevado de Cumbal, Azufral de Túquerres, Sotará, Puracé, Coconucos, Pan de Azúcar, Doña Juana and the "ignimbrite area" in the East of Popayan.

Petrography

The lavas of the first group are quartz-andesites to dacites. The pyroclastic rocks and obsidians of the second group are all of alkalirhyolitic composition with "anorthoclase-phenocrysts". The lavas of the third group are mainly olivine-basalts, basanites and nephelinites.

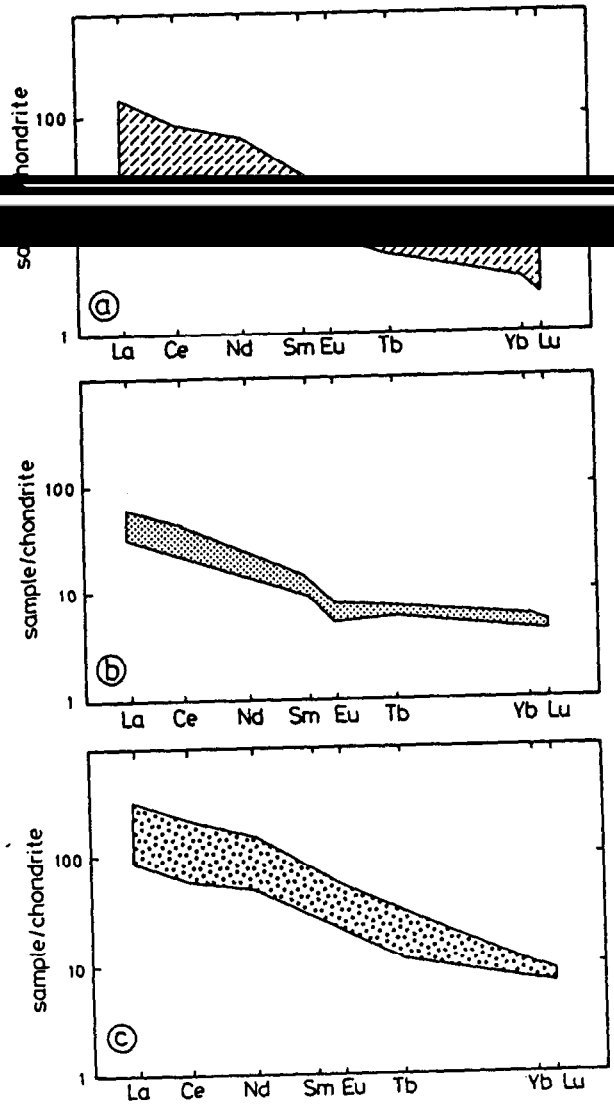

Fig. 1: Chondrite normalized REE patterns: (a) samples of group I, (b) samples of group II, (c) samples of group III.

Rare earth element geochemistry

Neutron activation analysis has been applied to the samples investigated (table 1). With this procedure a part of the REE cannot be traced. All patterns in chondrite normalized diagrams (Fig. 1) indicate a larger enrichment in light REEs and a lower enrichment in heavy REEs. The alkaline suite of group III (Fig. 1c) shows the highest enrichment whereas the alkalirhyolites (Fig. 1b) of the second group show the smallest enrichment compared with ordinary chondrites.

	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu
Group I	24.2	46.1	36.3	4.3	1.22	0.51	1.83	0.38
Group II	20.1	38.6	30.6	2.7	0.55	0.34	1.30	0.32
Group III	78.3	158.9	70.4	12.2	3.46	1.32	1.88	0.26

Table 1: Average REE composition of the volcanic rock groups (own data).

Isotopic geochemistry

Isotopic data are a very helpful hint for the discussion of magma genesis. Nethertheless very rare isotopic data of the Cenozoic volcanic rocks of southern Colombia are available (e. g. James 1982, Marriner & Millward 1984). These data are combined with own $^{87}Rb/^{86}Sr$, $^{87}Sr/^{86}Sr$, $^{147}Sm/^{144}Nd$ and $^{143}Nd/^{144}Nd$ analyses in table 2.

	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd$
Group I	0.036-0.295	0.7043-0.7046	0.1221	0.51257
Group II	1.768-2.665	0.7044-0.7047	0.097-0.105	0.5127-0.5129
Group III	0.126	0.7044	--	--

Table 2: Variation of radiogenic isotope composition in the different Cenozoic volcanic rock groups (own data (analyst: U. Kramm) and data from literature).

Conclusions

The melts of the southern Colombian volcanics originated from two different sources, induced by the subduction of the Nazca Plate below the South American continent.
Group I was formed by wet partial melting of the oceanic crust. A process of "magma mixing" and/or a more or less intensive upper crustal contamination followed. Finally, a plagioclase- and/or pyroxene-dominant fractional crystallization occurred (group II). Regarding the REE- and isotopic data, a partial anatexis of sialic continental crust with normal isotopic data can be excluded. Either no anatexis of sialic material took place, or the continental crust below Colombia has unusually low $^{87}Sr/^{86}Sr$ ratios. Therefore also rocks from the basement should be analysed the next time.
Group III originated from partial melting of the upper mantle in different depths, as can be

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