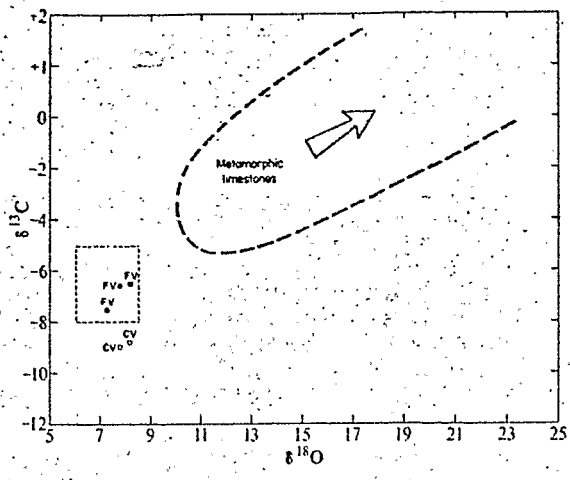

Fig. 1 Plot of $\delta^{18}O$ and $\delta^{13}C$ results of Canary and Cape Verde Islands. The δ is defined by $\left(\frac{R-R_{stand}}{R_{stand}}\right)\times 1{,}000$. The quadrangle is that defined by Taylor *et al.*[6]. *FV*, Fuerteventura (Canary Islands); *CV*, Cape Verde Islands.

After chemical separation of rubidium, strontium isotopic ratios were measured by means of single Ta filament, solid source mass spectrometry. During this study we measured the E and A strontium carbonate standard at various times and obtained an average value for the $^{87}Sr/^{86}Sr$ ratio of 0.7082± 0.0002 normalized to $^{86}Sr/^{88}Sr=0.1194$. Our technique for measuring $^{86}Sr/^{88}Sr$ rare earth element (REE) abundances by isotope dilution and mass spectrometry has been described in detail[4]; it is a modification of the method developed by Schnetzler *et al.*[5].

The plot of ^{18}O against ^{13}C shows that our measurements for the carbonatites of Fuerteventura are within the limits set by Taylor *et al.*[6] for carbonatites (Fig. 1), whereas our measurements for the Cape Verde Islands carbonatites are

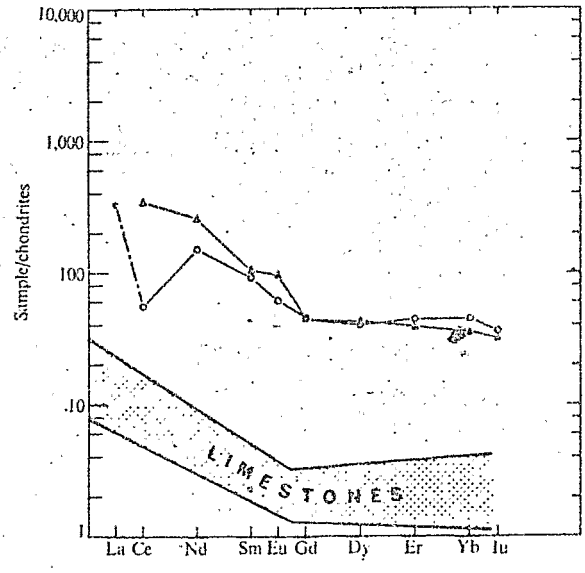

Fig. 2 Semi-log plot of rare earth abundances (normalized to chondrite abundances) against atomic number. ▲, Cape Verde sample (P50); ○, Canary Islands sample (P62). The region marked Limestones contains sedimentary, metamorphic and hydrothermal limestones. The data for this part of the graph are from ref. 8.

Evidence for the Occurrence of Carbonatites on the Cape Verde and Canary Islands

THE distinction between hydrothermal carbonate-rich rocks and carbonatites is frequently difficult and the occurrence of carbonatites on the Cape Verde and Canary Islands[1,2] has therefore been a controversial matter. Moreover, the geological setting of these deposits, an oceanic environment and the absence of a ring structure, is anomalous for carbonatite rocks. We have developed criteria by which we may distinguish carbonatites from hydrothermal limestones from studies of several European and African carbonatite complexes (refs. 3 and 4, and M. J., F. P. and C. J. A., to be published). In this communication we shall use these criteria to identify some carbonate-rich rocks in the Cape Verde and Canary Islands as carbonatites.

Carbon and oxygen isotopic ratios were measured mass spectrometrically. The standard techniques have been described previously[3]. We present our results in terms of $\delta^{13}C$ and $\delta^{18}O$ with respectively SNOW and PDB as reference standards. Our probable error is about 0.1δ.

just outside these limits. We have also measured ^{18}O and ^{13}C for a few hydrothermal limestones from the Canary Islands, but these values are quite different from the carbonatite values and fall in the normal range for hydrothermal limestones. The $^{87}Sr/^{86}Sr$ ratios for the carbonatites from Fuerteventura and the Canary Islands are close to 0.703, which is similar to the $^{87}Sr/^{86}Sr$ ratio of volcanic rocks with a deep-seated origin. These observations eliminate a remobilized young limestone origin for the carbonatites. The total strontium concentration in our carbonate samples from the Cape Verde and Canary Islands, determined by atomic absorption, is very high (13,000 p.p.m. in one sample); this could be anticipated for carbonatites. In Fig. 2 we give the REE abundances in the carbonatites of these islands and our results show clearly that these carbonatites are genuine (M. Loubet, C. J. A., M. B., and M. J., to be published).

The modern geochemical techniques we have used in this study confirm the early assertions made by Spanish and Portuguese geologists[1,2] about the presence of carbonatites on these islands. Recent compilations of data on carbonatites[7,8] indicate that the typical geological settings for carbonatite deposits are fracture or rift zones in old shield areas. The oceanic occurrence may be interpreted in two ways; either carbonatites can be generated in an oceanic environment as a by-product of oceanic volcanism or they were a pre-drift Mid-Atlantic rift product and were intruded when these islands were still pieces of the continental crust[1].

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