and MARID xenoliths suggest that the latter are either fragments or cumulates from, compared to a kimberlite, a very distinct non-oxidized magma type. Differences in minor elements in most minerals, as well as modal constituents, may reflect that the studied dikes represent a slightly more evolved composition than that from which MARID xenoliths are either fragments or cumulates. K-feldspar in the groundmass is the main difference between MARID nodules and the West Greenland lamproites.

L. M. Larsen reviewed the manuscript.

References

Bak, J., Sørensen, K., Grocott., Korstgård, J.A., Nash, D., & Watterson, J., 1975: Nature 254, 566-9.

Charles, R.W., 1975: Am. Mineral 60, 367-374.

Dawson, J.B., & Smith, J.V., 1977: Geochim, Cosmochim. Acta 41, 309-23.

Edgar, A.D., Green, D.H., & Hibberson, W.O., 1976: J. Petrol. 17, 309-56.

Ernst, W.G., 1968: Amphiboles. Crystal chemistry, phase relations and occurrence. Springer-Verlag, Berlin.

Larsen, L.M., 1980: Rapp. Grønland Geol. Unders. 100, 65-9.

Prider, R.T., 1939: Mineral Mag. 25, 373-387.

Vartiainen, H., Kresten, P. & Kafkas, Y.: Bull Geol. Soc. Finland 50, 59-68.

Scott, B.H., 1979: Proceedings of the Second International Kimberlite Conference, vol. 1, 190-215.

Scott, B.H., 1981: Meddr. Grønland Geoscience 4, 24 pp.

H4 TRIASSIC POTASSIUM-RICH BASALTS AND COEXISTING CARBONATE MELTS IN THE ECRINS-PELVOUX AREA, FRENCH ALPS.

Georges BUFFET and Nicole VATIN-PERIGNON
USMG 1, Institut Dolomieu, LA 69 CNRS, Rue Maurice Gignoux, F-38031 - GRENOBLE Cedex.

Throughout the Ecrins-Pelvoux area, an explosive and effusive volcanism is essentially represented by series of sheets with a consistent stratigraphic position. Upper triassic to lower Jurassic sedimentary rocks interlayered with the volcanic sequence suggest a rifted passive continental margin. The pre-rift sedimentary sequence (argillites, black shales and dolomitic limestones) represents a upward transition from supratidal to intertidal deposits (Baron, 1981).

Numerous doleritic dikes up to several meters in thickness injected into the metamorphic basement (partly Hercynian in age) are the feeders of the overlying volcanic sequence. The mineralogical relationships and field evidence have established that the cogenetic dikes and lava flows derived from a single source. Doleritic volcanic rocks including dikes, rare sills, massive flows, tuffs and volcanic breccias are generally porphyritic, showing a change in texture from fine- to coarse-grained. The original basaltic paragenesis, based upon relict minerals (with the exception of rare fresh olivine), is alkaline in composition and have been subjected to low-grade regional metamorphism (greenschist facies; Adline, 1982).

The alkali basalts may be divided into two quite separate groups on the basis of their REE contents (fig.1) : (1) alkali basalts (Na series) show a small light-REE enrichment, lesser heavy-REE depletions and positive Eu anomalies ; (2) potassium-rich basalts (K series) - 8 to 10 % of K_2O and less than 45 % SiO_2 - uniformly have high REE contents, are strongly LREE enriched, and have a small but distinct negative Eu anomaly. However, the difference in Eu anomalies between the two basaltic sequences can be accounted for by feldspar fractionation producing a small Eu depletion in the potassium-rich basalts. Accordingly, compared to ordinary alkali basalts (Frey, 1968), the Na sequence has a low, and the K sequence a high content of REE. The potassium-rich basalts cannot be clearly related to an effect of hydrothermal alteration or greenschist metamorphism.

These rocks present a close carbonate-basalt association in space and time : carbonate occurs as pseudomorphs after plagioclase, peridot and clinopyroxene, as amygdules and smaller bleds dispersed throughout the matrix and also as veins in the rocks. Secondary carbonates fill almost all available gas bubbles and extensive fissures and appear generally in various basaltic fragments with abundant interbedded triassic sediments.

Possibilities of complex interactions between the basaltic magma and the carbonate phase cannot be ruled out ; the origin of the carbonate may result from a mechanism of magmatic separation during cooling

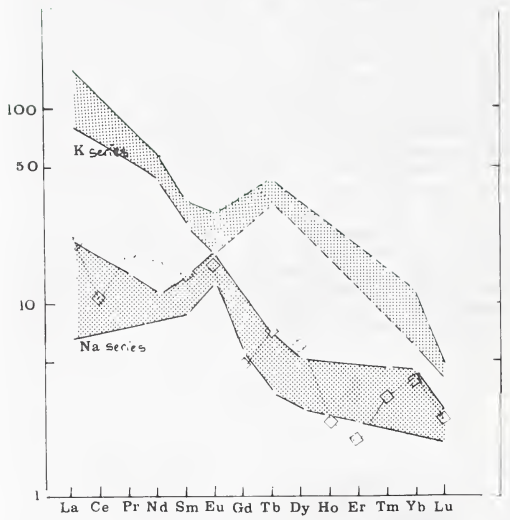

Fig. 1. Chondrite-normalized REE patterns for K series (9 potassium-rich basalts) and Na series (4 alkali basalts similar to hawaiites) ; the single line is a semi-quantitative determination.

Volcanic pipe and associated dikes are confined to the area of the metamorphic basement and are genetically connected with the lava flows but no contact between these rocks has been found. A North-South volcanic pipe, more than 100 m thick, is essentially filled with polygenic breccias intruded by potassium-rich lavas. To the west a dike, 1-2 m thick and 1 km-long, locally exhibits a 10 cm thick margin with small-scale brecciation of the doleritic lava and a carbonate matrix. To the east an alkaline dike, 6 m thick, shows a doleritic texture with carbonate dissemination in the matrix and peridotite xenoliths now altered through complete carbonatation.

No traces of carbonatation could be observed in the gneisses intruded by pipe and dikes and the envi-

ronmental conditions of these rocks excluded a contamination by sedimentary material. It is thus likely that these deep-seated rocks have been carbonated by a process closely related to the basaltic magma genesis.

Lava flows : occurences of secondary carbonate are typically the results of assimilation of sediments such as small dolomitic beds progressively inserted in the effusive volcanic sequence as veins and amygdaloids ; however the overwhelming majority of carbonate inclusions connected with the other types of secondary carbonates may be not attributed to this process and a magmatic origin therefore need to be considered.

Oxygen and carbon isotope variations for carbonate included in lava material. Oxygen and carbon isotope analysis have been made on carbonate extracted from 12 samples from vesicles and amygdules of lava flows (open circles) and 3 samples from 2 dikes (solid circles). In addition, 2 samples of dolomitic sediments interbedded with the basaltic lavas (solid stars) and 2 relicts of sediments included as xenoliths in lava flows (open stars) have also been analyzed, as well as the calcitic matrix of a Tl deposits (J :Jarousite, Mantienne, 1974), which cuts the triassic volcanic sequence but not the overlying sediments. Results and relationships between $\delta^{18}O$ and $\delta^{13}C$ are shown in Fig.2 for all these samples together with some classic references. Analytical measurements (R. Létolle, Laboratoire de Géologie Dynamique, Univ. Paris VI) are expressed in conventional delta notation as permil deviation from the PDB standard. For commodity, corresponding values of $\delta^{18}O$ are also expressed from the SMOW standard using the convertion scale of Pilot (1974). Taylor box : defined from extreme values from primary carbonatites estimated by Taylor et al. (1967) ; evolution trends by fractionation (F) or alteration (A) and the dispersion between calcites from matrix (M) or as phenocrysts (C) are determined by Pineau (1977) ; dashed area : values of carbonate kimberlites and associated peridotite nodules (Deines and Gold, 1973 ; Sheppard and Dawson, 1975; Pineau, 1977). Approximative limit between marine carbonate sediments (MCS) and continental carbonate deposits (CCS) ; ondulated dashed line is drawn after Rösler et al. (1968) from formations with age and environmental tectonic setting not very far from those of alpine triassic dolomites.

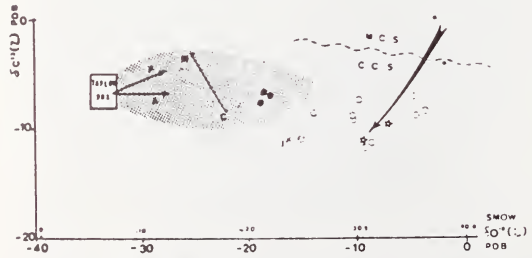

Fig.2. Oxygen and carbon isotope data for carbonates included in lava material.

First, it can be seen that the $\delta^{13}C$ values vary from -6.8 to -11.4, as do those obtained from various localities of Glarus spilites (Amstutz and Patwardhan, 1974). These values are too negative to represent a sedimentary origin, but they recall those observed in kimberlitic rocks. Nevertheless, the $\delta^{18}O$ values of the flows show an important enrichment in ^{18}O isotope , which cannot be interpreted directely in terms of igneous origin. Only the $\delta^{18}O$ values of carbonates from the dikes cutting the metamorphic basement are similar to those of kimberlites. As contamination by metasediments in unlikely in this case, and since one of those carbonate samples shows REE patterns very similar to that of the surrounding matrix, a cogenetic origin for both silicate and carbonate can be advanced. The isotopic values obtained on both intrusive and effusive materials with $\delta^{18}O$ < 30‰ (SMOW), are within the range of values observed for unaltered rocks from the Mid-Atlantic Ridge, and obtained through phosphoric acid extraction (Pineau et al., 1976). The remaining samples showing low $\delta^{13}C$ and high $\delta^{18}O$ values from CO_2 liberated by the acid treatment have been interpreted by these authors as carbonates of primary origin, formed during a late-stage medium-temperature cristallization.

A sedimentary bed of dolcmitic limestone has been incorporated and assimilated on a distance of a few meters by a lava flow and thus forms a very good natural experiment to in situ measure the processes of isotopic fractionation which occurs in high-temperature-lava marine-carbonate interaction. These observations show, better than any theoretical model, the isotopic behavior of C and O during destabilization and remobilization of carbonates. In lava flows, only a few millimeter to centimeter-sized varioles, usually dolomitic, may be interpreted as due to sedimentary contamination. Filled vesicles with very low $\delta^{18}C$ are likely to have a different origin, probably hydrothermal. It is generally accepted that cogenetic CO_2-rich liquid and basaltic liquid are required for the formation of kimberlites and related alkaline rocks. A similar hypothesis can be proposed for triassic carbonated lavas from the Ecrins-Pelvoux area (1) production during ascension through the sialic crust by differentiation or contamination of a special CO_2-rich magma ; (2) generation of a residual carbonate-rich liquid immiscible with normal alkali basalt magma (occels in veins or lava flows) ; (3) individualization of an independant carbonate phase which can locally dislocate and alter previously solidified lavas (carbonate breccias) ; (4) interaction of the carbonate phase with superficial non-marine water and production of hydrothermal fluids which are responsables of the final spilitic paragenesis.

On the basis of previous petrographic, mineralogical, chemical and the above isotopic evidence, this triassic alkalic volcanism would result from magmatic conditions recalling those of kimberlitic genesis. Certainly, superimposition of multiple stages of alteration together with a low grade syntectonic alpine metamorphism could a priori cast some doubts on this hypothesis ; but, whilst individual observations are not evidence these accumulation of data presented here appears as quite a strong argument for our conclusion.

REFERENCES

Adline G., 1982 : Les spilites potassiques du Trias de la bordure du massif des Ecrins-Pelvoux (Alpes françaises) : aspect volcanologique et problèmes de la carbonatation. Thèse de Spécialité, Grenoble 89 p.

Amstutz G.C., and A .M Patwardhan, 1974 : Spilites and spilitic rocks, Amstutz ed., 71-81.

Baron Ph., 1981 : Le Trias et le Lias inférieur de la bordure occidentale du massif du Pelvoux (Alpes occidentales) : stratigraphie et tectonique synsédimentaire. Thèse de Spécialité Grenoble, 154p.

Deines P. and D.P. Gold, 1973 : Geochim. Cosmochim. Acta, 37, 1709-1733.

Frey F.A., M.A. Haskin, J.A. Poetz and L.A. Haskin, 1968 : J. Geophys. Res., 73, 6085-6098.

Mantienne J., 1974 : La minéralisation thallifère du Jas Roux (Hautes-Alpes). Thèse Doctorat Univ. Paris, 146p.

Pilot J., 1974 : Les isotopes en géologie (méthodes et applications) Doin ed., Paris, 176 p.

Pineau F., 1977 : La géochimie isotopique du carbone profond. Doctorat d'Etat, Paris, 203 p.

Pineau F., M. Javoy and Y. Bottinga, 1976 : Earth and Planet Sc. Lett., 29, 413-421.

Rösler H.J., J. Pilot, D. Harzer and P. Bruger, 1968 Report of the XXIIIth Internat. Geol. Congress, 6, 89-100.

Sheppard S.M.F., and J.B. Dawson, 1975 : Phys. Chem. Earth, 9,747-763.