

Very early chemical alteration of present-day basalts in Mount Cameroon

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Mount Cameroon is located at the edge of the African continental plate and is one of the active volcanoes of the Cameroon line. Volcanic activity has been continuous for several centuries and lavas erupted on several occasions during the 20th century. Climatic conditions are extreme with very high rainfalls (2 to 12 metres per year), high temperatures all year round (26° to 29°C) and constant high humidity (>80%). Luxuriant vegetation is present up to altitudes of about 2000 m and this has been shown to have drastic effects on the alteration rate of basalts (Benedetti *et al.*, 1994). Mount Cameroon is therefore an ideal site to determine and quantify chemical mobility during the very first stage in the alteration of basalts.

The lava flows are usually massive with variable amounts of vesicles and few phenocrysts. Their compositions range from alkali basalts to basanites and are characterized by high contents of trace elements such as Cs and Rb and major elements such as Na₂O and K₂O, elements that are known to be highly mobile in surface conditions.

Of the six eruptions that took place during the 20th century, we selected four massive lavas dated at 1909, 1922, 1959 and 1982. For each of them, we isolated the fresh inner part and the altered surficial part of the lavas. In the case of the 1959 basalt, four slices were made in order to examine in detail potential chemical mobilities from the surface to the inner parts of the lava.

All samples were analysed for major and trace elements as well as Sr, Nd and Pb isotopic compositions. As expected for alkaline lavas, trace element concentrations are high: Rb ranges from 37 to 48 ppm, Sr from 912 to 1200 ppm and Ce from 115 to 175 ppm. Trace element contents vary from flow to flow. These differences are correlated and can

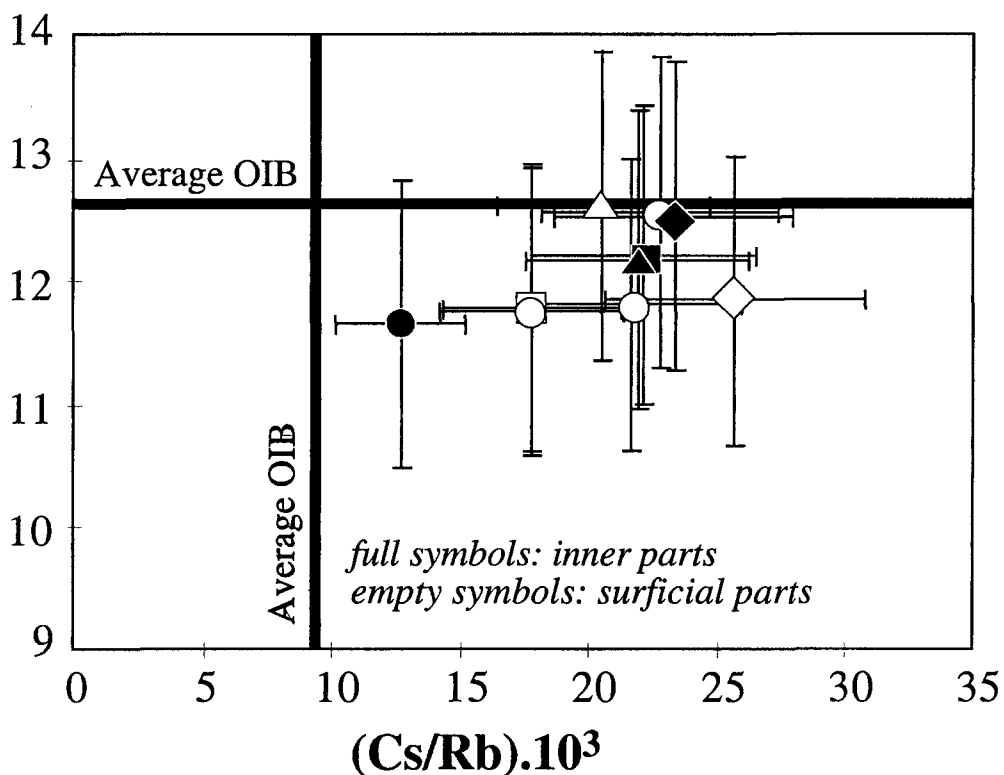
be interpreted as resulting of variable degrees of partial melting. Within-flow variations are much smaller and of the order of analytical errors. Isotopic ratios display small but significant variations: ⁸⁷Sr/⁸⁶Sr ranges from 0.70328 to 0.70341, ¹⁴³Nd/¹⁴⁴Nd from 0.51277 to 0.51282 and ²⁰⁶Pb/²⁰⁴Pb from 20.08 to 20.44.

Detailed examination of the trace-element and isotopic data shows that:

- Almost all elements display no significant variation between the inner and the surficial parts of the same flow. This is the case of course for elements such as Ti, Th and Nb which are known to be robust in severe alteration conditions. Yet it is also the case for elements such as the REE, Sr and Ba which are usually considered as relatively mobile during weathering.

- In the case of U, Rb and K, slightly lower concentrations are obtained on the surficial parts of lavas; however, the difference is extremely small and within the analytical uncertainties. A decrease in contents between the inner and the outer parts of lava flows is also noticed for Na₂O but, in this case, the difference is larger than analytical uncertainties.

Differences in Cs contents exist between the inner and the outer parts of all flows (from -15% to +70%). In three cases, the Cs content of the surficial sample is significantly higher than that of the equivalent inner sample. However, the most important finding is that even the inner parts of lava flows have an excess of Cs. By comparing the Cs/Rb ratio of all samples to values reported in the literature for average fresh OIB (oceanic island basalts), a difference of about 100% is noticed: Cs/Rb = 0.013 to 0.026 in Mount Cameroon samples compared to a Cs/Rb of 0.009 in OIB (Hofmann and White, 1983). Such high ratios are unlikely to be of magmatic

Ba/Rb

origin since the accompanying Ba/Rb ratio is similar to that of OIB (12.5). Cs, Rb and Ba are all very incompatible elements during melting processes and are not fractionated from each other during normal mantle processes. The fact that the Ba/Rb ratio is similar to normal magmatic ratio suggests therefore that the elevated Cs/Rb ratios result from Cs addition after basalt eruption.

Pb isotopic compositions vary from outer to inner parts of the lavas, but the changes show no systematic trend. In contrast, ⁸⁷Sr/⁸⁶Sr ratios appear to be lower in the surficial samples. The preferred interpretation is that Pb exchanges from flow to flow

as a result of water circulation.

In summary, chemical mobilities are extremely subtle considering the extremely severe climatic conditions. The only significant changes are non systematic changes in isotopic compositions and a general increase in Cs contents.

References

- Benedetti, M.F., Menard, O., Noack, Y., Carvalho, A. and Nahon, D. (1994) *Chem. Geol.*, **118**, 203–20.
 Hofmann, A.W. and White, W.M. (1983) *Z. Naturforsch.*, **38a**, 256–66.