

Complex Clinopyroxene Assemblage in Carbonatite and Alkaline Xenoliths from Moroccan Camptonites: Evidence for an Open-System Evolution

Christiane Wagner (cw@ccr.jussieu.fr)¹, Abdelkader Mokhtari², Etienne Deloule³ & Francois Chabaux⁴

¹ Laboratoire de Pétrologie, CNRS-7058, Université Paris 6, 4 Place Jussieu, 75252 Paris Cedex 5, France

² Département de Géologie, Université de Meknès, Morocco

³ CRPG-CNRS, UPRA9046, 54501 Vandoeuvre lès Nancy Cedex, France

⁴ Centre de Géochimie de la Surface, Ecole et Observatoire de la Terre, 67084 Strasbourg Cedex, France

One calcite carbonatite and numerous pyroxenite, melteigite, kaersutite, alkali gabbro, syenite, Ne-syenite and silico-carbonatite xenoliths have been found in camptonites from Morocco. The carbonatite consists of SrO-rich (2.8 wt%) calcite, pyrochlore, fluorapatite, and rare salite as major phases. The silicate xenoliths and the host lavas contain Al- and Ti- rich diopside/salite, mica/kaersutite, \pm nepheline, \pm feldspar, and ubiquitous apatite. Carbonate-rich ocelli are frequent in xenoliths and host rocks.

Clinopyroxenes exhibit complex chemical zoning which may be continuous or abrupt, normal or inverse. For example: i) diopside zoned to a Fe-enriched salitic rim. ii) pinkish diopside core rimmed by Mg-rich colourless diopside. iii) green salite with a rounded diopside core or diopside with a green salitic core in the same rock. Such rounded cores, considered as "relict crystals", are observed within all silicate rocks. Some crystals show irregular green or colourless patches which may indicate some secondary change in the pyroxene chemistry. Diopside/Mg-salite (mg* = 66-80) contain 6.3-11.7 wt% Al₂O₃, 2.4-5.8 wt% TiO₂ and 0.4-1.0 wt% Na₂O. Salites (mg* = 36-60) contain less Al₂O₃ (2.3-6.9 wt%) and TiO₂ (0.6-2.2 wt%), and are richer in Na₂O (1.0-2.4 wt%). The main characteristic of salites from the carbonatite is low TiO₂ (0.2 wt%) and Al₂O₃, (1.0-2.6 wt%), and high MnO (2-3 wt%) content. The compositional range of the pyroxenes, relict or not, are similar in the ultramafic/mafic xenoliths and in the host rocks. The pyroxenes from the silicate xenoliths (except the Ne-syenite) and the camptonite show similar smooth trace element patterns with a negative Sr anomaly in diopside and a positive Zr \pm Hf anomaly in salites. The REE composition is characterised by LREE-enrichment (La_N=50-150 x chondrites). Salites usually show a slightly steeper L- and MREE profiles with a flat Dy-Yb end. Salites from the Ne-syenite have more spiked trace element patterns with a negative Ti anomaly and high Zr (1962 ppm) content and the REE profile shows a distinct negative Gd-Dy anomaly and high abundances in HREE. In the carbonatite salites have smooth pattern except for a strong negative Ti anomaly, and other trace element abundances are

in the same range as those noted above with a high Sr content (up to 2300 ppm) and one of the most LREE-enrichment (La_N=199-262 x chondrites).

The clinopyroxene compositions show an apparent evolutionary trend of increasing acmite component from the pyroxenite xenoliths and host rocks through the alkali gabbros to the Ne-syenites and silico-carbonatites, while other elements (Al, Ti) show much scatter in the data. The salites from the carbonatite plot within this trend. A continuous variation in the clinopyroxene compositions is shown by carbonatite alkaline complexes world-wide, but it does not prove unequivocally their co-genetic nature. Indeed, there is little or no compositional overlap between the clinopyroxene compositions of the ultramafic/mafic rocks and the Ne-syenites. Some composite xenoliths have been found consisting of an inner part of pyroxenite surrounded by a Ne-syenite rim with sharp-edged contacts. These observations, as well as the distinctive REE concentrations in the Ne-syenites, suggest that the two rock types were derived from discrete magma batches. In addition, the clinopyroxene complex zoning requires an open-system behaviour which involved mixing of different magmatic pulses. The high Zr/Sm and low La/Yb ratios in most salites compared to those in diopsides suggest a distinct trace element composition for diopside- and salite- parental liquids, which may be linked to the concentration of carbonate in the liquids. Whole-rock Sr and Nd isotopic data (⁸⁷Sr/⁸⁶Sr = 0.7032-0.7038; ¹⁴³Nd/¹⁴⁴Nd = 0.51265-0.51287) show a negative array of Nd-Sr isotope compositions as known for many carbonatite complexes (e.g. Bell, 1998). The various xenoliths are thus isotopically different and cannot represent a suite related through simple closed-system magmatic differentiation. They may represent separate and unrelated intrusions. Similarly, the isotopic difference between the carbonatite and the silicate rocks suggests unrelated magmas (Harmer and Gittins, 1998).

Bell K, *J. Petrol*, **39**, 1987-1996, (1998).

Harmer RE & Gittins J, *J. Petrol*, **39**, 1895-1903, (1998).