

C and O isotope compositions of the Matongo carbonatite (Burundi) : new insights into alteration and mineralization processes

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The Matongo carbonatite intrusion is part of the Neoproterozoic Upper Ruvubu alkaline plutonic complex (URAPC), located in Burundi along the western branch of the East African Rift. This alkaline complex, which also comprises feldspathoidal syenites, diorites, quartz-bearing syenites and granites, emplaced around 750 Ma (Tack et al., 1996). The carbonatite intrusion was dated at 690 ± 32 Ma (Pb-Pb isochron; Demaiffe, 2008). Sr, Nd and Pb isotope data point to a cogenetic relation between carbonatites and feldspathoidal syenites (Demaiffe et al., 1986). Moreover, a large amount of idiomorphic zircon crystals, up to 4 cm in size, occurring at one locality in the laterite crust of the Matongo region are thought to bear witness of the circulation of alkaline fluids during a late pegmatitic phase in the formation of the URAPC (Fransolet and Tack, 1982). Primary carbonate inclusions in the zircons support the carbonatitic environment in which these zircons have grown (Touret, pers. comm.). Ongoing work (U-Pb dating on zircons) will help to constrain the timing of these events.

In the Matongo carbonatite, several facies have been recognized, among which three are studied here:

- (1) A fine grained sövite (with calcite as the carbonate phase), associated with aegirine and apatite, constitutes the dominant facies of the intrusion. From a geochemical point of view, the sövite samples are enriched in REE compared to chondrites ($\Sigma\text{REE} = 442$ to 956 ppm; La_N up to $1000 \times$ chondrites) and display LREE-enriched patterns (La_N/Yb_N between 49 and 94).
- (2) A “late carbonatite”, made up of a very fine grained calcite cemented by Fe-oxides, is present as veins, veinlets and even breccia in the intrusion. The sample representative of this facies shows an enrichment in REE ($\Sigma\text{REE} = 397$ ppm), with a MREE-humped pattern ($\text{La}_N/\text{Yb}_N = 3.7$).
- (3) Fenites, which are marked by the formation of K-feldspar and/or biotite-bearing rocks, at the contact with the Mesoproterozoic metasediments. These fenites, sometimes referred to as silicocarbonatites (Demaiffe, 2008), are also enriched in REE ($\Sigma\text{REE} = 134$ to 681 ppm), particularly in LREE, with La_N/Yb_N ratios varying from 25 to 46.

Most of the oxygen and carbon isotope compositions obtained on these facies are typical of carbonatites: the $\delta^{18}\text{O}$ values are between 7.2 and 8.5‰ (vs. SMOW), the $\delta^{13}\text{C}$ values are between -4.7 and -5.4‰ (vs. PDB). These values correspond to the magmatic signature of the intrusion. A few samples show a significant increase in the $\delta^{18}\text{O}$ value, near 11‰, with an extreme value of 21.6‰ for the “late carbonatite” sample. The corresponding $\delta^{13}\text{C}$ value of this sample is also high (-1.1‰). Such high $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values cannot correspond to the magmatic history of the carbonatite and rather point to the hydrothermal deposition of calcite, an interpretation which is consistent with the crustal Sr and Nd isotope signatures of this sample (Demaiffe, 2008). From a metallogenic point of view, the “late hydrothermal carbonatite” contains a lesser amount of REE than the magmatic carbonatite. The hydrothermal fluids may have interacted with the carbonatite body and become enriched in REE in the leaching process. Its REE stock was deposited in a zone (the above-mentioned laterite crust), presently encountered above the carbonatite intrusion, where large (~2 cm) euhedral monazite grains crystallized, as inclusions within hematite-magnetite megacryst (Midende, 1984). The same fluids could have finally precipitated hydrothermal calcite. Clearly, additional analyses on the megacrysts themselves are necessary to strengthen this hypothesis. Some other carbonatites show an increase of the $\delta^{18}\text{O}$ value, without significant change in the C, Sr and Nd isotope signatures nor in the REE pattern. This evolution probably relates to a fluid-rock interaction independent from the one recorded by the “late hydrothermal carbonatite”, and could be the result of exchange with high- $\delta^{18}\text{O}$ country rocks at the time of emplacement.

References: Demaiffe et al. (1986), *Abstract book of the International Congress on Magmatism of extensional regions, Lubumbashi*. Demaiffe (2008), *Bull. Séanc. Acad. R. Sci. Outre-Mer* 54, 171-196. Fransolet and Tack (1982), *Ann. Soc. Géol. Belg.* 115, 1, 113-118. Midende (1984), *Unpublished PhD thesis*, Université Libre de Bruxelles, 258p. Tack et al. (1996), In *Petrology and geochemistry of magmatic suites of rocks in the continental and oceanic crusts. A volume dedicated to J. Michot* (Demaiffe, ed.), ULB-MRAC, Brussels, 219-226, 91-114.

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