

REE-rich minerals in Paleoproterozoic carbonatites from Ihouhaouene

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The Ihouhaouene area is located in the northern part of In Ouzzal terrane (Western Hoggar, South of Algeria) (23°36'14"N, 3°10'32"E) and contains carbonatite bodies associated with syenites that are among the oldest in the world (2030 Ma).

The area of Ihouhaouene (In Ouzzal terrane, NW Hoggar, Algeria) is exceptional by the presence of numerous carbonatite outcrops which are systematically associated with syenites when they occur at the contact of granulites. Syenite and carbonatite complex from the In Ouzzal terrane present a linear shape contrary to what is observed in the other outcrops of continental cratonic regions. Syenites are particular since they are SiO₂-saturated. As a consequence, the assemblage wollastonite-calcite-quartz is omnipresent in these rocks. All carbonatites are calico-carbonatites and form a continuous range of whole-rock major and trace elements from Si-poor carbonatite (<20 wt.% SiO₂; 24-36 wt.% CO₂) to Si-rich carbonatite (20-35 wt.% SiO₂; 11-24 wt.% CO₂), white syenite (52-58 wt.% SiO₂; 0.1-6.5 wt.% CO₂) and red syenite (57-65 wt.% SiO₂; 0.1-0.4 wt.% CO₂). Si-rich carbonatite and white syenite are distinguished both by higher REE content, LREE/HREE fractionation (Ce/Lu= 1690-6182) and high Nb/Ta ratio (>50).

Carbonatites from the Ihouhaouene contain apatite and clinopyroxene set in a matrix with up to 50% of calcium-carbonate and can be defined as calico-carbonatite. Brecciated carbonatites are medium to coarse grained with clinopyroxene (1-20%), wollastonite (< 10%), green or pink apatite (1 to 22%) set in groundmass of pink, gray or white calcite (50 to 70%). Green apatites have quartz, calcite and fluorite as inclusions, whereas monazite, calcite, quartz and allanite occur as inclusions or around pink apatites. Accessory minerals are K-feldspars (4-8 mm, < 1%), magnetite (<1%) as inclusions in clinopyroxenes, allanite (0.5-1%) around clinopyroxene, sphene (<2%), quartz (<1%) and coronitic garnet (<3%).

The pegmatitic carbonatites have large calcite grains (1-3 cm, up to 70 vol.%), clinopyroxene (1 to 5%) and green, pink or yellow apatite (up to 10 cm, 1 to 10%). Green and pink apatites are similar to brecciated carbonatite with the same inclusions. Yellow apatites differ from brecciated carbonatite with britholite exsolutions (up to 40 vol.%). Allanite, fluorite, quartz, wollastonite and alkali feldspar are present as accessory minerals (< 1%).

The most remarkable feature of these complexes is the presence of REE-rich minerals that can also include thorium like monazite (REE: 64-67%), britholite (REE: 60%), apatite (REE up to 9%) and allanite (REE: 14-25%).