

COMPARISON OF ELEMENT DISTRIBUTION IN RARE EARTH-RICH ROCKS FROM THE KANGANKUNDE AND KNOMBWA CARBONATITE COMPLEXES.

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Rare earth (REE) minerals are often important constituents of carbonatites where they may be of primary igneous origin, such as some of the fluocarbonates in the Sulfide Queen carbonatite at Mountain Pass, or be the result of late stage metasomatic, hydrothermal or supergene processes.

The Kangankunde carbonatite complex, Malawi and the Nkombwa carbonatite complex, northern Zambia are similar in that they consist of predominantly magnesium and iron-rich carbonatites, have no associated silicate rocks, have caused extensive fenitization to the surrounding basement rocks, and contain high concentrations of REE which are particularly concentrated in an unusual "epidote coloured" green monazite associated with Ba, Sr, REE mineralization. The petrography of the Kangankunde complex is well described by Garson and Campbell-Smith (1965) and the Nkombwa carbonatite is described by Reeve and Deans (1954). It is hoped that an electron microprobe study and subsequent comparison of the chemistry of the minerals in the two carbonatites will help to find common factors in the element distribution in REE-rich carbonatites of this kind.

Abundant monazite, baryte, and quartz are common to both carbonatites. Some degree of REE mineralization pervades most of the carbonatite at Kangankunde but the main REE mineral assemblages are: (1) monazite, quartz, baryte, florencite/goyazite, limonitic iron oxide, and minor apatite intergrown with the florencite and (2) ankerite and/or dolomite, monazite, strontianite, and minor bastnäsite. At Nkombwa the assemblage is different and much of the REE mineralization is concentrated in quartz rocks, including (1) monazite, quartz, baryte, iron oxides (2) monazite, daqingshanite, baryte, quartz, iron oxides and (3) monazite, isokite, quartz, dolomite.

A comparison of the monazite from the two carbonatites shows that its chemistry is broadly similar in being Th-poor (less than 1 wt% ThO₂) and in containing Sr but there are some compositional differences and texturally the monazites are quite different. Kangankunde monazite forms aggregates of euhedral crystals whereas the Nkombwa monazite occurs as chains of spherulites. Both monazites can show replacement textures: at Kangankunde monazite and strontianite can be pseudomorphous after an unknown hexagonal mineral and at Nkombwa the monazites sometimes appear to define relic rhombohedral cleavage directions in quartz suggesting replacement of carbonate. The Nkombwa monazite is more Sr-rich than that at Kangankunde (2 - 5 wt% SrO rather than 1 - 3 %) and, unlike the Kangankunde monazite, it usually contains small amounts of Ca and Ba. There is also a Ca-rich variant with 5 wt% CaO and low totals although analysis by x-ray diffraction and infrared spectroscopy has not confirmed the presence of a hydrated phase such as rhabdophane.

The baryte in both carbonatites is always Sr-poor, even though it must have formed in a strontium-rich environment

and is known to be able to accommodate several per cent strontium. The Sr must have partitioned preferentially into minerals such as strontianite, Sr-containing monazite, daqingshanite, isokite and goyazite.

Bastnäsite at Kangankunde always occurs as sheaves of needles, a habit that Mariano (1989) observes to be indicative of a hydrothermal origin, and does not selectively partition any of the light REE with respect to the monazite. The florencite/goyazite series minerals show more variation: the, often euhedral rhombic, crystals are highly concentrically zoned Sr versus REE and can contain inclusions of bastnäsite as well as intergrown REE-poor apatite. Chondrite normalized signatures are light REE-enriched but more variable than those of the monazite. Like the bastnäsite at Kangankunde, the daqingshanite has a light REE chondrite-normalized distribution which is very similar to that of associated monazite.

The most different distribution of REE in either complex is seen in occasional Kangankunde quartz-apatite-iron oxide rocks which are interpreted as of late hydrothermal origin. The apatite consists of turbid cores with overgrowths which are strongly zoned with mid-REE enriched patterns quite different from that of the main carbonatite.

Although the monazite mineralization in the two carbonatite complexes is similar, each has its own distinctive suite of associated minerals and range of monazite compositions. This latter comparison is useful because it is noted that within each carbonatite complex the monazite compositions from both carbonate and quartz rocks plot together indicating that the within each complex both the quartz and carbonate rocks have been subject to the same phases of mineralization. The mineralization in both carbonatites is believed to be of secondary, probably low temperature, hydrothermal origin. Under these conditions, monazite is Th-poor but can accommodate some Sr and possibly, at Nkombwa, Ca and Ba. Baryte appears not to be able to accommodate strontium and there is little differential partition of REE between monazite and coexisting REE minerals such as bastnäsite.

Tiny blebs of the sodium-containing mineral, burbankite which are found occasionally in carbonates in both carbonatites may be evidence of a primary crystallising REE mineral and apatites seen being altered by incipient REE mineralization in some dolomite carbonatites at Kangankunde may be a source of phosphate.

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