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Contrasting styles of supergene phosphorus and rare earth element mineralisation in weathered carbonatites – examples from southern Africa including Glenover, Zandkopsdrift and Karingarab

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The last few years have seen extensive resource investigations being conducted into carbonatite complexes worldwide – largely driven by the search for rare earth element (REE) resources. These investigations, through the use of detailed REE analyses using ICP MS methodologies, and detailed logging and study of diamond drill core through the introduction of rigid quality assurance and quality control principles through regulations such as NI 43 101, SAMREC or JoRC, has seen an unprecedented increase in both the quality and quantity of geochemical results, and has enhanced our understanding of REE behaviour considerably. Much of the enrichment in REE in these complexes can be noted to be the product of paleo- (and sometimes contemporary), weathering processes [1]. These include elluvial as well as solution/dissolution and precipitation (supergene enrichment). Weathering from a number of past tropical events may be superimposed. The general desiccation of southern Africa from the Pliocene onwards has seen the preservation of many of these paleo or fossil regoliths.

The Karingarab Carbonatite Complex is located in southern Namibia approximately 25 km from the coast in a presently hyper-arid weathering environment. The intrusion comprises both an early silicate (phonolite) phase, and a later crosscutting dolomitic carbonatite phase. The intrusion is about 2 km in diameter, but as much of the intrusion is covered in windblown sand, the edge is defined on magnetic grounds. Weathering is deep with over 70 m of supergene alteration noted. REE and phosphate minerals are dominated by monazite. The Zandkopsdrift Intrusive Complex is located along the west coast of South Africa about 40 km inland. The intrusion is early Eocene (55.9 +/- 4.3 Ma) in age. It forms a circular intrusion approximately 1 km across. Although much of the complex consists of carbonate-rich, phlogopite breccias, a late stage, array of subvertical dolomitic carbonatite veins crosscuts the centre and southwest of the Complex. Depth of weathering is commonly witnessed to be up to 50 m, with reconstitution of primary apatite, as well as primary monazite, into secondary, supergene monazite. The Glenover Carbonatite Complex [2] is located in north-western South Africa. It is noteworthy for its large size at over 8 km diameter, its Palaeoproterozoic age, and in the past the production of very rich phosphate material for the fertilizer industry. Recently it has attracted attention as a possible source of REE. The intrusion has been mapped in detail using high resolution airborne magnetic and radiometric survey data as a reference. The distinct rock types, which include late stage dolomitic carbonatite, and earlier glimmerite and pyroxenite, can be noted to have been deeply weathered in the central parts. It is now recognised that the REE enriched martite-apatite breccia - previously mined for phosphorus - was

formed through karst fill mass weathering of primary carbonatite and pyroxenite apatite, over multiple climatic events.

References:

[1] Cocker M D (2012) Arizona Geol Survey Special Paper 9: 17pp
[2] Verwoerd W J (1967) South Africa Geological Survey Handbook 6: Government Publishers, 43 - 75