

Variation in Styles of REE Mineralization in African Deposits

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There are currently (as of January 2015) 11 rare earth element (REE) projects in Africa that have a published resource or reserve in the public domain. Discovery of these deposits and their potential for mineralization was predominantly by academic research in 1960s and 1970s, possibly due to the extremely unusual nature of these rocks and the first scientifically documented observation of an active carbonatite at Oldoinyo Lengai in Tanzania. Details of the geology of all the current projects in southern Africa are given in a study by W.J., Verwoerd, whereas in Malawi, Tanzania, and Kenya details are found in the Geological Survey memoirs for each country.

These deposits have a variety of styles of mineralization although most of them are associated with carbonatites. The carbonatites typically exhibit multipulse intrusions, with an early phase(s) of brecciation followed by dolomite and/or calcite carbonatite intrusive phases. The most magmatic deposit would appear to be Wigu Hill (Tanzania) which consists of sheeted calcite and dolomite carbonatites, including carbonatite pegmatites and also carbonatite breccias. At Glenover (South Africa), REE mineralization is associated with a pyroxenite-carbonatite complex where the REE mineralization predominantly occurs within iron-rich apatite-calcite breccia at the contact between carbonatite and pyroxenite.

In two of the deposits, Kangankunde (Malawi), and Songwe Hill (Malawi), REE mineralization is best considered as magmatic-hydrothermal, where typically the carbonatite intrusives evolve to either a more ferroan variety and/or the hydrothermal fluid was also iron enriched. Two of the deposits are associated with substantial levels of alteration such as at Lofdal (Namibia) and Zandkopsdrift (South Africa), whereas at Ngualla (Tanzania) weathering is a contributing process for REE concentration. At Mrima Hill (Kenya), the REE resource occurs in a laterite capping developed on top of the carbonatite and associated alkaline intrusions. Similarly, at Xiluvo (Mozambique), the resource occurs within alluvial/elluvial soils that are derived from the weathering and erosion of the carbonatite complex.

The Tantalus (Madagascar) deposit is an uncommon style of REE mineralization in which a regolith of REE-enriched ion-adsorption clays are developed on Oligocene/early Miocene peralkaline calderas. At Steenkampskraal (South Africa) the genesis of the mineralization is not well understood and has been interpreted as a vein-style deposit or also as a magmatic intrusion. It is difficult to make broad generalizations based on such a variety of deposit styles. However, for the carbonatite-associated deposits, it is clear that hydrothermal activity and mobilization of REE is particularly important. In addition, the evolution of the carbonatites to an iron-rich variety seems important although at this stage it is not well quantified due to a lack of data. It is also pertinent to note that surface processes, weathering, and lateritization have also been significant in the formation of these deposits.