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Monazite characterization in a carbonatite weathering profile – a new tool for landscape geochronology

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The Post-Gondwana geology of South Africa is marked by two prominent planation surfaces. These are the result of two distinct phases of uplift and erosion processes that took place under tropical and subtropical conditions: the first of these took place during the mid and late Cretaceous (African planation) whilst the second is tentatively placed into the Miocene (Post-African I planation) [1] or Oligocene [2]. Humid and warm climatic conditions along the African and Post-African I planation surfaces are evidenced by deep lateritic weathering columns of suitable lithologies. The ancient nature of the weathering residues has been well documented by Ar-Ar geochronology on supergene Mn-oxihydroxides [3]. The present study is carried out to test the suitability of U-Th-Pb dating on supergene monazite as a geochronometer for landscape formation and the downward progression of chemical weathering processes.

The study is carried out on material from the Zandkopsdrift carbonatite, Namaqualand, South Africa. The Zandkopsdrift carbonatite is a pipe-shaped intrusion located in the Northern Cape Province of South Africa. Its age of intrusion has been determined as being Eocene (54-56 Ma) [3]. The carbonatite has a well developed lateritic cap that is more than 80 m thick in places. This lateritic cap is greatly enriched in REE – hosted mostly by very fine crystalline monazite that is presumably of supergene origin. Due to the fact that the age of intrusion postdates the African planation surface, the lateritic cap almost certainly marks the Post-African I erosion surface.

There is pre-existing information for the development of the Post-African I planation from geological, paleontological [1] and geochronological evidence [2] [4]. The Post-African I planation surface was carved into the African surface as a consequence of renewed uplift and westward tilting of the African Plate. Climatic conditions during the development of the Post-African I planation surface remained at first humid and warm, but subsequently became more arid and thus less conducive to chemical weathering. The onset and duration of the Post-African I cycle of erosion remains uncertain.

The latter question will be addressed by the current study by dating supergene monazite from different depth in the Zandkopsdrift laterite cap – as intersected in exploration drill core. A detailed description of the petrographic and mineralogical attributes was used to identify the most promising samples for chemical dating using secondary ion mass spectrometry (SIMS). A detailed description of the internal structure, microporosity and inclusions as well as intergrowths and pseudomorphic mineral formations of each analysed monazite crystal allowed us to interpret and evaluate the respective results. The results describe the alteration of the REE minerals, the weathering process as well as the stabilization of the weathering column during arid climatic conditions. These data set important anchor points for the reconstruction of the landscape evolution in South Africa.

References:

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