

Pilanesberg, South Africa: The “forgotten” alkaline complex

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The Mesoproterozoic Pilanesberg Complex in the Northwest Province of South Africa is one of the largest alkaline intrusive complex on Earth. After initial studies in the early half of the 20th century, little research has been published on its petrology, mineralogy and geochemistry, despite its variety of rock associations and mineralogical features, and a potential for REE and Th mineralization.

The Pilanesberg consists of a series of concentric, ring-shaped hills, made up by intrusions that range from miaskitic syenite, through mildly agpaitic nepheline syenites (red and white foyaite) to highly agpaitic lujavrite (green foyaite). They are capped by lavas derived from the underlying intrusive. The overall structure of the intrusion is debated, and now considered to be a gently inward-dipping sheet. Subsequent injections of magma inflated an existing and evolving magma chamber rather than intruding into solid rocks.

Syenites and nepheline syenites in Pilanesberg are characterized by higher Mn/Fe and K/Na ratios and Ca content than is commonly seen in agapaitic complexes, and water activity during crystallization was high, resulting in considerable hydrothermal alteration.

Whereas the green foyaite is a classic agpatitic rock with rock-forming eudialyte, the white foyaite offers a rare opportunity to study a transition between miaskitic and agpaitic crystallization regimes, in which the different High Field Strength Elements show contrasting behaviour. Whereas Ti is hosted in a sequence of progressively more alkaline minerals (titanite, astrophyllite, aenigmatite, lorenzenite, rinkite), Zr remains hosted in clinopyroxene almost to the end of magmatic crystallization