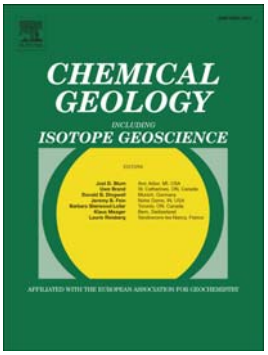

Source and evolution of the alkaline Pilanesberg Complex, South Africa

Marlina A. Elburg, R. Grant Cawthorn

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Source and evolution of the alkaline Pilanesberg Complex, South Africa

Marlina A. Elburg[1], R. Grant Cawthorn[2]

[1] Department of Geology, University of Johannesburg, P.O Box 524, Auckland Park 2006, South Africa; marlinae@uj.ac.za.

[2] School of Geosciences, University of the Witwatersrand, P.O. Wits, Johannesburg 2050, South Africa

Abstract

The Pilanesberg Complex (South Africa) is one of the world's largest but least studied alkaline complexes. It consists of trachytes, phonolites, syenites and nepheline syenites (foyaites) and the preservation of the volcanic carapace makes it unique among the larger alkaline complexes. The intrusive history of the Pilanesberg Complex shows similarities to the Greenland Kangerlussuaq Intrusion, and our new whole-rock major and trace element analyses, combined with existing data, show that the complex belongs to the Sr-rich type of evolved alkaline rocks, more similar to the complexes of the Kola Peninsula than Ilímaussaq. Despite the absence of mafic lithologies, comparison with experimental studies shows that the parental magma was most likely an alkali basalt. Significant iron enrichment is caused by an early stage of fractionation involving clinopyroxene and amphibole rather than olivine and plagioclase, reflecting water-rich compositions and intermediate levels of oxygen fugacity. This fractionation trend has led to strong enrichment in Sr and Ba, but only moderate levels of Y and middle to heavy rare earth elements, and minimal Eu-anomaly. Late-stage water-rich fluids caused significant autometasomatism in most units. New U-Pb dating of titanite constrains the age of the Pilanesberg Complex as 1395 +10/-11 Ma. Initial $^{87}Sr/^{86}Sr$ isotope ratios around 0.7028 (εSr_{1395} = -1) are typical for a moderately depleted mantle source, unlike the local lithospheric mantle. The combination of an enriched trace-element signature and depleted isotopic characteristics is evidence for small degrees of partial melting. Epsilon Sr values are similar to those reported for other alkaline complexes worldwide, emplaced in crust with contrasting geological histories; this likely reflects lithospheric metasomatism shortly before magmatism and minimal crustal contamination.

Highlights:

- The Pilanesberg Complex (PC) is one of the world largest Sr-enriched, Y-depleted evolved (per-)alkaline intrusions
- It has been more accurately dated than previously at 1395 +10/-11 Ma