Goldilocks or Plain Jane? The PGE metallogeny of the Bushveld LIP as recorded by the Rooiberg lavas

Hannah S.R. Hughes[1,2], Dominique Tanner[3], Iain McDonald[3], Olutola Jolayemi[4], Wolf Maier[3], Nils Lenhardt[4], Judith Kinnaird[1]

[1]School of Geosciences, University of the Witwatersrand, Wits 2050, Johannesburg, South Africa (hannah.hughes@wits.ac.za; hhughes2000@gmail.com)
[2]Present address: Camborne School of Mines, University of Exeter, Penryn, UK
[3]School of Earth and Ocean Sciences, Cardiff University, Cardiff, UK
[4]Department of Geology, University of Pretoria, Pretoria 0002, South Africa

The metal wealth of the Bushveld Large Igneous Province (LIP) and Kalahari Craton (including the Kaapvaal and Zimbabwe cratons) are famous: the mineralisation of the Bushveld LIP comprises an array of resources, from platinum-group elements (PGE) and chromite, to tin and fluorite. But the question of *how* the craton and the LIP acquired their spectacular metal endowment remains hotly debated.

The bulk rock geochemistry of lavas (as 'liquid' compositions) has been used to assess the Ni-Cu-PGE prospectivity of LIPs globally, with geochemical tools (often including chalcophile element ratios) being used to trace whether the magmas have equilibrated with sulphides prior to or during emplacement (e.g., [1]). According to these criteria, LIPs that contain both metal-depleted and undepleted magmas are deemed particularly prospective. In addition, the abundance of PGE, Cu and Au in lavas is also used as an indicator of fertility for the region.

The Rooiberg Group comprises of suite of lavas coeval with the intrusive Bushveld Complex and synchronous intrusions of mafic-ultramafic to syenitic-carbonatitic rocks that comprise the Bushveld LIP. The Rooiberg lavas consist of nine units (comprising low-Ti basaltic andesites, high-Ti basalts, low-Mg and high-Mg felsites, Fe-Ti-P andesites, and rhyolites) divided between four formations: Dullstroom, Damwal, Kwaggasnek and Schrikkloof [2].

In this study, we present new major and trace element data for the Dullstroom basalts and basaltic-andesites and the first complete PGE and Au datasets for the Rooiberg lavas. In essence, we pose the following questions: (a) would one predict (by modern geochemical exploration techniques akin to those employed in LIPs globally) the Bushveld Complex PGE mineralisation had it not outcropped at surface? And (b) is the Bushveld LIP tantamount to a metallogenic Goldilocks? Total PGE abundances of the Dullstroom lavas range from 6.5 to 17 ppb – a low-to-moderate concentration for basaltic lavas, when compared to a global dataset for LIP liquid compositions [3]. Chalcophile element ratios such as Cu/Pd and Pd/Ir highlight a non-komatiitic parental magma which is generally not significantly metal depleted.

References:

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