Karoo Continental Flood Basalt (CFB), southern Africa-Geochemically more similar to the Southwest Indian Ocean Ridge (SWIOR) MORB

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Karoo Continental Flood Basalt (CFB), southern Africa-Geochemically more similar to the Southwest Indian Ocean Ridge (SWIOR) MORB

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The ~182 Ma bimodal Karoo CFB of southern Africa, which is considered as a part of the Karoo-Ferrar-SE Australia large igneous province, is currently thought to have been emplaced in the back-arc setting of a northerly subducting palaeo-Pacific convergent margin predating the breakup of Pangea [1], although no nearby magmatic arc structure is supported by geophysical data [2]. Recent findings of ~180 Ma zircons from the SWIOR gabbro, on the other hand, indicates a possible link between the eruption of Karoo CFB and the onset of Gondwana rifting to form Africa and Antarctica, followed by opening of the SWIOR (current full spreading rate: 15-30 mm/yr) [3]. This possibility, which has also been suggested for other CFB provinces [4], is examined in this research. It has been suggested that the Kaoo CFB province represents volcanic equivalent of the bimodal A-type granitoid suite, and the isotopic and absolute trace and minor element abundances of the parent Karoo basaltic magma were modified by magma mixing (chemical diffusion) with the spatially and temporally associated rhyolitic parent melt in the shallow depth (~4 km) sub-surface magma chamber prior to eruption [5]. As such, we have examined the possible compositional similarity between the Karoo basalts and recent SWIOR MORB using mainly trace element ratios, which are considered to be insensitive to magmatic fractionation [6]. In these ratio plots (e.g. Nb/Ta versus Zr/Hf and Sr/Nd), along with their plots in Ti/P versus Sr/P and CaO/Al_2O_3 diagrams, the Karoo high- and low-Ti basalts completely overlap in composition within the SWIOR MORB field, indicating a probable genetic linkage. The bulk compositions of basalts from these two distinct tectonic settings also overlap completely in major oxide plots, e.g., TAS and AFM diagrams. Relative enrichments of highly non-conservative trace elements in the Karoo basalts over the distribution of global MORB in Nb/Yb versus M/Yb plots (where M represents highly non-conservative elements) [7] do not support a Phanerozoic subduction zone model for eruption of these basaltic rocks. This is because enrichment of these elements in the Karoo basalts resulted from magma mixing between the parent Karoo basalt and coexisting rhyolitic magmas in their sub-surface, shallow level magma chamber [5]. The role of mantle plumes in the genesis of CFBs has been questioned for some time [8, 9, 10]. This research adds support to the idea that the evolution of the Karoo CFB was related to the opening of the SWIOR, a shallow mantle phenomenon, and not a mantle plume.

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