Understanding geochemical diversity of CFBs: rift and rift-shoulder magmas in the Jurassic Karoo-Ferrar province

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Geochemical grouping of continental flood basalts (CFBs) aims at understanding genetic links and spatial-temporal evolution of compositionally diverse magma suites. Recently accumulated data for ca. 180 Ma CFBs in Africa and Antarctica show that the conventional division into Karoo and Ferrar provinces and further into low-Ti and high-Ti magma types is not optimal for petrogenetic discussions. Firstly, the Ferrar and Karoo magmas have been shown to be spatially intercalated and, secondly, many high-Ti magmas appear to be associated with low-Ti parental magmas.

A revised geochemical grouping founded on rare earth element (REE) characteristics divides the CFBs into two compositionally and geographically distinctive categories:

(1) CFBs that exhibit strongly fractionated Sm/Yb values (>1.9 x C1) indicative of deep sources are almost exclusively associated with the triple arms of the Limpopo rift system and their counterparts in Antarctica. The wide range of low-Ti to high-Ti compositions (e.g. eNd +9 to -16) can be modelled quite well by variable lithospheric contamination of parental magmas derived from the same overall DM source. The magma volumes were probably relatively small due to partial melting under high pressure conditions below or adjacent to the thick Kaapvaal craton.

(2) CFBs with mildly fractionated Sm/Yb (<1.9 x C1) are widespread around the Limpopo rift and only include relatively monotonous (e.g. eNd +3 to -4) low-Ti types. These can be divided into three geographically and geochemically distinctive subgroups (Ferrar, Karoo, Dronning Maud Land) all of which represent extensive low-pressure partial melting within distinct lithospheric thinning zones. They may have different principal magma sources, possibly within variably subduction-modified lithospheric mantle, although our models for the Antarctic CFBs infer a possibility of precursory magmas from DM sources.

We believe that the suggested rift vs. rift-shoulder grouping clarifies the relationships of geochemically different magma types and promotes better understanding of the sources and processes related to Gondwana breakup magmatism.