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# Petrogenesis of the Swaziland and Northern Natal Rhyolites of the Lebombo Rifted Volcanic Margin, South East Africa

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*The Jozini and Mbuluzi rhyolites and Oribi Beds of the southern Lebombo Monocline, southeastern Africa, have geochemical characteristics that indicate they were derived by partial melting of a mixture of high-Ti/Zr and low-Ti/Zr Sabie River Basalt Formation types. Compositional variations within the different rhyolite types can largely be explained by subsequent fractional crystallization. The Sr- and Nd-isotope composition of the rhyolites is unique amongst Gondwana silicic large igneous provinces, having* $\varepsilon_{Nd}$ *values close to Bulk Earth (–0·94 to 0·35) and low, but more variable, initial* $^{87}Sr/^{86}Sr$ *ratios (0·7034–0·7080). Quartz phenocryst* $\delta^{18}O$ *values indicate that the rhyolite magmas had* $\delta^{18}O$ *values between 5·3 and 6·7‰, consistent with derivation from a basaltic protolith with* $\delta^{18}O$ *values between 4·8 and 6·2‰. The low-*$\delta^{18}O$ *rhyolites (<6·0‰) come from the same stratigraphic horizon and are overlain and underlain by rhyolites with more 'normal'* $\delta^{18}O$ *magma values. These low-*$\delta^{18}O$ *rhyolites cannot have been produced by fractional crystallization or partial melting of mantle-derived basaltic material. The rhyolites have low water contents, making it unlikely that the low* $\delta^{18}O$ *values are the result of post-emplacement alteration. Modification of the source by fluid–rock interaction at elevated temperatures is the most plausible mechanism for lowering the* $\delta^{18}O$ *magma value. It is proposed that the low-*$\delta^{18}O$ *rhyolites were derived by melting of earlier altered rhyolite in calderas situated to the east, which were not preserved after Gondwana break-up.*

KEY WORDS: *rhyolite; Lebombo; stable and radiogenic isotopes; low-*$\delta^{18}O$ *magmas; partial melting*

## INTRODUCTION

Large Igneous Provinces (LIPs) located near present-day continental margins provide an important record of crustal and mantle geodynamics during the pre- to syn-rift stages of the break-up and dispersal of supercontinents. Most studies of LIPs have tended to focus on the extensive and generally better preserved mafic sequences along volcanic rifted margins; however, LIPs can also contain aereally and volumetrically significant amounts of silicic volcanic rocks. Understanding the relative timing of the eruptions and petrogenetic characteristics of the silicic volcanic rocks with respect to the flood basalts provides important constraints on the contribution of crustal material to LIP magmatism and the role of ancient subduction episodes in generating hydrous lower crustal source materials as well as environmental and climatic impacts during LIP emplacement (Wignall, 2001; Bryan *et al.*, 2002). Other studies have emphasized the stratigraphic importance of the silicic eruptive units in constraining the volcanic stratigraphy over several hundred kilometres within often monotonous and internally complex flood basalt lava successions, and for reassembling volcanic provinces now isolated by continental break-up and seafloor spreading (Milner *et al.*, 1995; Bryan *et al.*, 2002; Ukstins *et al.*, 2002).

The Mesozoic break-up of Gondwana was associated with four LIPs emplaced across southern Africa, Antarctica, and southern South America: the Ferrar (~180 Ma; Encarnacion *et al.*, 1996), the Karoo (183–180 Ma; Allsopp *et al.*, 1984; Duncan *et al.*, 1997; Riley *et al.*, 2004), the Chon Aike (188–178 Ma; V1 of Pankhurst *et al.*, 2000); and the Paraná–Etendeka (~135–130 Ma; Hawkesworth *et al.*, 1992) provinces. The Ferrar, Karoo and Paraná–Etendeka provinces are dominated by mafic volcanic rocks with less than 5%

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