Bimodal volcanism within trans-tensional extension basins developed along craton-arc suture subsequent to continental collision: An example from southern Africa

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Bimodal volcanic rocks occurring along trans-tensional basins that developed subsequent to the collision between a mobile belt and a craton offers unique opportunity to examine the magmatic and tectonic processes associated with the collision/accretion. The Koras Group is such a bimodal volcanic suite on the eastern margin of the poly-deformed and highly metamorphosed Proterozoic Namaqua-Natal Belt (NNB) at its contact with the Archaean Kaapvaal Craton in southern Africa. SHRIMP geochronology results indicate that the Koras Group is comprised of two volcanic successions, a lower, older succession of ~1.17 Ga age and an upper, younger succession of ~1.10 Ga age. The successions are comprised of basalt-basaltic andesites and rhyolitic porphyries sandwiched between immature siliciclastic sediments, with minor intermediate volcanic rocks associated with the upper succession.

The basalt-basaltic andesites have slightly higher Nb and low La/Yb ratios, indicating that the subduction-like patterns observed in their multielement diagrams could be the result of a lithospheric mantle source signature created by a subduction process which has been imposed as an inherited signature on the basaltic andesites long after subduction has ceased. The rhyolitic porphyries yield a within-plate geochemical signature. The overall coherence of major and trace element trends of the Koras Group rocks, along with their similar and parellel REE patterns, and reasonably well reproduction of whole-rock compositional trends by MELTS modelling favours a single liquid line of descent that connect rhyolitic rocks to mantle-derived basaltic magmas. Fractional crystallisation was accompanied by varying degrees of assimilation of older crustal material, as evident from Sm-Nd isotopic signatures and depleted mantle (T_{DM}) model ages of 2.16-1.68 Ga. T_{DM} model ages of 1.8–2.5 Ga are typical of the Namaqua Province of NNB, suggesting assimilation of crustal material of this province for the lower volcanic succession. The older T_{DM} model ages for the upper volcanic succession suggest assimilation of older crustal material, possibly from the Kaapvaal Craton.

The effects of chemical weathering on bulk chemistry derived from TIR spectral models

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Chemical trends from rocks and soils on the martian surface can elucidate past and present chemical weathering environments. For example, trends derived from remote sensing data from Mars, including TES, Mini-TES, and GRS, indicate most chemical variability occurs in FeO+MgO concentrations, rather than in $CaO+K_2O+Na_2O$ and Al_2O_3 concentrations, as seen in terrestrial chemical weathering trends [1]. The trends in martian data are explained with an acidic weathering model, resulting in the dissolution of Fe- and Mg-rich igneous phases (olivine and pyroxenes) and the precipitation of amorphous silica [1, 2].

Thermal infrared (TIR) spectral models from spectra of two- and three-component physical mineral mixtures containing one or two igneous minerals (plagioclase, pyroxene, olivine) and small to moderate amounts of one secondary silicate (amorphous silica or montmorillonite clay) were used to calculate model-derived bulk chemistries. For mixtures containing silica, the model-derived chemistries show most chemical variability in FeO+MgO concentrations, as is seen in martian data, even though the actual chemistry of the mixtures does not have variability in FeO+MgO.

Previous studies have shown the presence of weathering rinds and silica coatings on terrestrial basalts can cause nonlinear mixing in TIR spectral models [3, 4]. From our experiments, we propose that the presence of amorphous silica in the mineral mixtures causes nonlinear mixing in spectral models, causing variations in the modeled abundances of Fe- and Mg-rich phases, particularly olivine and pyroxenes. We suggest the precipitation of amorphous silica from chemical weathering of mafic surfaces may enhance the chemical signature of acidic weathering in TIR data.

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