

Extreme variation in quartz phenocryst $\delta^{18}\text{O}$ value along quartz porphyry dykes, Koegel Fontein complex, South Africa

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The 134 Ma Koegel Fontein igneous complex on the west coast of South Africa intruded during the initial phase of break-up of Africa and South America. Quartz porphyry dykes that intruded gneisses that form the roof of the main 25 km diameter Rietpoort granite, contain quartz phenocrysts that have extremely low $\delta^{18}\text{O}$ values (as low as -2.5 ‰). These values reflect those of the original magma, which were as low as -3.1, some of the lowest ever recorded. In order to understand better the mechanism of formation of such low $\delta^{18}\text{O}$ magmas, samples were analysed from various points along two ~6 km long NW-SE striking 10-15 m wide quartz-porphyry dykes that cross the roof zone of the granite. These dykes are cut by the Rietpoort granite at either end and therefore predate the granite. Quartz phenocrysts in the dykes have $\delta^{18}\text{O}$ values that range from +1.1 to +4.6 ‰, and -2.3 to +5.6 ‰, respectively. There is no systematic variation in $\delta^{18}\text{O}$ value along the length of the dykes. Individual quartz phenocrysts from two dyke samples have average $\delta^{18}\text{O}$ value of -1.76 ± 0.51 ‰ (n=6), and $+4.68 \pm 0.62$ ‰ (n=5), respectively. These data show that the variation in $\delta^{18}\text{O}$ value within the quartz crystal population of individual dykes is small, and much less than the lateral variation.

We suggest that the dykes are being fed by magma produced by partial melting of a mafic to intermediate source, variably altered at high-temperature by ^{18}O -depleted meteoric water. Magma so formed was dominantly vertically emplaced, at variable rates of ascent along the dyke. The $\delta^{18}\text{O}$ value of the magma changing with time as the low- $\delta^{18}\text{O}$ alteration zones were progressively consumed. Thus the lateral variation in quartz, and hence magma $\delta^{18}\text{O}$ value depends on the 'age' of the magma at a particular location along the dyke. Major element compositions of dyke samples show limited variation suggesting a source that has variable $\delta^{18}\text{O}$ value, but was otherwise homogeneous or constrained by melting at a eutectic. The Rietpoort granite shows little variation in $\delta^{18}\text{O}$ value (average quartz $\delta^{18}\text{O} = 8.2$ ‰). This indicates that magmas became homogenised after the initial generation of low- $\delta^{18}\text{O}$ magma.