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Isotopic Variation in Cumulate Xenoliths from Bequia, Lesser Antilles

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The island of Bequia is situated in the southern Lesser Antilles arc. It is the northernmost island of the Grenadines and is located directly south of St Vincent. Bequia was volcanically active in the Pliocene (Briden et al. 1979). Southern Lesser Antilles arc lavas show elevated $^{87}Sr/^{86}Sr$ ratios compared to “normal” arc values, e.g. Martinique (Davidson 1987) and Bequia (Smith et al. 1996); this trend is also seen in cumulate xenoliths from Bequia.

The majority of cumulates from Bequia are gabbroic in composition, being mostly composed of: plagioclase and clinopyroxene ±olivine, amphibole and orthopyroxene. This study presents analyses of samples from two localities less than two and a half kilometres apart: Park estate on the east of the island and a second locality on the Eastern main road in the centre of the island. Plagioclase and clinopyroxene, and amphibole for a few samples, from both localities were analysed for $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$. The samples from Park Estate have enriched $^{87}Sr/^{86}Sr$ values ranging from 0.70515 to 0.70686 in feldspars, and 0.70517 to 0.70670 in clinopyroxene. These values can not result from radioactive decay of ^{87}Rb to ^{87}Sr over the 4-5 Ma period since their formation. Their values show good agreement with the isotopic ratios found in the isotopically diverse suite of lavas (IDS) of Smith et al. (1996). The feldspars from the Eastern main road have a range of $^{87}Sr/^{86}Sr$ ratios from 0.704271 to 0.70457 thus displaying unenriched ratios similar to those of Smith et al’s (1996) isotopically homogenous lava suite (IHS). Gabbros from both localities have a very similar mineralogy. There is a degree of heterogeneity in Sr ratios in minerals from the same cumulate with plagioclase generally having different Sr ratios from amphibole and clinopyroxene. Feldspar does not consistently have a higher Sr ratio than the ratio in the mafic mineral. When feldspar has a higher ratio than clinopyroxene the difference in the ratio is: 0.000519 and the largest difference when the clinopyroxene has a greater ratio is 0.0003. Hence these minerals are unlikely to have crystallised simultaneously in the magma chamber.

$^{143}Nd/^{144}Nd$ ratios in mineral separates from the cumulates from Park Estate display a similar heterogeneity to those of the IDS lavas studied by Smith et al. (1996). Both the cumulates and the IDS lavas define a negative trend on a $^{143}Nd/^{144}Nd$ vs. $^{87}Sr/^{86}Sr$ diagram. Both sample types define a negative correlation on the plots, indicating that as Sr ratios increase the Nd ratio decreases.

Samples from Park estate are in enriched $^{87}Sr/^{86}Sr$ whereas those from the nearby Eastern main road are not despite their geographical proximity. This enrichment may have been caused by different, the two most previously discussed being: (1) subducted sediment being incorporated in the melt, Pushkar et al. (1973) or (2) crustal contamination of magmas during magma chamber evolution Smith et al (1996). The variation in Sr isotopes between mafic and felsic minerals may indicate that crustal contamination has occurred, with ratios becoming elevated, as more crust was assimilated into magma chambers. This variation would decrease if a pulse of fresh magma entered the chamber.

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