Possible REE-rich carbonatite in central Iran: evidence from xenoliths of calcite-bearing plutonic rocks within highly potassic tephrite tuffs of Quaternary Qa'le Hassan Ali maars

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The Quaternary Qa'le Hasan Ali (QHA) maars in central Iran (Milton, 1976-77; Bull. VolcanoI. 40-3: 201) occur at the intersection of the north-south Nayband fault, which defines the western boundary of the Lut microcontinental block in Iran, and a system of northwest-southeast trending faults which to the southeast merge into Makran volcanic arc along the southern boundary of the Lut block. The Makran arc extends eastward into Pakistan and towards the Khanneshin Catbonatite Complex in Afghanistan. The highly potassic basanite tephrites forming the tuff rims of the QHA maars contain tephrite-coated plutonic xenoliths. Some of the plutonic Xenoliths are interpreted as co- genetic with the phlogopite, Mg-rich (Fo89-92) olivine, aegirine-augite, anorthoclase tephrites based on their similar mineralogy and isotopic composition (87Sr/86Sr=0.7059). Some of these cognate plutonic xenoliths have up to ~20 volume % calcite, considered to be primary igneous calcite based on (1) grain size, which is similar to alkali feldspars and aegirine-augite pyroxens in these rocks, (2) the presence of small crystals of pyroxene and apatite within calcite grains, and (3) the similarity of the isotopic composition of the calcite with the other minerals in these rocks. The fact that calcite has remained intact and not volatilized during the transport of these xenoliths to the surface in the hot tephrite magma implies a short transit time, and suggests that they are samples of a shallow plutonic complex, as does the presence of anorthoclase in these rocks. The presence of high modal proportions of primary igneous calcite in these xenoliths suggests that these shallow plutonic complexes have affinities with carbonatites. The calcite bearing plutonic xenoliths have high LREE/HREE ratios and contain ~0.3 wt percent LREE. A large proportion of the REEs may occur in REE-rich allanite, with up to ~20 wt % LREE content, that makes up 5 modal % of the most calcite rich samples.

Key words: Qa'le Hasan Ali, Xenoliths, Carbonatite, Basanite tephrite, Iran