Age constraints for rare felsic mantle xenoliths from Elie Ness, Scottish Midland Valley

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EN-101, a rare albitite [Pl +Fe-Ti oxide +Ap +Zrn] xenolith from Elie Ness, Scottish Midland Valley, is hosted by a c. 290 Ma old alkali basaltic diatreme [1, 2]. EN-101 is considered to belong to the Scottish “anorthoclasite suite” comprising xenoliths and megacrysts of various compositions which are interpreted as samples from the upper mantle – lower crust where they form (syenitic) vein or dyke-like bodies e.g., [3, 4, 5]. The “anorthoclase suite” has been found in all Scottish terranes suggesting that the presumed dyke system must be extensive.

Xenoliths of the “anorthoclase suite” primarily consist of Na-rich and Ca-poor feldspar megacrysts, with generally high Na/K ratios [3] that are typically accompanied by accessory zircon, apatite, biotite, magnetite and Fe-rich pyroxene whereas garnet and corundum with Nb-rich oxides are only occasionally present [3, 4, 5]. Upton et al. [4, 5] argued that the parental melt of the “anorthoclase suite” formed through small-fraction melting of metasomatized mantle and subsequent melt–solid phase reaction was also involved. Upton et al. [5] proposed that crystallization of the anorthoclase suite samples occurred shortly prior to- or contemporaneously with their entrainment. However so far no in-situ dating has been carried out on these samples.

Early attempts to date the anorthoclase suite using zircon and feldspar megacrysts from Elie Ness suggested at least a two-stage formation mechanism, where zircon megacrysts yielded a U-Pb age of c. 318 Ma, while euhedral feldspar xenocrysts are significantly younger and roughly coeval with the host volcanism yielding a K-Ar whole-rock age of c. 294 Ma [6]. In this study we present the first in situ U-Pb dating of zircon, which yielded a concordia age of 328 ± 2 Ma (MSWD=0.19; n=12) for EN-101. Zircons εHf328 values range from +5.2 to +7.5 consistent with a mildly depleted source refreshed by metasomatism. These results may indicate that the proposed extensive syenitic veining within the Scottish upper mantle not only has a complex source [5], but is possibly the result of repeated episodes of magma intrusion.

References: