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^{40}AR/^{39}AR ANALYSES OF KELYPHITE: A NEW APPROACH FOR DATING KIMBERLITES AND RELATED ROCKS

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INTRODUCTION

A number of techniques have been applied to kimberlite and related rock geochronology, with the most widely used methods including the Rb-Sr (macrocrystic) phlogopite, U-Pb perovskite and U-Pb zircon (megacryst) methods. These techniques all have method-specific advantages and disadvantages. For example: not all kimberlites contain phlogopite, perovskite or zircon (with the latter particularly rare and usually only recovered from bulk samples); phlogopite is susceptible to alteration and Sr contamination; perovskite typically contains significant common lead and may be very fine-grained (<20 microns).

Despite many kimberlites containing phlogopite, the ^{40}Ar/^{39}Ar phlogopite dating method has only been sparsely applied. This is largely due to the almost ubiquitous presence of excess ^{40}Ar in phlogopite macrocrysts. In contrast, the ^{40}Ar/^{39}Ar method has been applied successfully to date finer grained matrix phlogopite grains, which are usually devoid of excess ^{40}Ar (e.g. Phillips et al., 1998, 1999). However, matrix phlogopite is uncommon to most kimberlites and, where present, is often very fine-grained and difficult to separate. In this study, we have investigated the potential for ^{40}Ar/^{39}Ar dating of kelyphite hosting fine-grained phlogopite.

KELYPHITE

Kelyphite reaction rims develop around garnets from eclogitic and peridotitic mantle xenoliths that are transported to surface by kimberlites and related rocks. Kelyphite reaction rims are generally fine-grained and typically contain spinel in addition to a variety of other minerals such as phlogopite, ilmenite, perovskite and calcite. Although the exact origin of kelyphite is debated, they appear to have formed in response to decreasing pressure and metasomatic reaction with the host kimberlite (or related rock) magma. Consequently, kelyphitic phlogopite formed during kimberlite and related rock eruption events could provide a new approach for dating these rocks.

SAMPLE SELECTION AND NALYTICAL METHODS

To test this potential, we undertook ^{40}Ar/^{39}Ar laser probe step-heating analyses of kelyphite fragments, removed from garnet macroscrysts, from two kimberlite localities: Bultfontein, South Africa (85 Ma) and Dando-Kwanza, central Angola (235 Ma). The samples were loaded into aluminium foil packets and placed in quartz tube, together with the fluence monitor GA1550 biotite (98.8 ± 0.5 Ma; Renne et al., 1998) and irradiated in position 5C of the McMaster University reactor, Hamilton, Canada. ^{40}Ar/^{39}Ar laser probe step-heating analyses of kelyphite fragments were carried out in the Noble Gas Geochronology and Geochemistry Laboratory at the University of

Melbourne, following procedures described previously by Phillips & Harris (2008). Single mineral grains were analysed using a CO_2 laser system attached to a MM5400 mass spectrometer equipped with a Daly detector. Argon isotopic analyses were corrected for system blanks, mass discrimination, radioactive decay, reactor-induced interferences and atmospheric argon contamination.

^{40}AR/^{39}AR RESULTS

Some kelyphite fragments yielded concordant step-heating age results, in agreement with ages determined by other methods (Rb-Sr phlogopite and U-Pb zircon). Other fragments produced more discordant step-heating age spectra, with apparent ages both older and younger than the inferred host eruption age; however, total-gas ages are generally within a few percent of the accepted eruption age. The latter discordant behaviour is attributed to recoil redistribution of $^{39}Ar_K$ from the fine-grained phlogopite within kelyphite; consequently, the best results are obtained from kelyphite hosting coarser phlogopite.

DISCUSSION

The results obtained demonstrate that the ^{40}Ar/^{39}Ar method applied to unaltered kelyphite can be used for precise and accurate dating of kimberlites and related rocks. In addition, the accuracy of the ages can be determined from the concordance of the step-heating results, with recoil artefacts or alteration affects evident from discordant age spectra. Furthermore, as garnets with remnant kelyphite rims are sometimes recovered from diamond prospecting operations, there also exists the possibility of determining source provenance ages from exploration samples.

References

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