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NEW ^{40}AR/^{39}AR AGES FOR THE WEST KIMBERLEY LAMPROITES AND IMPLICATIONS FOR AUSTRALIAN PLATE GEODYNAMICS

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INTRODUCTION

Lamproites and related rocks are volumetrically insignificant, but have attracted considerable attention due to their unusual mineralogy, geochemistry, depth of origin and association (in some cases) with diamonds. Lamproites are also important for studying the evolution of the mantle, diatreme emplacement mechanisms and the origins of diamonds. Approximately twenty separate lamproite provinces are known worldwide, with most located along the margins of Archean cratons.

The Miocene West Kimberley lamproite Province (WKP) of northwestern Australia is located southwest of the Precambrian Kimberley Block and adjacent Proterozoic King Leopold Orogen (Fig. 1).

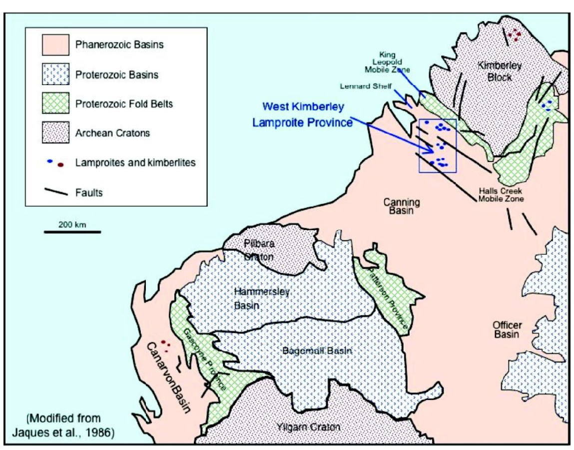

Figure 1. Locality map for the West Kimberley lamproite Province, northwest Australia (modified from Jaques et al. (1986).

The WKP has been sub-divided into four main (olivine and leucite) lamproite fields, termed the Ellendale, Calwynyardah, Noonkanbah and Eastern Lennard Shelf fields. The first three fields form a (~150 km) north-south lineament from the southwest margin of the Proterozoic King Leopold Orogen to the Phanerozoic Fitzroy Trough. This north-south distribution has been attributed to movement of the Australian plate over a mantle plume.

The objective of the current project was to investigate this hypothesis, using high precision ^{40}Ar/^{39}Ar ages obtained from fresh magmatic lamproite samples collected across the WKP (Gesocience Australia collection).

SAMPLE SELECTION AND ANALYTICAL METHODS

Samples were prepared from 21 WKP lamproites from all four fields and from both olivine and leucite lamproites. Mineral separates of euhedral phlogopite grains (but also wadeite and jeppeite) were prepared from this material for ^{40}Ar/^{39}Ar analysis.

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.

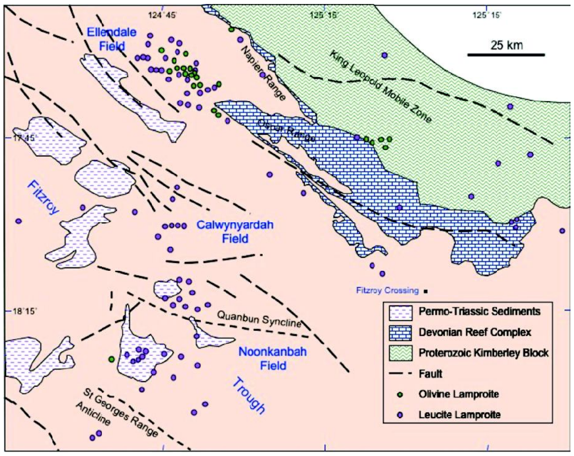

Figure 2. West Kimberley Province lamproite fields, northwest Australia (modified from Jaques et al. (1986).

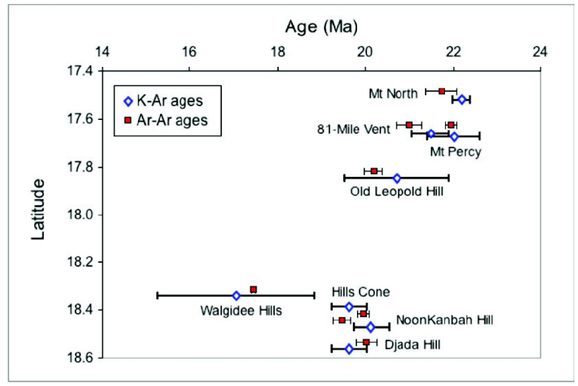

Figure 3. Comparison of previous K-Ar ages and new $^{40}Ar/^{39}Ar$ ages (this study) for the WKP lamproites. Most $^{40}Ar/^{39}Ar$ ages are within error of the K-Ar results, but show enhanced precision.

$^{40}Ar/^{39}Ar$ laser probe step-heating analyses of phlogopite and other mineral grains 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

With some exceptions, the measured $^{40}Ar/^{39}Ar$ for the WKP lamproites are consistent with previously reported K-Ar ages (Jaques et al., 1984; Wellman, 1973) (Fig. 3).

Lamproites from the northern Ellendale field yielded ages ranging from 21.00 ± 0.29 to 22.16 ± 0.12 Ma (errors are ±2σ) (Fig. 4). Samples from the southern Noonkanbah lamproite field yielded more variable ages, attributed to alteration, with the more consistent results indicating an age range from 20.13 ± 0.14 to 20.70 ± 0.65 Ma. One lamproite from the central Calwynayardah Field recorded an age of 20.83 ± 0.22 Ma. The isolated Rice Hill lamproite from the Fitzroy Valley yielded an age of 19.12 ± 0.22 Ma. Only one lamproite was analysed from the Eastern Lennard Shelf field giving an age of 20.26 ± 0.38 Ma. The unusual Walgidee Hills lamproite was dated at 17.45 ± 0.05 Ma, confirming it as the youngest known lamproite occurrence in the WKP.

DISCUSSION

The new $^{40}Ar/^{39}Ar$ results improve upon the precision of the existing K-Ar ages and provide new ages for previously undated lamproites (Fig. 4). The results confirm the north-South progression of lamproite ages in the WKP (Fig. 4). Correlation of these new ages with their geographic location and the structural architecture of the area provide constraints on the geodynamic controls on the emplacement of the WKP lamproites. Possible models for emplacement of the WKP include: (i) emplacement of lamproites in response to plume magmatism, with the age progression related to northward migration of the Australian continent during the Miocene; and (ii) emplacement of lamproites along trans-lithospheric structures associated with the Proterozoic King Leopold Orogen and the Paleozoic Fitzroy Trough, with age progression related to sequential dilation along these structures.

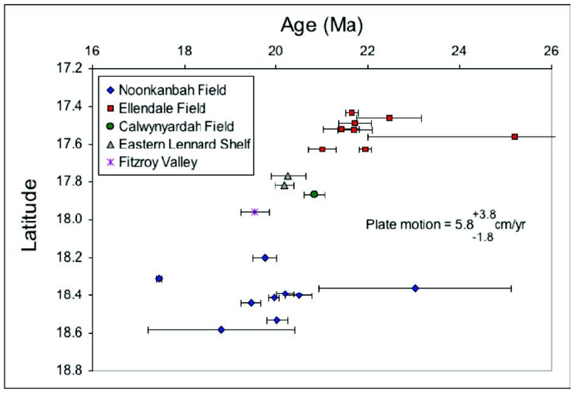

Figure 4. $^{40}Ar/^{39}Ar$ ages for the WKP lamproites plotted against latitude, confirming the north-south age progression indicated by previous K-Ar results.

References

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