THE AGES OF KIMBERLITE AND LAMPROITE EMPLACEMENT IN WESTERN AUSTRALIA

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INTRODUCTION

The purpose of this paper is to report new zircon U-Pb, Rb-Sr, K-Ar and fission track age determinations for kimberlite and associated rocks from the north-west of Western Australia and to discuss the significance of the results together with previous age determinations on lamproites (Jaques et al, 1984). The locations of the investigated pipes are shown on Figure 1. Age determinations on these pipes are decribed below.

THE WANDAGEE M142 PIPE

A zircon U-Pb age of 160 $\pm$10 Ma was determined for this pipe. This age is interpreted as the time of crystallisation of the zircon and also as the time of emplacement of the pipe in the middle Jurassic. This accords with local geological constraints.

THE SKERRING KIMBERLITE PIPE

U-Pb measurements on zircons from this pipe indicate an age of 802 $\pm$10 Ma. These zircons have uranium contents of 5 ppm which are the lowest uranium contents in zircons known to the authors. There is no isotopic or morphological evidence for the presence of inherited lead in the clear, rounded zircons which are typical of kimberlites; the measured age is interpreted as dating the crystallisation of the zircons. This is also interpreted as the age of emplacement of the kimberlite although independent evidence is not presently available to confirm this interpretation.

THE PTEROPUS CREEK KIMBERLITE PIPE

A fission track age zircon of 510 $\pm$30 Ma and a zircon U-Pb age of 810 $\pm$20 Ma have been determined for this pipe. There are a number of possible explanations for the discrepancy between the two ages. One possibility is that the zircon U-Pb age dates the crystallisation of the zircon whereas the fission track age dates the emplacement of the kimberlite 510 $\pm$30 Ma ago. Another explanation is that the zircon U-Pb age of 810 $\pm$20 Ma is essentially the age of emplacement of the pipe and the fission track age is dating a later resetting - for example the heating associated with the extrusion of the Antrim Plateau lavas. The coincidence of Skerring and Pteropus Creek zircon U-Pb ages is presently interpreted as favouring the second explanation.

THE BOW HILL LAMPROPHYRE

K-Ar age determinations on phlogopites from this pipe range from 804 to 826 Ma with a mean age of ca 815 Ma. Rb-Sr measurements for the phlogopites yield model ages within the range 769 to 841 Ma for a postulated R_i = 0.705, and 752 to 819 Ma (R_i = 0.710) in approximate agreement with the K-Ar age. However, a Rb-Sr isochron regression treatment suggests a reset age of ca 570 Ma (R_i = 0.766) for the phlogopites not recorded by K-Ar systematics. The general agreement between K-Ar and Rb-Sr model ages suggests emplacement of the lamprophyre at ca 800-815 Ma with a younger, ca 570 Ma indistinct overprint.

THE ARGYLE AK1 LAMPROITE

At the time of this report no zircons have been recovered from this lamproite and dating has relied on Rb-Sr - K-Ar measurements on whole rock and phlogopite samples. Rb-Sr whole rock systems of the sandy tuff unit suggest an imprecise age of 1100 $\pm$300 Ma for the pipe. A better estimate of the age is provided by an isochron age of 1045 $\pm$150 Ma for samples of lamproite drill core. Rb-Sr measurements on phlogopites from three samples of the drill core yield consistent ages of ca 1147 $\pm$20 Ma with an R_i of ca 0.707 (based on isochron regression and model age calculations). K-Ar ages for the

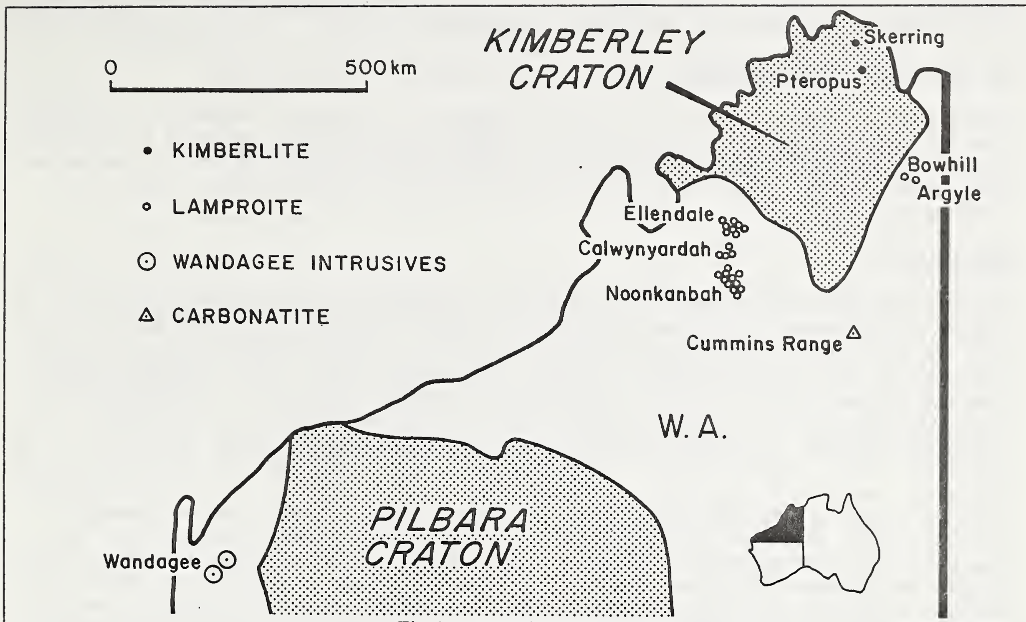

Fig 1. Locality Plan

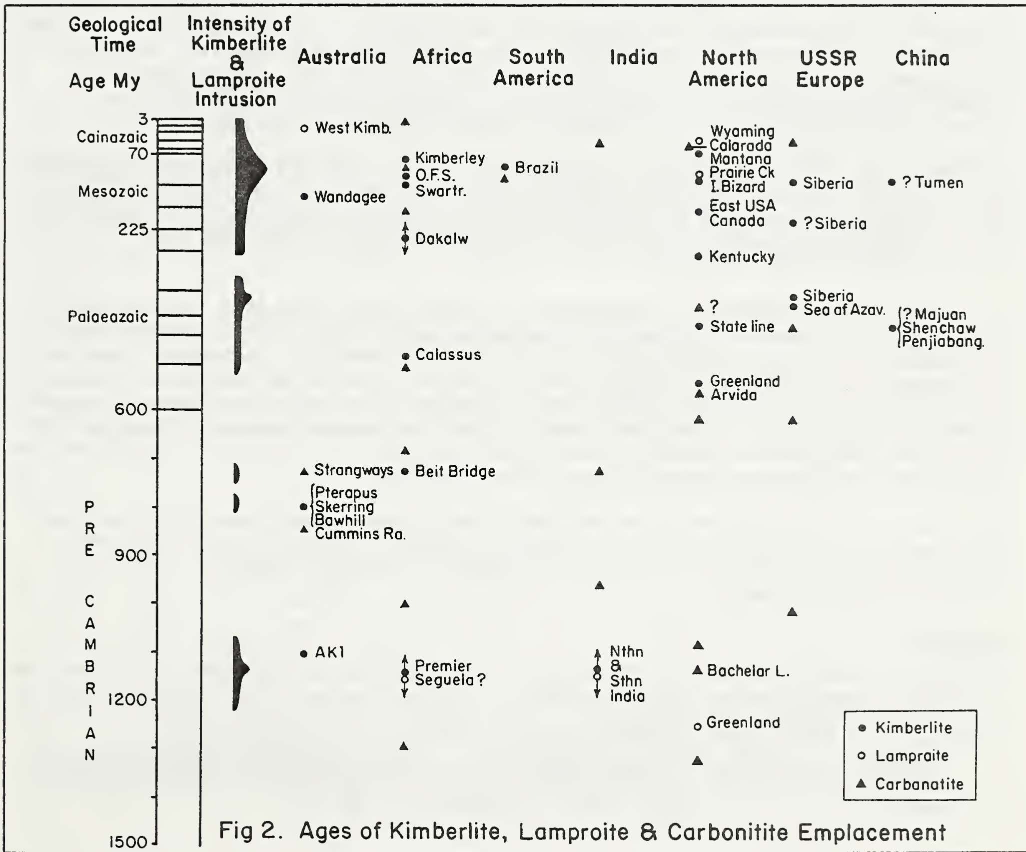

Fig 2. Ages of Kimberlite, Lamproite & Carbonitite Emplacement

phlogopites are slightly older ranging from 1224 ±12 Ma to 1253 ±26 Ma, but anomalously low K contents indicate that these ages are probably too old.

THE WEST KIMBERLEY LAMPROITES

Jaques et al (1984) reported K-Ar and Rb-Sr ages for 14 separate lamproite intrusions from the Fitzroy area of the West Kimberley region. The results showed a transition in ages of emplacement from 20-22 Ma in the Ellendale area to 18-20 Ma in the Noonkanbah area further south. These early Miocene pipes are the youngest primary sources of diamonds yet found.

CONCLUSIONS

The age determinations presented in this paper indicate a long, possibly episodic, history of emplacement of kimberlitic rocks in the Kimberleys of Western Australia (Fig. 2). The first recognised kimberlitic events were at ca 1200 Ma and ca 810 Ma; these follow long after and therefore were not related to the intense metamorphism, granitic and basic to ultramafic magmatism of the King Leopold and Halls Creek Mobile Zones (which concluded at about 1800 Ma) and the basic magmatism of the Carson Volcanics (1760 Ma). Widespread eruption of tholeiitic basalt across Northern Australia in the Cambrian (Antrim Plateau basalt) also cannot be related in time to any Australian kimberlitic activity. Post-Cambrian igneous activity in the Kimberley is restricted entirely to the west where there is a possible date of 357 Ma (Bennett & Gellatly, 1970) on some acid volcanics (Spielers volcanics, Oscar Range Inlier) and some dolerites were emplaced in the Triassic. Again, there is a big difference in age between this magmatism and the Miocene lamproite emplacement in the West Kimberley. Whereas in South Africa and in Siberia kimberlites appear to have been emplaced just prior to and just after major periods of flood basalt activity, no such relationship exists in the Kimberley of Western Australia.

Comparison of the periods of emplacement of the kimberlitic rocks with the timing of major structural events in the Kimberley (Fig. 2) also shows no apparent relationship. The Miocene lamproites of the West Kimberley were emplaced some 150 My after the Triassic/Jurassic period of transcurrent faulting, and there is no known phase of tectonism within 100 My of the Pre-Cambrian lamproites and kimberlites.

At Wandagee in the Carnarvon Basin, emplacement of the Jurassic kimberlitic diatremes and sills was towards the end of a period of rifting and tensional conditions, just prior to crustal separation of Australia from the Indian plate during the Cretaceous. Acid and alkaline volcanic activity also occurred offshore during the late Carboniferous or early Permian.

On a global scale, kimberlitic rocks appear to have been emplaced at certain specific ages (Fig. 2). A peak of such activity occurred during the Cretaceous and is well represented in Africa, South America, USSR and North America. Curiously it has not yet been recorded in Australia. However, the Cretaceous peak may be part of a broader cycle encompassing activity ranging from the Triassic (or even Carboniferous) upwards. The Miocene lamproites of the West Kimberley and the Jurassic bodies of Wandagee and South Australia (Terowie, Eurelia), effectively belong to this cycle. Palaeozoic age kimberlites have not yet been described from Australia.

The other major global peak is at ca 1200 My and is represented in Africa, India and North America (including Greenland). Argyle coincides with this cycle. The only recorded overseas analogue of the ca 800 My bodies of Western Australia is the Beit Bridge body in Zimbabwe.

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