THE MERLIN KIMBERLITES, NORTHERN TERRITORY, AUSTRALIA

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The Merlin kimberlites are located in the Batten region of the Northern Territory of Australia, 800 km south east of Darwin. They were found by intensive exploration during 1993 and 1994. The kimberlites are in a 10 km by 5 km oblate field on the eastern side of the Batten Trough. Four clusters of kimberlites with from one to five in each cluster, have been found in the field. The pipes vary in size up to 125 m in diameter, the diameter is constant to a depth exceeding 100 m. The eleven kimberlites have been named Excalibur, Palomides, Sacramore, Launfal, Ywain, Gawain, Tristram, Gareth, Kay, Ector and Bedevere.

Petrography

The kimberlites are difficult to describe petrographically as only drill chips are available so far and there is very extensive alteration of the rocks. Drill chips (up to 5 cm) from five of the kimberlites all contain two generations of pseudomorphed olivine which include anhedral and often rounded macrocrysts (up to 11 mm) as well as numerous smaller (<1 mm) typically euhedral phenocrysts. Altered mica phenocrysts (up to 1 mm) are present in variable abundances. The interstitial areas appear to be mainly poorly crystalline. This feature, together with the alteration, preclude strict rock type and mineralogical classifications. Observed primary groundmass minerals include mica, spinel, apatite, serpentine and possible carbonate. The nature of the olivines, matrix and complex textures are all typical of kimberlites. No features were observed which suggest that these rocks are not kimberlites. In some instances sufficient xenolithic material was present to show that some rocks are breccias. A few samples have uniform groundmasses and appear to comprise hypabyssal kimberlites. More common examples of non-uniform textures are present which range to well developed pelletal textures. Most of these pelletal structures comprise a single olivine or mica grain which is surrounded by a thin rim of very fine grained to microlitic material. The pelletal lapilli are set in a matrix which is composed of serpentine but devoid of carbonate. These textures are a hallmark of diatreme-facies kimberlites. Although difficult to discern, the probable microlites appear to be composed of mica rather than the more typical clinopyroxene. If so, this feature is somewhat unusual. At Palomides, in addition to the thin rimmed pelletal lapilli just described, possible globular segregations may also be present. There is no evidence to suggest that any of the pelletal rocks are crater-facies. Samples from some of the occurrences are classified as follows:

Bedevere: Possible diatreme-facies kimberlite (rather than hypabyssal).

Palomides: Probable diatreme-facies pelletal tuffisitic kimberlite (±breccia).

Launfal: Hypabyssal spinel-bearing mica kimberlite and probable pelletal tuffisitic kimberlite breccia.

Excalibur: Probable hypabyssal mica-bearing kimberlite.

Gawain: Tuffisitic pelletal kimberlite (±breccia) and tuffisitic kimberlite breccia.

Geochemistry

Extensive alteration of the kimberlites and contamination by xenoliths has affected the geochemistry of most samples. One analysis of carbonated kimberlite from Palomides has a low ilmenite index (Ilm.I =0.28) that falls within the range of relatively unaltered kimberlite (Taylor et al., 1994). The major trace element ratios of this rock should, therefore, provide a reasonable basis for comparison with other kimberlites so that the geochemical affinities of the Merlin kimberlites can be established.

COMPARISON OF KEY GEOCHEMICAL RATIOS FOR KIMBERLITES

	Merlin	Aries	Bow H.	Koidu	Group I	Group II	O.Lamp
FeOt/MgO	0.30	0.40	0.36	0.34	0.32	0.30	0.33
Ni/MgO	39.00	61.00	48.00	42.00	40.00	49.00	34.00
TiO_2/K_2O	0.28	0.48	0.22	1.27	1.70	0.42	0.84
K/Na	5.00	3.00	5.00	9.00	2.00	10.00	6.00
P_2O_5/Ce	20.00	9.00	13.00	18.00	58.00	33.00	34.00
Nb/Zr	3.700	4.20	0.90	1.70	1.10	0.48	0.20
Ba/Rb	17.00	12.00	9.00	24.00	26.00	19.00	20.00
Nb/La	1.30	1.70	1.30	1.40	1.80	0.70	0.80

The Merlin rock is an ultrapotassic composition (molar K/Na >2) with low TiO_2/K_2O ratio similar to micaceous kimberlites and some phlogopite lamprophyres such as that from Bow Hill (Fielding and Jaques, 1989). Its Ni/MgO and FeOt/MgO ratios are within the range of kimberlites and olivine lamproites indicating that it is a primitive mantle-derived composition. The P_2O_5/Ce ratio of the Merlin rock is lower than that of South African Group I or II kimberlites but similar to that of the Koidu and Aries kimberlites. A useful geochemical indicator is the Nb/Zr ratio because Nb and Zr are not strongly susceptible to alteration and these elements tend to be diagnostic of a particular mantle source. For the Merlin kimberlite, Nb/Zr is very high having a value close to that of the Aries kimberlite. The high Nb/Zr ratio of Merlin clearly indicates this rock does not have geochemical affinities with olivine lamproites (such as Argyle) or Group II kimberlites. Other ratios such as low Ba/Rb and high Nb/La are also characteristic of an Aries signature. In conclusion, the Merlin kimberlite Palomides has geochemical features that indicate it is allied with the Aries kimberlite and Bow Hill lamprophyres in the Kimberley region of Western Australia. The Merlin rocks were evidently generated from a geochemically anomalous deep mantle source that underlies parts of the North Australian Craton.

Diamonds

The Merlin kimberlites contain diamonds and they are being sampled to determine the quantity and quality of diamonds present. Microdiamonds (+0.1 mm to 0.4 mm) are abundant in the pipes and exceed five per kilogram in some cases.

IR spectra were obtained for 40 microdiamonds from the Ector pipe. One golden yellow specimen contained a small percentage of nitrogen in the Ib form indicating it represents a very young diamond and/or one that formed under low temperature conditions (<1,000°C). Three specimens were fragments of large stones and some of these had an inhomogenous aggregation state such EC-02 and EC-08. Fractures on three stones were new and, therefore, were possibly sustained during the recovery process and 50% showed old octahedral point fractures and surfaces which had been etched or resorbed after breakage.

A significant number (50%) of the specimens are composite stones (twins or aggregates) indicating multiple nucleation and hence a relatively abundant supply of carbon. Most of the microdiamonds are composed of colourless, sharp-edged octahedra and 20% contained visible inclusions.

Quantitative analysis of the nitrogen data indicates that there are three main time-temperature populations of microdiamonds:

(i) a cool and/or young population of mainly pure type IaA stones (nitrogen aggregation temperatures - T[NA] ~1,025°C for 1.65 Ga residence in the mantle);

(ii) a moderate temperature population of type IaAB diamonds (T[NA] ~1,100 - 1,150°C for a 1.65 Ga residence time) with platelet intensities (type-M behaviour, see Mendelssohn and Milledge, 1995) consistent with these T(NA) values. Some of these diamonds such as EC-08 show strong zonation;

(iii) a population of high temperature diamonds (T[NA] ~1,200°C for a 1.65 Ga residence time), again with platelet intensities consistent with these temperatures (type-L and type-K behaviour). Type II, i.e. nitrogen free, diamonds were not common in the microdiamonds studied (2 out of 40).

Further studies of diamonds from the Merlin kimberlites are in progress.

Mineralogy

Chrome spinels and peridotitc garnets are present in the kimberlites. Megacrysts are absent. Olivine, observed as pseudomorphs in thin section, is not present in the kimberlite heavy mineral concentrates. Small quantities of chrome diopside are found in one of the kimberlites (Kay).

The chrome spinels occur in two forms, one with very high chrome content and the other intermediate to low chrome. The garnets are predominantly lherzolitic but a few harzburgitic garnets are present. Mica is present in varying abundance in the kimberlites.

References

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SIXTH INTERNATIONAL KIMBERLITE CONFERENCE

Novosibirsk, August 1995

EXTENDED ABSTRACTS

RUSSIA