# PETROLOGY, MINERALOGY, AND GEOCHEMISTRY OF THE METTERS BORE NO. 1 LAMPROITE PIPE,. WEST KIMBERLEY PROVINCE, WESTERN AUSTRALIA.

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The Metters Bore No. 1 lamproite is a small (2.5 ha) pipe-shaped intrusion, belonging to the Calwynyardah field within the Miocene (≈20 Ma) West Kimberley lamproite province (Jaques et al. 1986). It intrudes Permian sediments of the Fitzroy Trough. It is concealed beneath 2 m of red-brown sandy soil and 1.5 m of pisolitic laterite, but is detectable by its strong magnetic signature.

Both magmatic lamproite and fragmental (tuffaceous) material are present. The tuffaceous units occur in the southwest portion of the pipe, and are comprised of at least four types of juvenile lamproite lapilli, supported by a matrix of ash with smaller cognate or accidental particles and occasional veined calcite. The lapilli are typically non-vesiculated, subangular fragments of diopside-olivine-leucite lamproite (up to 3mm across), although fine-grained vitrophyric leucite lamproite, medium-grained diopside-leucite-phlogopite lamproite, and lattice-textured leucite-phlogopite lamproite also occur.

The magmatic rock is dominantly a porphyritic olivine-diopside-leucite-(phlogopite) lamproite (olivine » phlogopite), with an altered glassy groundmass. *Olivine* phenocrysts and microphenocrysts are almost wholly altered to clays, although one fresh grain with a magnesium number [$100Mg/(Mg+Fe^{2+})$] of 91 was found as an inclusion in a wadeite crystal. Inclusions of *chromite* up to 20 µm across are common.

*Diopsides* (five compositionally distinct and one indistinct form) describe fields within the pyroxene quadrilateral representing: (1) phenocrysts; (2) groundmass; (3) Ca-rich phenocrysts; (4) heavy mineral concentrate (HMC) fraction; (5) Cr-rich xenocrystic diopsides; (6) broad field of inclusions within amoeboid leucite phenocrysts. They are generally Ti- and Cr-rich, Al-poor diopsides which follow evolutionary trends of Cr-depletion and Fe-enrichment.

*Leucite* phenocrysts are completely altered to analcite and montmorillonite and occur in three different morphologies: (1) singular euhedral phenocrysts; (2) amoeboid-shaped, (3) poorly crystallised glomerocrysts containing abundant pleonaste phenocrysts; poorly crystallised glomerocrysts containing microlites of diopside but no pleonaste.

Three generations of *phlogopite* are present: (1) rare phenocrysts, (2) microphenocrysts and euhedral groundmass flakes, and (3) inclusions. The micas typically have high F contents which range up to 4.13 wt%, BaO contents which average 0.7 wt%, and evolutionary trends of $TiO_2$- and FeO-enrichment and $Al_2O_3$-depletion.

Compositions of *spinels* fall into three distinct populations which represent: (1) cognate chrome spinel; (2) heavy mineral concentrate (HMC) spinel; (3) pleonaste. The cognate spinels show evolutionary trends of initial Cr and Ti-enrichment and $Fe^{3+}$-depletion, followed by co-evolving trends of (a) constant Cr and $Fe^{3+}$ and (b) Cr depletion and $Fe^{3+}$-enrichment. HMC grains fractionate towards increasing Ti, Cr, and $Fe^{3+}$ compositions with decreasing Al, and pleonastes show the same trends but without Cr-enrichment.

*Amphiboles* are present as K- and Ti-rich richterites and show trends of increasing Ti, Na, and Fe with decreasing Mg.

Accessory phases include *priderite, perovskite, ilmenite, sphene, apatite, wadeite, zircon,* and *barite*. The diopsides, phlogopites, tetraferriphlogopites, tetraferribiotites, and Ti-rich K-richterites have consistent tetrahedral site deficiencies which can be satisfied by tetrahedral $Ti^{4+}$. This is probably a result of the high Ti/Al ratio in lamproite magma.

The groundmass contains abundant needles of priderite and apatite; less abundant perovskite, interstitial potassian titanian richterite, Mn- and Mg- rich ilmenite; and rare chrome-spinel, pleonaste, and wadeite. Heavy mineral concentrates yielded various minerals of mantle origin including Cr-rich diopside (up to 2.5 wt% $Cr_2O_3$), magnesian chrome spinel (up to 16 wt% MgO), and rare pyrope garnet.

Geochemically, the Metters Bore No.1 lamproite is an ultrapotassic, perpotassic, and peralkaline rock with high $TiO_2$ and a magnesium number [100Mg/(Mg+$Fe^{2+}$)] of 62.5. K, Rb, and Ba show considerable mobility due to secondary alteration processes. Incompatible elements are strongly enriched (Fig.1a), at up to 1000 times primitive mantle abundances (370ppm Rb, 1400ppm Sr, 4000ppm Ba, 1100ppm Zr), and Rb/Sr ratios are typically higher than other lamproite suites. Abundances of the compatible elements Ni and Cr are moderate, and average 342 ppm Ni and 367 ppm Cr. These, together with the moderate Mg-numbers, imply evolution of the Metters Bore magma from a more primitive parent. Mantle normalised Sc/V ratios are <1, which is typical for leucite lamproites but different from olivine lamproites in the West Kimberley province. The rare earth elements (REE) are strongly enriched, with 700 times chondrite abundances for light REE and 8 times chondrite for heavy REE (Fig.1b).

Diamond prospectivity diagrams, using chrome-spinel and pyrope garnet compositions, imply a low potential for the Metters Bore No.1 lamproite to host economic quantities of diamond.

**Reference**

Jaques, A.L., Smith, C.B. & Lewis, J. (1986) The kimberlites and lamproites of Western Australia. Bulletin of the Geological Survey of Western Australia, 132.

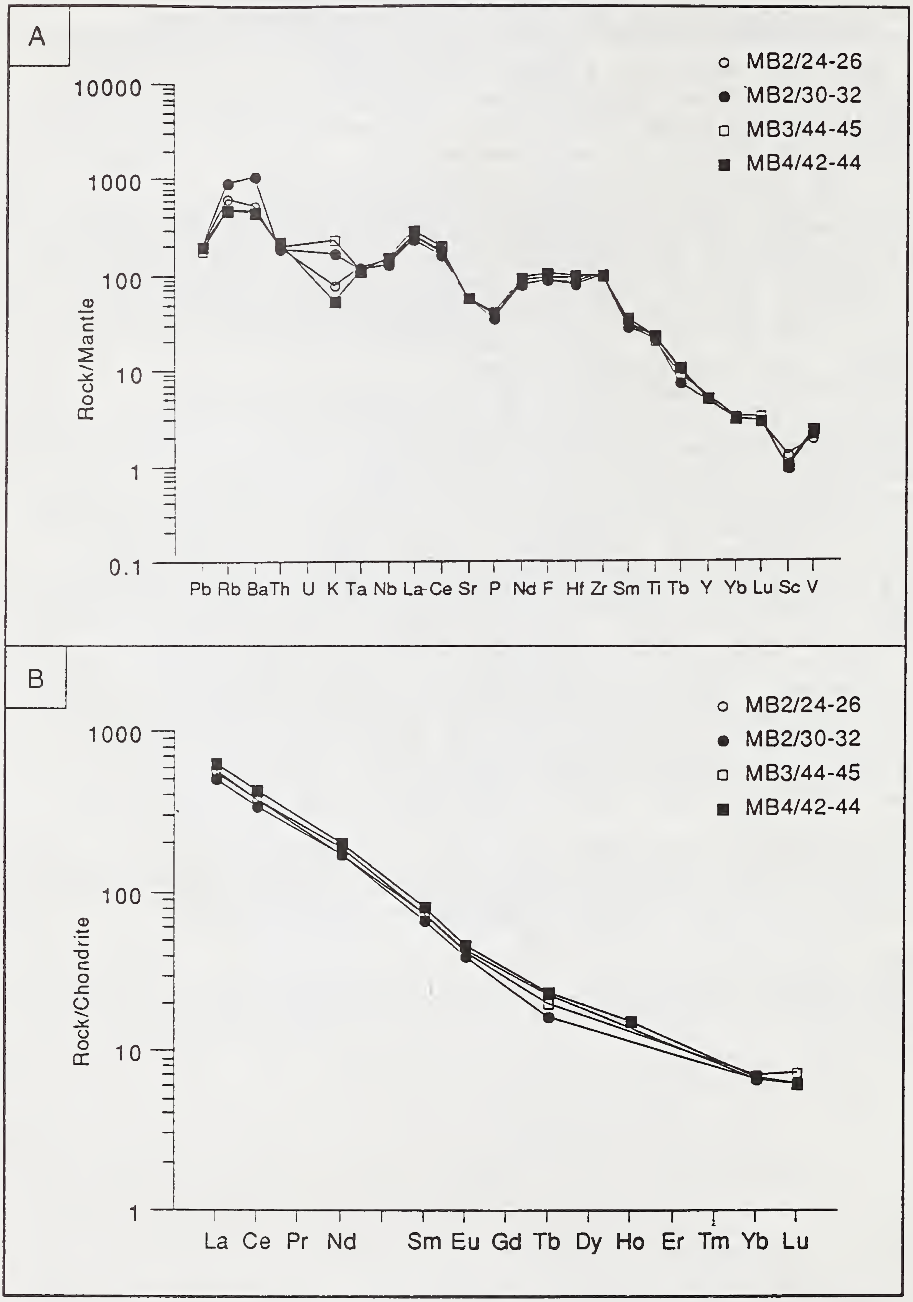


Fig.1. 'Spidergrams' of representative whole-rock samples of the Metters Bore #1 lamproite. (a) Normalized to primitive mantle, (b) normalized to average chondrites.