SHORT COMMUNICATIONS

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A glassy lamproite from the West Kimberley area Western Australia

THE lamproites of the West Kimberley area of Western Australia, with the exception of the very coarse-grained variety wolgidite, are mostly highly weathered and, until a few years ago, no specimens were available from which the original nature of the groundmass, now an earthy lustred clay, could be determined. In spite of the occurrence of leucite and olivine and their alteration products (Prider and Cole, 1942) in these rocks, their silica-saturated nature (Prider, 1960, p. 106; Wade and Prider, 1940, p. 75) indicated that this groundmass must be siliceous in nature.

The discovery of a fresh, unweathered, vitrophyric leucite lamproite in the Oscar Plug has provided material for an electron microprobe analysis of the unaltered groundmass.

Occurrence. The 'Oscar Plug' (18° 08′ S., 125° 25′ E.) consists of several small lamproite intrusions into sandstones of the Permian Grant Formation (fig. 1). These intrusions are on the southern flank of the hill, and consist of two small plugs and a narrow dyke striking 250°.

The westernmost plug is approximately 20 ft. in diameter and slightly elongated in an east-west direction. It is separated from the lamproite dyke to the south by a low ridge, 10 ft. wide, of sandstone. This plug has a core of vesicular fitzroyite (vesicles to 0.1 in. diameter) surrounded by massive fine-grained cedricite, which constitutes the bulk of the plug. This pipe contains large sandstone xenoliths, and has an outer rim of lamproite-breccia. The eastern plug, approximately 10 ft. in diameter, is of fine-grained wyomingite.

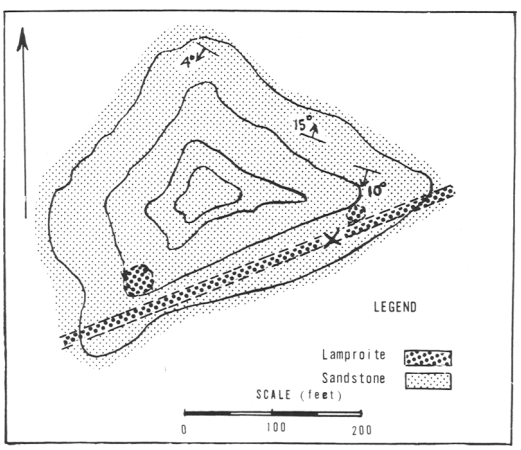

FIG. 1. Geological sketch map of Oscar Plug [25-ft. form lines after Wade in Wade and Prider, 1940, pl. IV(3)], showing location (X) of specimen 73284.

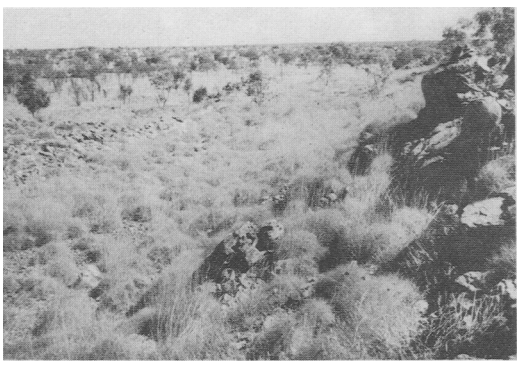

FIG. 2. Oscar Plug, view looking 230° across olivine-leucite lamproite dyke (poor outcrop in linear depression) in Permian sandstone.

The dyke, striking 250°, consists of vitrophyric olivine-leucite lamproite. This intrusion, which outcrops sporadically, is approximately 20 ft. wide, and occupies a linear depression along the southern margin of the hill (fig. 2). This depression was initially considered by Wade to be the result of two parallel faults (Wade and Prider, 1940, p. 47 and Plate IV), but my later examination, in 1973, indicates that this is not the case, but that this linear depression is actually a lamproite dyke. It is specimen 73284* collected from this dyke at the locality shown in fig. 1 that is the subject of this paper.

* Numbers refer to the General Collection, Department of Geology, University of Western Australia.

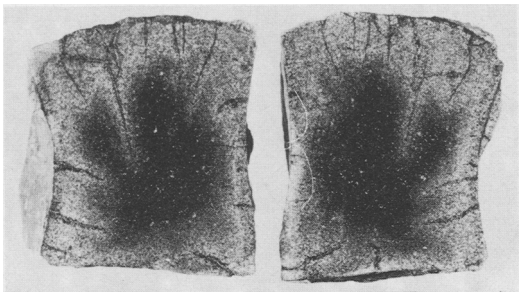

FIG. 3. Specimen 73284, showing weathering of glass (darker colour) along cracks to lighter-coloured product. Note typical subconchoidal fractures on outer margin of specimen. Width of specimen is five cm.

Petrography. Specimen 73284 in the field occurs as small fragments up to 2 in. across, bounded by gently curved fractures (the subconchoidal fractures of the glassy rock). It is dark grey, dense, and vitrophyric, and weathered to a lighter-coloured earthy-lustred product in the marginal parts of these fragments, i.e. these fragments look like the normal weathered lamproites, but when broken reveal a central core of unweathered material. This unweathered lamproite may be traversed by fractures, along which weathering has taken place (fig. 3).

The unweathered lamproite is microporphyritic, with euhedral phenocrysts of olivine (to 1 mm long) and water-clear leucite (to 0.25mm diameter) in a light-brown glassy groundmass enclosing abundant water-clear euhedral leucite (to 0.05 mm diameter), deep brownish phlogopite (flakes to 0.1 mm long) and diopside and/or magnophorite prisms (to 0.1 mm long) (fig. 4). Slender black opaque rods of priderite, up to 0.05 mm long, form the only recognizable accessory. Some of the leucite phenocrysts have regularly arranged inclusions of glass.

The glass of the groundmass makes up approximately one-third by volume of the rock. It is clear, unaltered, light brownish in colour, with refractive index 1.585. In some glass areas, there is an outer, slightly darker, brownish zone, but electron microprobe analyses show no significant chemical differences between the lighter and darker coloured zones in the glass (Table I, columns 7, 8, 9).

Geochemistry. Electron microprobe analyses* were made of the glass, leucite, olivine, and diopside. The results are set out in Tables I and II. The analyses of the glass confirm the earlier suggestion about the siliceous nature of the groundmass (Wade and Prider, 1940). An interesting feature of the composition of the glass, in addition to its high SiO_2 content, is its high titania content (average of 9 analyses is 10.32% TiO_2)—much higher than that of the whole rock (mean of 2 analyses 4.86% TiO_2—see Table III). The titania-rich character of this glass is even more pronounced than that of a glassy wyomingite from the Leucite Hills, Wyoming, which contains 4.9% TiO_2 (Carmichael, 1967) and of a glassy leucitite (gaussbergite) from Gaussberg, Antarctica, which contains 6.2% TiO_2 (Sheraton and Cundari, 1980).

All of the highly potassic leucite lamproites—from the Leucite Hills of Wyoming, Jumilla in

* I am indebted to Mrs J. Muhling and Mr P. Morant for these analyses.

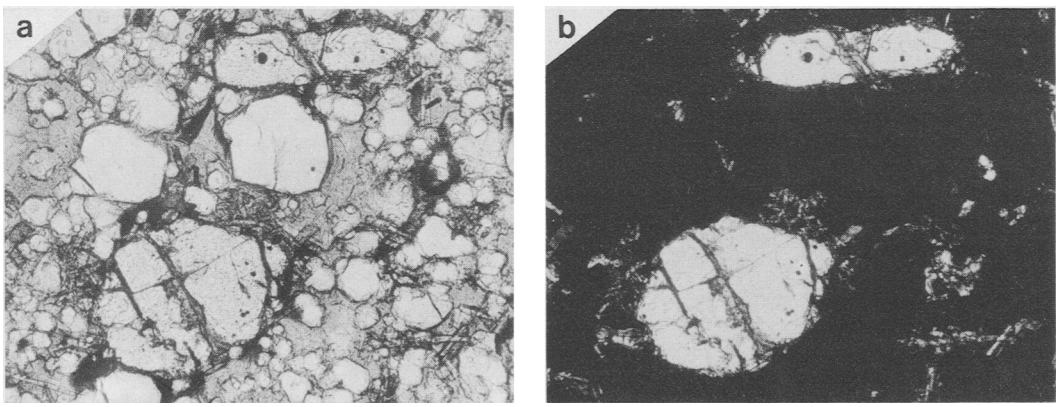

FIG. 4. Photomicrograph of olivine–leucite lamproite (73284) in (*a*) plane polarized light, (*b*) crossed polars. Width of field approximately 1 mm. The two large birefringent phenocrysts are olivine, the small birefringent prisms of the groundmass are diopside, magnophorite, and phlogopite, the clear isotropic phenocrysts are leucite, and the greyish isotropic matrix is glass.

TABLE I. *Electron microprobe analyses of glass in groundmass of olivine-leucite lamproite (73284)*

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	61.91	61.11	60.87	61.06	63.63	63.46	60.45	63.77	61.46	61.97	57.17
TiO_2	10.70	10.43	9.84	10.71	10.45	10.25	9.80	9.88	10.79	10.32	11.04
Al_2O_3	2.32	2.81	2.73	2.31	2.92	2.88	2.75	2.91	2.61	2.69	2.92
V_2O_3	—	—	—	—	—	—	—	—	—	—	0.25
FeO*	8.23	7.86	7.70	8.03	8.03	7.91	7.86	8.06	7.83	7.95	8.18
MgO	3.96	3.83	3.64	3.63	3.48	3.67	3.74	3.39	3.51	3.65	3.57
CaO	—	—	—	—	—	—	—	—	—	—	0.92
K_2O	2.92	1.27	1.22	1.62	4.16	4.00	0.62	3.64	0.65	2.23	1.09
Na_2O	—	—	—	—	—	—	—	—	—	—	0.24
BaO	2.18	1.88	1.85	2.23	2.02	1.82	1.93	1.76	1.92	1.96	—
P_2O_5	—	—	—	—	—	—	—	—	—	—	0.99
Cl	—	—	—	—	—	—	—	—	—	—	0.19
Total	92.22	89.19	87.85	89.59	94.69	93.99	87.15	93.41	88.77	91.65	86.56

* Total iron as FeO. — Not determined.

1, 2, 3. Points in a single glass grain.
4, 5, 6. Edge, centre, and edge of a single glass grain.
7, 8, 9. Dark, light, and light points in a single glass grain.
10. Glass, average of nine points (1–9) in three grains.
11. Glass, average of three points by a second observer. TiO_2 contains some BaO; V_2O_3 and Na_2O determined in one analysis only; no ZrO_2 detected.

Spain, Gaussberg in Antarctica, and the West Kimberley area of Western Australia—are characterized by high titania. The concentration of Ti in the glassy matrix of the rock presently under consideration is surely a pointer to the high fractionation that could have taken place in a parent magma (such as a mica-peridotite magma) to produce the highly potassic titania-rich leucite lamproites as formerly proposed (Prider, 1960). The discovery of diamonds in the West Kimberley area of Western Australia in 'kimberlites' which are, undoubtedly, genetically related to the leucite-lamproites is further confirmation of the hypothesis that these rocks were derived from the mantle.

Weathering. Attention has been drawn to the ubiquitous weathered state of the surface exposures of the Western Australian lamproites. They are generally completely weathered to an earthy-lustred clayey aggregate, and the only localities where fresh unaltered leucite has been found previously are Mt. Gytha, Mt. Percy, and Old Leopold Downs (Prider, 1960, p. 114). Nevertheless, the weathered lamproites are of similar chemical composition to the perfectly fresh glassy lamproite of

TABLE II. *Microprobe analyses of crystalline components of olivine-leucite lamproite (73284)*

	1(A)	1(B)	2	3(A)	3(B)
SiO_2	40.94	(0.42)	53.28	56.14	(0.28)
TiO_2	0.02	(0.01)	—	—	
Al_2O_3	0.00	(0.01)	—	20.60	(0.12)
FeO*	7.63	(0.28)	3.30	0.83	(0.06)
MnO	0.33	(0.25)	0.10	—	
MgO	50.66	(0.50)	16.23	0.14	(0.14)
CaO	0.12	(0.00)	22.94	1.22	(0.06)
Na_2O	0.01	(0.01)	—	—	
K_2O	0.00	(0.00)	—	21.07	(0.26)
BaO	—		—	—	
NiO	—		0.03	—	
Total	99.71		95.88	100.00	

* Total iron as FeO. — Not determined.

1(A). Olivine phenocrysts (mean of six points in three phenocrysts), composition $Fo_{91.9}$ $Fa_{8.1}$.
1(B). Standard deviation of 1(A).
2. Diopside (one point).
3(A). Leucite (mean of six points, three from each of two phenocrysts normalized).
3(B). Standard deviation of 3(A).

TABLE III. *Fresh and weathered glassy leucite lamproites*

	1	2	3
SiO_2	51.39	45.46	52.00
TiO_2	4.47	5.25	4.92
Al_2O_3	8.55	9.83	9.49
Fe_2O_3	4.75	5.69	5.66
FeO	1.80	1.87	1.38
MnO	0.07	0.06	0.07
MgO	6.30	7.79	6.73
CaO	3.15	3.33	3.15
Na_2O	0.25	0.23	0.35
K_2O	7.62	6.82	10.45
P_2O_5	0.98	1.05	1.17
BaO	2.12	1.84	0.95
H_2O^+	5.31	5.29	1.97
H_2O^-	2.80	5.43	1.77
CO_2	<0.01	<0.01	—
Total	100.03*	100.46*	100.06

* Totals include trace analyses.

	ppm		
Co	200	230	
Cr	698	756	
Cu	125	140	
Ni	310	470	
Zn	225	240	
Rb	3100	2570	
Sr	1093	865	
Y	32	38	
Zr	1132	1270	
CIPW norms			
Q	9.06	3.78	4.38
C	—	2.04	—
or	45.04	40.03	51.71
ab	1.05	2.10	—
ac	0.92	—	2.31
ks	—	—	2.77
di	2.59	1.08	—
hy	14.60	19.00	16.80
hm	4.32	5.76	4.96
il	3.95	4.10	3.04
tn	7.25	8.81	6.46
ru	—	—	0.88
ap	2.35	2.35	2.69

1. Specimen 73284, darker coloured vitrophyric (unweathered) part. *Anal.* R. F. Lee.

2. Specimen 73284, lighter coloured, earthy-lustred (weathered) part. *Anal.* R. F. Lee.

3. Average of six previously published analyses of lamproite from Prider, 1960, analyses iv–ix.

the Oscar Plug, retaining the characteristic high potash content.

Specimens of the glassy lamproite from Oscar Plug all have an outer weathered zone of variable thickness and are weathered along the subconchoidal fractures (fig. 3) traversing individual specimens. Analyses of the weathered and unweathered parts of such a specimen, which are set out in Table III, indicate that there has been comparatively little leaching of potash during the devitrification and weathering processes. The main change noticeable is the lower silica and higher alumina, leading to the presence of a small amount of normative corundum in the weathered product.

The significance of these two analyses is in connection with most previously published analyses of the Western Australian lamproites which, of necessity, were of somewhat weathered material—the only material available at that time. The analyses of specimen 73284 indicate that the earlier published analyses validly indicated the unusual composition of these rocks.

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