

DEVONIAN LAMPROPHYRES FROM MT LYELL, WESTERN TASMANIA

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(with two tables and two text-figures)

BAILLIE, P.W. & SUTHERLAND F.L., 1992 (31:x) Devonian lamprophyres from Mt Lyell, western Tasmania. *Pap. Proc. R. Soc. Tasm.* 126: 19-22. <https://doi.org/10.26749/rstpp.126.19> ISSN 0080-4703. Department of Mines, PO Box 56, Rosny Park, Hobart, Tasmania, Australia 7018 (PWB); and Division of Mineralogy, Australian Museum, PO Box A285, Sydney South, NSW, Australia 2000 (FLS).

Mica concentrated from a post-cleavage lamprophyre occurring at the Prince Lyell Mine, Queenstown, has yielded a K-Ar age of 363 ± 3 Ma (latest Devonian). This minette is the first confirmed evidence of Devonian potassic lamprophyric activity from Tasmania and places an upper constraint on Devonian ductile deformation in western Tasmania.

Key Words: lamprophyre, geochronology, Devonian, Mt Lyell, Tasmania.

INTRODUCTION

Tasmania consists of a basement orogen (the southern extremity of the Tasman Fold Belt) overlain by relatively flat-lying Upper Carboniferous–Upper Triassic glacio-marine and fresh water successions, all of which have been intruded by thick sheets of mid-Jurassic dolerite (Burrett & Martin 1989).

Unsheared lamprophyre dykes intrude the Jurassic and older rocks at numerous localities throughout Tasmania (Sutherland & Corbett 1974). Previous dating of these post-orogenic lamprophyres of shoshonitic affinity has indicated episodes related to mid-Cretaceous syenitic or dioritic activity (Cygnnet – McDougall & Leggo 1965; Cape Portland – McDougall & Green 1982), or similar potassic alkaline activity of late Jurassic–early Cretaceous age (King Island – McDougall & Leggo 1965).

However, the extent of the Cretaceous alkaline magmatism was uncertain, particularly in respect to lamprophyric bodies intruding the Palaeozoic–Precambrian basement rocks of western Tasmania (Sutherland & Corbett 1974). To help resolve the question, lamprophyre dykes exposed in the Prince Lyell mine, Queenstown, were sampled for age determination.

DYKE RELATIONSHIPS

Lamprophyre dykes intruding both mineralised and unmineralised Mt Read Volcanics rocks in the Queenstown area (Solomon 1964, Corbett 1981) lie within a belt (fig. 1) that extends from north of Queenstown to south of Low Rocky Point and east to the Florentine Valley (Sutherland & Corbett 1974).

The Queenstown lamprophyres all consist of narrow tabular bodies, generally less than 2 m in width, which are unmineralised and uncleaved. In underground exposures at the Mt Lyell mine, it can be clearly observed that dyke intrusion was controlled by the strongly-developed pre-existing (presumably mid-Devonian) cleavage. Figure 2 is traced from a photograph taken in the now mined-out 30-Series stoping block and shows that some faulting locally accompanied the dilational intrusion.

DYKE CHEMISTRY AND PETROGRAPHY

In all surface and most sub-surface outcrops the lamprophyres are strongly weathered or altered. The freshest material available was excavated during construction of the Prince Lyell No. 1 Shaft (grid reference 55GCP825426).

The rock selected for dating (Geological Survey Tasmania specimen 101698) is a minette, porphyritic in texture and comprising 25–30% scattered euhedral to subhedral phenocrysts and glomeroporphyritic clusters of altered olivine, dark mica, clinopyroxene and opaques. Petrographically, two size ranges make up the phenocryst fraction; coarser crystals between 0.8 and 5.0 mm and smaller microphenocrysts.

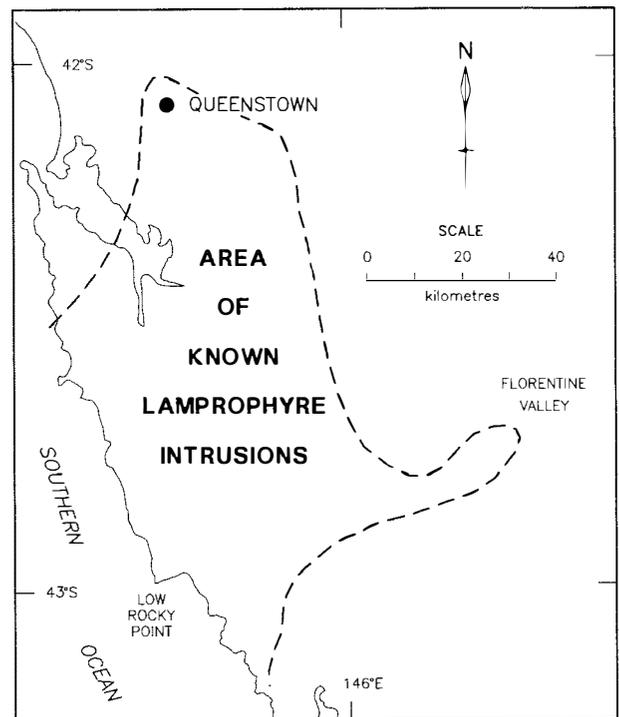


Fig. 1 — Locality map of western Tasmania showing known distribution of lamprophyre intrusions (after Sutherland & Corbett 1974).

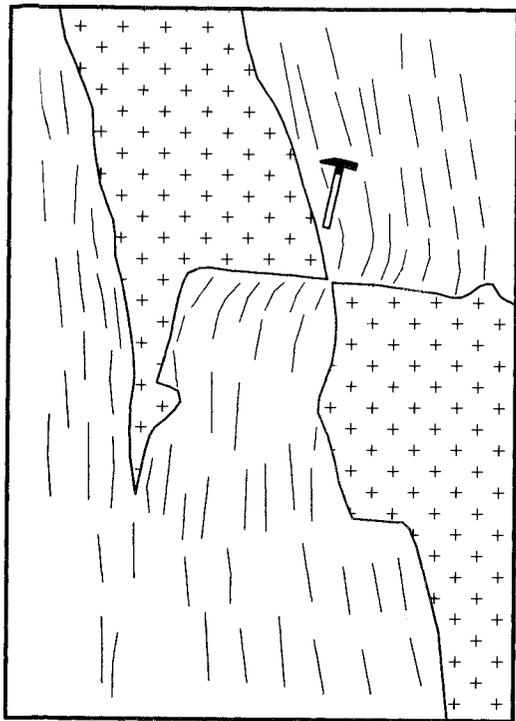


Fig. 2 — Outcrop in 30-series stopes, Prince Lyell mine, showing relationships between lamprophyre intrusion and pre-existing tectonic cleavage. Drawing traced from a photograph, geological hammer for scale.

Olivine comprises about 35% of the phenocrysts and is now composed of a talc-like mineral intergrown with carbonate (magnesite?), some minor chlorite and remnant small inclusions of red-brown spinel (chromite?). The mica (32%) is strongly pleochroic, mid-brown to straw coloured biotite-phlogopite; clinopyroxene (25%) is colourless with pale green margins; opaque oxides are also present (8%). The extremely fine-grained groundmass is largely altered and consists of subradiating aggregates of ?K-feldspar \pm ?nepheline, carbonate, and small aggregates of the biotite, opaque oxides and clinopyroxene.

Electron microprobe analyses of the main mineral phases (table 1) gave mica compositions ranging from Ti phlogopite to Ti biotite ($Mg_{72}Fe_{28}$ to $Mg_{60}Fe_{39}Ca_1$), pyroxene compositions ranging from diopside into augite ($Ca_{45-47}Mg_{42-46}Fe_{9-11}$) and feldspar compositions in the sanidine range ($K_{74-80}Na_{17-20}Ca_6$). The opaque oxides were mostly Ti magnetite and rarer ulvöspinel.

An analysis (table 2) shows the potassic character and high Ba, Rb, Sr typical of such mica-bearing rocks, although the Ba is also commonly carried in K-feldspar (Nemec 1987). This analysis is similar to the other minettes analysed from the Queenstown area (Solomon 1964), which are hypersthene \pm olivine \pm quartz normative rocks.

The relatively low silica and high magnesia (MgO 13.8 wt%; $Mg/(Mg+Fe^{2+}) 0.81$), with high compatible trace elements such as Cr and Ni and low incompatible elements such as Zr, suggests a primitive lamprophyre ($SiO_2 < 60\%$; mole% $Mg/(Mg+Fe) > 60$; $Cr > 200$ ppm; $Ni > 75$ ppm; Rock *et al.* 1988). The lamprophyre is difficult to classify within the four main groups, being slightly richer in MgO than the limit for calcalkaline lamprophyres, but like them shows a typical low Nb content (Rock 1987). The SiO_2 is too high for the ultramafic lamprophyres, K_2O too low for

most lamproites and K_2O/Na_2O (4.0) too high for most alkaline lamprophyres. More detailed assignment will require specific chemistry of the mineral phases and more extensive trace element data to compare with that documented for other lamprophyres.

GEOCHRONOLOGY

A sample of the rock was crushed and a biotite concentrate obtained by magnetic separation. Standard techniques were used to determine the potassium content in duplicate and for the extraction and isotopic analysis of the argon.

Analyses and calculated age are:

% K	6.80
$^{40}Ar^*$ ($\times 10^{-11}$ moles/g)	47.433
$Ar^*/^{40}Ar_{total}$	0.981
Age ($\times 10^6$ years)	363 ± 3

* Denotes radiogenic Ar.

Constants used:

$$^{40}K = 0.01167 \text{ atom\%}$$

$$\lambda_{\beta} = 4.962 \times 10^{-10} \text{ y}^{-1}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10} \text{ y}^{-1}$$

DISCUSSION

This paper documents the first recorded Devonian K-rich lamprophyric activity from Tasmania. Dolerites of possible Early Devonian age are present in the Que River region of northwestern Tasmania (Corbett & Komysan 1989), but these rocks are sodic and tholeiitic in character.

Using the time scale of Harland *et al.* (1990) the lamprophyre is latest Devonian (late-Famennian) in age, near the older end of the spectrum of granitoid ages in western Tasmania which range from 367 ± 10 to 319 ± 10 Ma (McClenaghan *et al.* 1989). The mica-bearing lamprophyric activity seems to precede intrusion of the nearest granitic batholith, over 40 km away at Heemskirk (331–362 Ma, maximum range of Rb-Sr and K-Ar ages), and may represent a similar situation to lamprophyric dyke swarms in Britain (Rock *et al.* 1988). There mica-bearing lamprophyres are less closely associated with granites than amphibole lamprophyres, and were related to generation at higher pressures (26–27 kb) at depths greater than 80–100 km where CO_2 exercises greater control than H_2O over melting of mantle sources. Although the primitive character of the Mt Lyell minettes initially suggests a relatively deep source, perhaps partial melting of a Large Ion Lithophile Element-enriched mantle, the role of crustal modifications in such melts is a critical aspect (Rock 1980).

The Mt Lyell dyke age shows that at least some of the western Tasmanian lamprophyres are Devonian. The age places an upper constraint on Devonian ("Tabberabberan") ductile deformation in western Tasmania, consistent with the presence of late Middle Devonian spores (*optivus-triangularis* spore assemblage zone, latest Givetian, about 375 Ma) in nonfolded cave deposits occurring within folded Ordovician limestone at Eugenana, near Devonport in northern Tasmania (Burns 1964, McGregor & Playford in press).

Table 1
Representative mineral analyses, Mt Lyell minette

Mineral analysis	Ti phlogopite (large)	Ti biotite (small)	Diopside (phenocrysts)	Sanidine (g/mass)
SiO ₂	37.30	35.39	52.09	64.74
TiO ₂	5.12	5.62	0.50	0.00
Al ₂ O ₃	15.00	15.46	1.85	19.01
FeO (total)	11.87	16.08	5.75	0.38
MnO	0.00	0.00	0.00	0.00
MgO	17.22	13.76	16.53	0.00
CaO	0.00	0.35	22.83	1.32
Na ₂ O	0.37	0.63	0.00	2.04
K ₂ O	9.39	8.82	0.00	13.18
Total	96.27	96.30	100.55	100.67
Si ⁴⁺	5.9386	5.7900	1.9411	11.8243
Ti ⁴⁺	0.6132	0.6871	0.0136	0.0000
Al ³⁺	2.8106	2.9606	0.0794	4.0873
Fe ²⁺	1.5802	2.1878	0.1759	0.0582
Mn ²⁺	0.0000	0.0000	0.0000	0.0000
Mg ²⁺	4.0865	3.3381	0.9011	0.0000
Ca ²⁺	0.0000	0.0607	0.8942	0.2592
Na ⁺	0.1128	0.1975	0.0000	0.7229
K ⁺	1.9070	1.8305	0.0000	3.0700
	17.0489	17.0523	4.0053	20.0219
	Fe 27.9	Fe 39.2	Fe 8.9	Ca 6.3
	Mg 72.1	Mg 59.8	Mg 45.7	Na 17.8
	Ca 0.0	Ca 1.1	Ca 45.4	K 75.8

Analyst B.J. Barron, using an automated ETEC electron microprobe, Macquarie University, NSW. Cation contents are based on 24 oxygens (mica), 6 oxygens (pyroxene) and 32 oxygens (feldspar) respectively.

Table 2
Whole-rock chemical analysis and CIPW norms, minette* from
Prince Lyell mine shaft[†]

Oxide	%	Trace element	g/t	CIPW Norm (anhydrous)
SiO ₂	48.14	Ba	2600	Fe ₂ O ₃ /FeO ratio 0.30
Al ₂ O ₃	10.94	Ni	460	Or 22.1
Fe ₂ O ₃	2.24	Pb	45	Ab 7.8
FeO	5.69	As	30	An 15.9
TiO ₂	0.89	Bi	b.d.	Di 6.9
MnO	0.19	Ga	13	Hy 28.2
CaO	7.47	Zn	79	Ol 9.3
MgO	13.80	Cu	78	Mt 2.8
K ₂ O	3.59	Co	45	Il 1.8
Na ₂ O	0.89	Sr	320	Py 0.1
P ₂ O ₅	0.34	U	5	Ap 0.9
SO ₃	0.17	Rb	130	Cc 4.2
CO ₂	1.78	Y	28	
+H ₂ O	3.62	Zr	200	
Total	99.75	Nb	10	
		Mo	b.d.	
		Cr	830	
		V	165	
		Sc	23	
		Th	18	
		Nd	46	
		Ce	125	
		La	60	

* Specimen no. 101698

[†] Analysis no. 851325

b.d. = below limit of detection for that particular element

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