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The mineralogy of K-richterite-bearing lamproites

Tables 5,6,7, 14, 15, and 16

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Table 5. Modal analyses (volume %) of the lamproites studied.

	74A1	72A7	11A8	73A8	7B8	5B6	MG77	8A12	SO136	60A7
Olivine	15.5	18.7	20.2	7.1	2.9					19.0
Clinopyroxene	9.3	12.1	22.3	15.3	5.7	21.6	6.6	1.1	0.3	12.5
Phlogopite	3.5	26.0	6.6	14.1	19.6	30.0	13.0	17.6	11.6	12.5
Richterite	26.6	2.6	2.0	1.5	6.7	0.7	30.7	18.8	24.9	0.2
Feldspar	42.3	36.0	20.2	48.3	18.7	41.7	45.8	47.7		49.6
Leucite					7.0				20.5	
Oxides	1.1	2.5	0.8	11.9	28.7	3.8	3.9	0.2	9.3	5.8
Glass			21.3		8.6	2.2				
Others	1.7	2.1	6.6	1.8	2.1			14.6	33.4	

Table 6. Representative electron microprobe analyses of unaltered olivines from the lamproites studied.

	1	2	3	4	5	6	7	8	9
	74A1	74A1	72A7	72A7	11A8	73A8	73A8	60A7	60A7
SiO <sub>2</sub>	39.83	39.46	40.07	40.15	40.47	38.83	39.65	38.97	40.69
FeO°	12.06	14.93	8.37	10.39	11.38	22.33	14.28	21.51	10.51
MgO	47.85	46.01	52.26	50.35	50.12	40.81	47.43	40.31	49.14
CaO	0.03	0.19	0.06	0.10	0.21	0.20	0.05	0.16	0.12
MnO	0.12	0.22	0.11	0.14	0.25	0.33	0.16	0.37	0.14
NiO	0.31	0.28	0.62	0.50	0.42	0.26	0.37	0.23	0.55
Total	101.20	101.11	101.49	101.63	102.85	102.74	101.94	101.55	101.15
Si	0.987	0.983	0.967	0.976	0.975	0.984	0.977	0.995	0.992
Fe <sup>2+</sup>	0.250	0.311	0.169	0.211	0.229	0.473	0.294	0.459	0.214
Mg	1.767	1.708	1.880	1.823	1.801	1.541	1.741	1.534	1.785
Ca	0.001	0.005	0.002	0.003	0.006	0.005	0.001	0.004	0.003
Mn	0.003	0.005	0.002	0.003	0.005	0.007	0.003	0.008	0.003
Ni	0.006	0.006	0.012	0.010	0.008	0.005	0.007	0.005	0.011
Total	3.014	3.018	3.032	3.025	3.024	3.015	3.023	3.005	3.008

FeO° = Total iron as FeO

Table 7. Representative electron microprobe analyses of clinopyroxenes from the lamproites studied.  
 $Fe^{3+}$  calculated assuming 4 cations and 6 oxygens.

	1	2	3	4	5	6	7	8	9	10	11	12
	74A1	72A7	11A8	73A8	7B8	7B8	5B6	5B6	MG77	61A3	SO136	60A7
SiO <sub>2</sub>	52.83	53.62	53.40	53.28	52.49	50.46	49.28	53.13	54.19	52.15	53.85	52.68
Al <sub>2</sub> O <sub>3</sub>	0.33	0.28	0.59	0.30	0.33	0.48	4.27	0.62	0.02	0.10		0.53
FeO°	3.35	3.31	2.35	5.30	3.59	4.58	8.08	3.68	3.27	3.97	2.26	3.80
MgO	17.31	18.06	17.40	17.64	18.48	17.38	12.64	17.80	19.12	19.19	17.98	18.85
CaO	22.53	22.26	23.61	21.16	21.08	20.45	22.63	23.27	21.89	21.94	24.64	21.69
Na <sub>2</sub> O	0.38	0.26	0.31	0.21	0.27	0.32	1.15	0.41	0.13		0.15	0.27
MnO	0.15	0.13	0.04	0.22	0.11	0.13	0.05	0.06	0.13	0.19	0.04	0.10
TiO <sub>2</sub>	0.96	0.83	0.49	0.72	1.36	2.58	0.35	0.36	0.75	0.66	1.03	0.65
Cr <sub>2</sub> O <sub>3</sub>	0.41	0.66	0.78	0.57	0.26	0.34	0.01	0.17	0.01	0.08	0.06	0.79
Total	98.36	99.41	98.97	99.40	97.97	96.72	98.46	99.50	99.51	98.28	100.01	99.36
Si	1.959	1.963	1.961	1.962	1.947	1.911	1.847	1.938	1.973	1.924	1.957	1.924
Al	0.014	0.012	0.026	0.013	0.014	0.021	0.189	0.027	0.001	0.004		0.023
Fe <sup>3+</sup>	0.030	0.015	0.025	0.021	0.028	0.023	0.180	0.102	0.020	0.109	0.040	0.084
Fe <sup>2+</sup>	0.074	0.086	0.048	0.142	0.083	0.122	0.073	0.011	0.079	0.014	0.029	0.032
Mg	0.957	0.986	0.953	0.968	1.022	0.981	0.706	0.968	1.038	1.055	0.974	1.026
Cr	0.012	0.019	0.023	0.017	0.008	0.010		0.005		0.002	0.002	0.023
Mn	0.005	0.004	0.001	0.007	0.003	0.004	0.002	0.002	0.004	0.006	0.001	0.003
Ti	0.027	0.023	0.014	0.020	0.038	0.073	0.010	0.010	0.021	0.018	0.028	0.018
Ca	0.895	0.873	0.929	0.835	0.838	0.830	0.909	0.909	0.854	0.867	0.959	0.849
Na	0.027	0.018	0.022	0.015	0.019	0.023	0.084	0.029	0.009		0.011	0.019

FeO° = Total iron as FeO

Table 14. Representative analyses of ilmenites from various lamproites, Fe<sup>3+</sup> calculated assuming 2 cations and 3 oxygens. Analysis n°9, from Shiprock, is a magnetite coexisting with ilmenite (formula calculated assuming 3 cations and 4 oxygens).

	1	2	3	4	5	6	7	8	9(M)	10	11	12	13	14
	74A1	74A1	72A7	11A8	73A8	73A8	5B6	5B6	5B6	MG77	MG77	8A12	S0136	60A7
Al <sub>2</sub> O <sub>3</sub>	0.07	0.02	0.02	0.03	0.05	0.05	0.02	0.03	0.17					
FeO°	44.69	40.50	41.31	41.74	40.53	34.15	43.97	48.21	76.61	41.15	33.51	44.00	41.58	46.97
MgO	1.92	6.41	3.18	4.15	4.02	8.49	0.66	1.15		3.64	9.58	0.68	1.99	1.57
MnO	0.72	0.58	0.89	0.93	0.79	0.50	4.76	1.25	0.98	1.25	0.78	1.59	2.88	0.79
TiO <sub>2</sub>	51.64	50.18	53.90	50.96	53.63	56.49	50.29	47.50	13.11	53.65	55.78	53.75	53.16	49.07
Cr <sub>2</sub> O <sub>3</sub>	0.50	0.58			0.18	0.36	0.04	0.05	0.20	0.09	0.31		0.28	0.05
Total	99.54	98.18	99.30	97.81	99.15	100.04	99.74	98.19	91.07	99.78	99.96	100.02	99.89	98.45
Fe <sub>2</sub> O <sub>3</sub>	2.67	8.17		4.73	0.30		5.27	9.79	39.87	0.73	1.35		0.12	7.16
FeO	42.29	33.15		37.49	40.26		39.23	39.40	40.74	40.49	32.29		41.47	40.53
Al	0.002		0.001	0.001		0.001	0.001	0.001	0.008					
Fe <sup>3+</sup>	0.050	0.150		0.089	0.006		0.100	0.187	1.198	0.014	0.024		0.002	0.136
Fe <sup>2+</sup>	0.882	0.675	0.855	0.781	0.831	0.674	0.824	0.835	1.361	0.833	0.634	0.920	0.863	0.856
Mg	0.071	0.233	0.118	0.154	0.148	0.299	0.025	0.043		0.133	0.335	0.025	0.074	0.059
Mn	0.015	0.012	0.019	0.020	0.017	0.010	0.101	0.027	0.033	0.026	0.016	0.034	0.061	0.017
Ti	0.969	0.917	1.004	0.955	0.995	1.003	0.950	0.906	0.394	0.992	0.985	1.011	0.995	0.932
Cr	0.010	0.011			0.004	0.007	0.001	0.001	0.006	0.002	0.006		0.005	0.001

FeO° = Total iron as FeO

(M) = magnetite

Table 15. Partitioning coefficients of fluorine (OH calculated) and of iron and magnesium between coexisting micas and K-richterites.

	$\frac{F}{F + OH}$			$\frac{FeO}{FeO + MgO}$		
	Mica	Richt.	$K_D$	Mica	Richt.	$K_D$
74A1	0.215	0.233	0.91	0.2407	0.2374	1.02
72A7				0.2677	0.2457	1.12
11A8				0.3536	0.3355	1.08
73A8	0.614	0.632	0.92			
7B8	0.295	0.254	1.23	0.2895	0.2109	1.50
5B6				0.4291	0.4907	0.78
8A12	0.074	0.088	0.83	0.4212	0.4382	0.93
S0136	0.124	0.098	1.30	0.2945	0.2009	1.60
60A7				0.3535	0.3078	1.20

Table 16. Representative electron microprobe analyses of micas and amphiboles, with fluorine determinations. Formula calculations are made assuming ideal values for interlayer site occupancy.

TAB 16

	1A	2A	3M	4M	5A	6M	7M	8A	9M	10M	11A	12A	13M	14A	15M
	74A1	74A1	74A1	74A1	73A8	73A8	73A8	7B8	7B8	7B8	61A3	61A3	61A3	SO136	SO13
SiO <sub>2</sub>	54.60	53.25	40.94	40.54	53.14	38.37	40.89	51.29	38.76	37.98	51.85	52.02	38.75	50.05	39.67
Al <sub>2</sub> O <sub>3</sub>	0.27	0.41	10.34	10.40	0.36	11.04	10.95	0.39	10.21	9.65	0.13	0.05	11.15	0.08	6.03
FeO°	4.23	3.06	5.87	5.82	5.78	5.33	4.05	4.28	6.02	7.85	12.91	11.82	6.12	5.31	9.93
MgO	18.99	20.87	20.46	21.12	19.13	23.29	24.10	18.98	18.78	17.04	14.14	14.70	23.30	17.40	18.66
CaO	6.45	6.73		0.01	6.51			6.24		0.07	5.24	5.33		6.30	
Na <sub>2</sub> O	4.26	4.24		0.10	5.13			3.95	0.16	0.10	4.43	4.13	0.09	3.18	0.27
K <sub>2</sub> O	4.06	3.93	9.84	9.80	2.61	9.60	9.85	4.09	9.15	9.10	3.92	4.04	9.93	5.39	9.72
MnO	0.04	0.06		0.01	0.05	0.05		0.06	0.03	0.13	0.21	0.24		0.09	0.02
TiO <sub>2</sub>	5.31	4.06	6.77	6.49	2.49	4.02	2.50	5.45	9.01	9.93	2.67	2.41	4.16	6.04	7.91
F	0.11	1.22	1.08	3.27	2.74	4.14	5.32	1.09	4.99	0.41	0.84	0.11	0.57	0.41	1.02
Cl	0.03	0.01	0.02	0.01	0.01	0.03	0.03					0.01	0.02	0.01	
Total	98.35	97.84	95.32	97.57	97.95	96.17	98.00	95.82	97.11	92.26	96.34	94.86	94.09	94.26	93.27
O=F	0.05	0.51	0.46	1.38	1.15	1.74	2.24	0.46	2.10	0.17	0.35	0.05	0.24	0.17	0.43
Total	98.30	97.33	94.86	96.19	96.80	94.43	95.76	95.36	95.01	92.09	95.99	94.81	93.85	94.09	92.84
Si	7.696	7.613	2.963	2.936	7.752	2.852	2.983	7.538	2.878	2.862	7.825	7.869	2.847	7.521	3.015
Al	0.045	0.069	0.882	0.888	0.062	0.968	0.942	0.068	0.894	0.857	0.024	0.009	0.966	0.014	0.541
Fe <sub>2+</sub>	0.499	0.366	0.356	0.353	0.705	0.332	0.248	0.526	0.374	0.495	1.620	1.495	0.376	0.667	0.632
Mg	3.990	4.447	2.206	2.279	4.169	2.581	2.620	4.157	2.078	1.913	3.180	3.314	2.551	3.897	2.115
Ca	0.974	1.031			1.018			0.983		0.006	0.847	0.864		1.014	
Na	1.165	1.175		0.014	1.451	0.044	0.044	1.126	0.023	0.015	1.296	1.212	0.013	0.927	0.046
K	0.730	0.717	0.909	0.906	0.486	0.911	0.917	0.767	0.867	0.875	0.755	0.780	0.931	1.033	0.944
Mn	0.005	0.007			0.006	0.003		0.007	0.002	0.008	0.027	0.031		0.012	0.003
Ti	0.563	0.436	0.369	0.354	0.274	0.225	0.137	0.602	0.503	0.563	0.303	0.275	0.230	0.683	0.453
F	0.049	0.552	0.242	0.749	1.264	0.974	1.228	0.507	1.172	0.098	0.401	0.053	0.133	0.195	0.281
OH	1.951	1.448	1.753	1.251	0.736	1.027	0.773	1.493	0.829	1.902	1.599	1.947	1.868	1.805	1.711
Total	17.667	17.861	9.680	9.730	17.923	9.917	9.892	17.774	9.620	9.594	17.125	17.849	9.915	17.768	9.750

FeO° = Total iron as FeO

OH is calculated

A, amphibole; M, mica