AM-77-047

AN EMPIRICAL STUDY OF DIFFUSION IN GARNET

(SUPPLEMENTARY INFORMATION FOR MICROFILM FILE)

Bruce W.D. Yardley

American Mineralogist, 62, pages 793-800

TABLE 1 : ELECTRON MICROPROBE ANALYSES OF GARNETS ILLUSTRATED IN FIGS. 1 & 2.

Analyses are given for the outermost edges, cores, and in some cases intermediate 'flanks', and are averages compiled from the point analyses plotted in Fig. 1. Total Fe is expressed as FeO, - denotes 'not determined'. Analyses were made using the 5 channel A.R.L. EMX-SM microprobe at the University of Washington. R^{2+} cations were determined simultaneously, and the traverse repeated for other elements. An accelerating potential of 15 kv and beam size of 5 microns were used throughout; counting was terminated on 200000 beam current units. Natural minerals, including Nuevo Spessartite, Chihuahua Grossular and 12442 Almandine-Pyrope were used as standards, and the data reduced using a Bence-Albee procedure.

SAMPLE	149 CORE	149 FLANKS	149 EDGE	111 CORE	111 FLANKS	111 EDGE
SiO_2	36.80	36.85	36.98	37.37	37.19	37.25
TiO_2	0.15	0.08	0.09	0.12	0.04	0.03
Al_2O_3	20.50	20.43	20.49	20.43	20.49	20.47
Cr_2O_3	0.01	0.03	0.03	-	-	-
FeO	30.28	35.30	32.83	30.82	34.62	35.11
MgO	0.90	2.23	2.00	1.35	3.00	2.69
MnO	4.44	1.62	3.99	4.39	2.54	2.72
CaO	6.85	3.27	2.83	4.40	1.72	1.31
Total	99.93	99.81	99.24	98.88	99.60	99.58
Formula cations to 12 Oxygens						
Si	2.987	2.994	3.015	3.045	3.014	3.024
Ti	0.009	0.005	0.006	0.007	0.002	0.002
Al	1.961	1.956	1.969	1.962	1.957	1.959
Cr	0.001	0.002	0.002	-	-	-
Fe	2.056	2.399	2.238	2.100	2.346	2.384
Mg	0.109	0.270	0.243	0.164	0.362	0.326
Mn	0.305	0.111	0.276	0.303	0.174	0.187
Ca	0.596	0.285	0.247	0.384	0.149	0.114
End member proportions						
Almandine	67.06	78.26	74.51	71.17	77.38	79.19
Pyrope	3.55	8.81	8.09	5.55	11.95	10.81
Spessartine	9.96	3.64	9.17	10.27	5.75	6.21
Grossular	19.40	9.19	8.13	13.01	4.93	3.79
Uvarovite	0.03	0.10	0.10	-	-	-

SAMPLE	146 CORE	146 EDGE	210 CORE	210 FLANKS	221 CORE	221 EDGE
SiO_2	37.30	37.26	37.07	37.09	37.40	37.32
TiO_2	0.18	0.10	0.05	0.03	0.02	0.03
Al_2O_3	20.24	20.46	20.42	20.70	20.26	20.30
Cr_2O_3	-	-	0.02	0.02	-	-
FeO	28.07	33.24	33.90	34.85	34.94	34.52
MgO	1.02	1.96	3.03	2.87	2.50	2.27
MnO	7.31	2.76	3.69	3.25	3.78	4.49
CaO	5.80	3.79	1.29	0.89	1.07	0.96
Total	99.92	99.57	99.47	99.70	99.97	99.89
Formula cations to 12 Oxygens						
Si	3.023	3.022	3.012	3.008	3.034	3.033
Ti	0.011	0.006	0.003	0.002	0.001	0.002
Al	1.933	1.956	1.955	1.978	1.937	1.944
Cr	-	-	0.001	0.001	-	-
Fe	1.903	2.255	2.303	2.364	2.370	2.346
Mg	0.123	0.237	0.367	0.347	0.302	0.275
Mn	0.502	0.190	0.254	0.223	0.260	0.309
Ca	0.504	0.329	0.112	0.077	0.093	0.084
End member proportions						
Almandine	62.77	74.89	75.85	78.50	78.35	77.85
Pyrope	4.06	7.87	12.08	11.52	9.99	9.12
Spessartine	16.55	6.30	8.36	7.41	8.58	10.26
Grossular	16.61	10.94	3.63	2.50	3.07	2.77
Uvarovite	-	-	0.06	0.06	-	-

AM MIN, Vol. 62 pp. 1052-1056

THE SOLUBILITY OF AMORPHOUS SILICA IN WATER AT HIGH TEMPERATURES AND HIGH PRESSURES

by

R. O. Fournier and J. J. Rowe

Supplementary table showing experimental conditions and measured solubilities. In both the colorimetric and total silica columns the two numbers show the analytical results for duplicate samples of solution extracted from the bomb.

Days from start with same silica charge	Days at constant T & P	T °C	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
0	0									Vitreous silica starting material
3	3	271	1.84	1034	.860	2115	2110	2110	2270	
4	4	271	1.84	1034	.860	1970	2160	2060	2145	
5	5	272	1.84	1034	.860	2175	2180	2180	2170	
5	0	295								Increased temp.
6	1	295	1.76	1034	.833	2445	2500	2440	2470	
7	2	295	1.76	1034	.833	2450	2470	2420	2485	
7	0	320								Increased temp.
10	3	320	1.69	1034	.810	2800		2900		
11	4	321	1.69	1034	.810	2860	2880	2875	2900	
11	0	357								Increased temp.
12	1	357	1.59	1034	.755	3300	3350	3320	3310	

Days from start with same silica charge	Days at constant T & P	T °C	1000/T °k	P Bars	Density of water	Colorimetric silica mg/kg a	Colorimetric silica mg/kg b	Total silica a	Total silica b	Remarks
12	0	421								Increased temp.
14	2	421	1.44	1034	.660	3980	3990	3980	3985	
14	0									Lowered temp.
15	1	125								
93	78	123	2.53	1034	.985	585		585		
94	79	124	2.52	1034	.985	580	615	585	615	
94	0	142								Increased temp.
102	8	142	2.41	1034	.971	725	755			
107	13	142	2.41	1034	.971	725	725	755	725	
107	0	171								Increased temp.
109	2	171	2.26	1034	.948	985	980	950	965	
112	5	171	2.26	1034	.948	1000		1000		
113	6	171	2.26	1034	.948	960	960	960	960	
113	0	215								Increased temp.
116	3	215	2.05	1034	.911	1420	1420	1375	1420	
121	8	214	2.05	1034	.911	1390	1430	1390	1390	
121	0	214		1379						Increased pressure
123	2	214	2.05	1379	.931	1520	1520	1490	1500	
128	7	214	2.05	1379	.931	1570	1560	1620	1560	
130	9	214	2.05	1379	.931	1540	1540	1470	1500	
131										Cooled and opened bomb. No apparent devitrification of the vitreous silica.

Days from start with same silica charge	Days at constant T & P	T °C	1000/T °k	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
0	0	382								Started new series of experiments using fresh charge of vitreous silica
5	5	382	1.53	245	.46	1000	1005	1005	1030	
5	0	382		355						Increased pressure
8	3	382	1.53	355	.53	2100	2070	2145	2345	
9	4	382	1.53	355	.53	2090	2060	2160	2080	
9	0	382		517						Increased pressure
15	6	382	1.53	517	.630	2760	2760	2880	2845	
15	0	382		690						Increased pressure
20	5	382	1.53	690	.672	3180	3135	3775	3685	
21	6	382	1.53	690	.672	2905	3100	3705	3885	Cristobalite starting to precipitate from solution.
22	7	382	1.53	690	.672	2905	3100	3705	3885	
23	8	382	1.53	690	.672	3145	3150	5060	5120	
23	0	382		866						Increased pressure
24	1	382	1.53	866	.702	3100	3280	6690	7060	
29	5									Cooled and opened bomb. Glass rods were coated with granuale bioefringent material, opal CT

Days from start with same silica charge	Days at constant T & P	T °C	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
0	0	200		200						Cleaned bomb and filled with fresh charge of vitreous silic Brought to temperature.
7	7	200	2.14	200	.878	975	975	1090	1020	
9	9	200	2.14	200	.878	965	970	960	965	
9	0	200		345						Increased pressure.
11	2	200	2.14	345	.888	1010	1010	1110	1120	
11	0	200		510						Increased pressure.
14	3	200	2.14	510	.895	1070	1080	1100	1085	
14	0	200		843						Increased pressure.
21	7	200		843	.915	1195	1210	1210	1240	
23	9	200		843	.915	1210	1210	1210	1210	
23	0	200		1034						Increased pressure.
35	12	200	2.14	1034	.925	1275	1285	1340	1340	
36										Cooled bomb for repair of sampling valve.
37	0	200		1045						Brought back to temperature
44	7	200	2.14	1045	.928	1265	1265	1275	1310	
44	0	265		338						Increased temp., lowered pressure, and bleed 400 ml of solution from the bomb

Days from start with same silica charge	Days at constant T & P	T °C	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
48	4	265	1.86	338	.808	1595	1625	1625	1650	
48	0									Increased pressure.
51	3	265	1.86	517	.827	1735	1760	1805	1770	
51	0	265		690						Increased pressure.
54	3	265	1.86	690	.841	1870	1870	1945	1935	
54	0	263		862						Increased pressure.
58	4	263	1.86	862	.856	1970	1990	2015	2035	
58	0	263		1034						Increased pressure.
62	4	262	1.87	1034	.867	2050	2055	2050	2070	
70	12	265	1.87	1034	.863	2110	2110	2175	2145	
70	0									Increased temp. and lowered pressure.
72	2	313	1.71	221	.708	1795	1795	1835	1815	
72	0	313		345						Increased pressure.
75	3	313	1.71	345	.737	1980	1990	1980	2000	
75	0	313		510						Increased pressure.
77	2	313	1.71	510	.762	2220	2200	2255	2255	
77	0	313		696						Increased pressure
79	2	312	1.71	696	.777	2410	2420	2475	2465	
79	0	312		862						Increased pressure.
81	3	310	1.72	862	.794	2550	2575	2035	2125	

Days from start with same silica charge	Days at constant T & P	T °C	1000/T °k	P Bars	Density of water	Colorimetric silica mg/kg a	Colorimetric silica mg/kg b	Total silica a	Total silica b	Remarks
83	5	311	1.71	862	.794	2585	2595			
84	6	312	1.71	872	.795	2595	2605	2595	2615	
84	0	312		1048						Increased pressure.
85	1	312	1.71	1048	.813	2760	2750	2780	2780	
85	0	340		1048						Increased temp.
92	7	340	1.63	1079	.782	3175	3190	3175	3190	
92	0	340		238						Bleed 55 ml of solution from bomb. Lower pressure.
96	4	336	1.64	238	.652	1900	1910	1850	1910	
98	6	339	1.63	234	.642	1875	1890	1910	1880	
103	11	337	1.64	241	.653	1910	1910	1910	1910	
103	0	337		497						Increased pressure.
106	3	338	1.64	497	.715	2385	2375	2385	2375	
111	8	338	1.64	510	.715	2420	2430	2430	2420	
111	0	338		690						Increased pressure.
113	2	338	1.64	690	.741	2700	2690	2670	2725	
116	5	338	1.64	703	.741	2720	2730	2705	2705	
116	0	338		848						Increased pressure.
118	2	338	1.64	848	.759	2890	2905	2875	2880	
120	4	338	1.64	855	.760	2870	2910	2910	2930	
120	0	338		1028						Increased pressure.

Days from start with same silica charge	Days at constant T & P	°C T	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
123	3	338	1.64	1028	.776	3100	3120	3090	3120	
125	5	338	1.64	1034	.776	3070	3100	3040	3090	
125										Bomb cooled and opened. No devitrification of glass rods detected.
0	0	225		276						Bomb reassembled with a 35 gm charge of gelatinous silica.
2	2	225	2.01	276	.855	1260	1245	1520	1540	
4	4	226	2.00	283	.855	1260	1260	1620	1650	
4	0	226		510						Increased pressure.
7	3	226	2.00	510	.871	1330	1330	1750	1780	
9	5	226	2.00	510	.871	1330	1330	1750	1725	
9	0	226		686						Increased pressure.
11	2	226	2.00	686	.882	1400	1420	1880	1915	
20	11	224	2.01	690	.882	1375	1370			
22	13	224	2.01	690	.882	1370	1365	1545	1505	
22	0	224		862						Increased pressure.
25	3	222	2.02	862	.891	1430	1425	1590	1585	
27	5	222	2.02	848	.889	1425	1420	1560	1590	
27	0	222		1034						Increased pressure.

Days from start with same silica charge	Days at constant T & P	T °C	1000/T °k	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
29	2	222	2.02	1034	.905	1495	1495	1640	1650	
35	8	222	2.02	1048	.908	1480	1485	1625	1705	
39	12	217	2.04	1048	.910	1470	1465	1690	1740	
39	0	259		414						Increased temp. and lowered pressure.
43	4	259	1.88	414	.823	1707	1705	1955	2025	
46	7	257	1.89	427	.823	1680	1710	1975	1970	
46	0	267		724						Increased pressure and temperature.
48	2	267	1.85	724	.838	1940	1930	2370	2630	
50	4	268	1.85	724	.838	1930	1935	2160	2145	
50	0	268		1034						Increased pressure
54	4	268	1.85	1034	.865	2136	2150	2375	2370	
55	5	268	1.85	1034	.865	2160	2150	2430	2430	
56	6	268	1.85	1034	.865	2130	2135	2420	2415	
56	0	313		345						Increased temp. and lowered pressure.
57	1	313	1.71	345	.738	2035	2040	2230	2195	
61	4	310	1.72	324	.737	1960	1965	2265	2290	
61	1	310		690						Increased pressure.
63	2	312	1.71	690	.778	2435	2430	2890	2840	
65	4	311	1.71	703	.783	2415	2425	2885	2860	
65	0	311		1007						Increased pressure.

Days from start with same silica charge	Days at constant T & P	°C	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg a	Colorimetric silica mg/kg b	Total silica a	Total silica b	Remarks
68	3	310	1.72	1007	.813	2680	2660	3205	3255	
68										Experiment terminated.
0	0	181		1034						Filled bomb with fresh charge of gelatinous silica and brought to T&P
1	1	181	2.20	1034	.943	1135	1125	1540	1990	
2	2	181	2.20	1034	.943	1080	1120	1800	1550	
2	0	192		1034						Increased temp.
3	1	192	2.15	1034	.932	1245	1250	1590	1645	
4	2	190	2.16	1034	.933	1210	1205	1560	1550	
4	0	208		1034						Increased temp.
7	3	208	2.08	1034	.920	1420	1425	1850	1870	
8	4	207	2.08	1034	.920	1420	1405	1850	1745	
8	0	214		1034						Increased temp.
9	1	214	2.05	1034	.914	1440		1825		
9	0	243		1034						Increased temp.
10	1	243	1.94	1034	.886	1700	1700	2105	2205	
11	2	240	1.95	1034	.889	1760	1820	2180	2200	
11	0	310		1034						Increased temp.
21	10	310	1.72	1034	.813	2700	2740	3345	3410	
21	0	352		1034						Increased temp.
24	3	352	1.60	1034	.762	2700	2600	4325	4280	
24	0	375		1034						Increased temp.

Days from start with same silica charge	Days at constant T & P	T °C	$\frac{1000}{T°k}$	P Bars	Density of water	Colorimetric silica mg/kg		Total silica		Remarks
						a	b	a	b	
27	3	375	1.54	1034	.729	3720	3720	4290	4205	
32	8	374	1.54	1034	.729	3780	3790	4100	4200	
32	0									Increased temp.
38	6	395	1.50	1034	.701	3560	3540	3580	3600	
38										Terminated experiment. Found mixture of amorphous material and opal CT.