Table 8. *Electron microbe analyses of garnets crystallizing from the rhyodacite II composition at high pressures. Runs conducted under wet conditions (1 mgm H_2O added) in graphite capsules*

Conditions of run	27 kb 1340°C 80 mins[b]	18 kb 920°C 150 mins	18 kb 880°C 240 mins	18 kb 890°C 180 mins	18 kb 840°C 240 mins	9 kb 820°C 255 mins
Co-existing phases	qz	—	—	qz, cpx ?	qz, amph	qz, amph, plag, mica
SiO_2	35.0[a]	37.2[a]	37.9[a]	36.3[a]	37.1[a]	36.8[a]
TiO_2	1.0	1.6	1.4	1.8	1.4	
Al_2O_3	21.9	21.6	20.7	21.9	21.0	20.8[a]
FeO	28.1	25.0	24.9	22.2	26.7	38.0
MnO	0.2	0.6	0.6	0.4	0.9	1.0[a]
MgO	4.5	7.4	5.9	5.2	4.1	1.0
CaO	4.4	4.4	6.5	9.0	7.4	2.4
	95.1	97.8	97.1	96.8	98.6	100.0
$\frac{100\ Mg}{Mg + Fe}$	22.2	34.5	29.7	29.4	21.5	4.4
Mol. prop.						
Ti-andracite	3.2	4.7	4.4	5.5	4.4	—
grossularite	10.0	8.1	14.4	20.9	17.0	7.1
pyrope	19.2	29.6	23.7	21.4	16.4	4.0
almandine	67.1	56.2	56.1	51.3	60.1	86.5
spessartine	0.5	1.4	1.4	0.9	2.1	2.4

Fe_2O_3 content cannot be determined using the electron microprobe, so the total iron content has been calculated as almandine. Since the runs were conducted in graphite capsules, reducing conditions results so that the Fe_2O_3 content is small or absent and neglect of any andradite component should not be serious.

[a] Denotes calculated content.
[b] No water added to this sample.

accidental inclusion as xenocrysts in the calc-alkaline magma. These features may be summarized as follows:

(i) The garnets exhibit large size (up to 1 cm), subhedral-euhedral habit and are free of inclusions. In contrast, almandine garnets from metamorphic environments typically contain abundant inclusions (Atherton and Edmunds, 1966; T. H. Green, 1966, 1967).

(ii) The natural garnets are characterized by an extremely uniform composition even though they come from different host rocks spread over an area of several thousand square miles.

(iii) There is a possible direct relation between the garnet composition and the composition of the host rock.

(iv) Minor zoning (rims slightly richer in Fe, Mn and poorer in Mg than the cores) which occurs in the garnet phenocrysts is consistent with the zoning expected during igneous crystallization. The zoning always followed this consistent pattern. No other variations or reverse zoning was observed as might be expected if the garnets were xenocrystal in origin, derived by accidental inclusion from a metamorphic terrain (e.g. garnets from metamorphic terrains studied by Atherton and Edmunds, 1966; Banno, 1965 exhibited marked zoning; however almandine garnets from some high grade metamorphic rocks from Australia showed no zoning, T. H. GREEN, 1967).

(v) Experimental evidence has shown that almandine-rich garnets are a liquidus or near-liquidus phase crystallizing from rhyodacite at >9 kb under conditions of $P_{H_2O} < P_{LOAD}$. Thus for these conditions almandine-rich garnet may crystallize directly from an acid calc-alkaline magma.

(vi) The garnet phenocrysts are unstable at near-surface conditions, and react with the rhyodacite liquid to form cordierite-hypersthene rims. This cordierite-

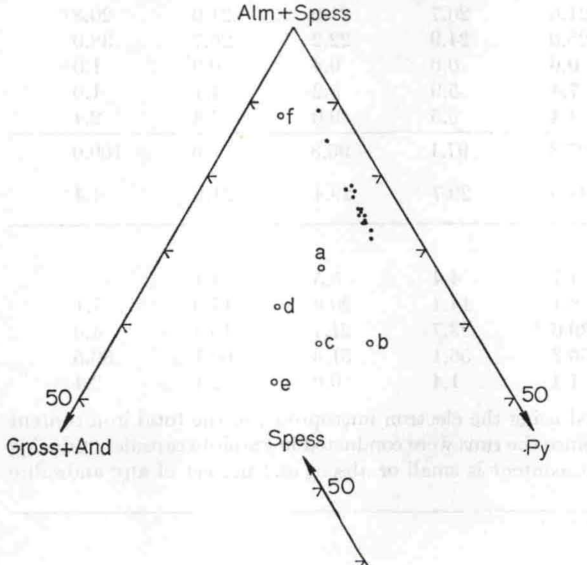

Fig. 1. Composition plot (mol. percent) of garnets analyzed from calc-alkaline igneous rocks of Victoria (solid circles) together with garnets analyzed from experimental runs on the rhyodacite II composition (open circles)
a) 27 kb, 1340° C
b) 18 kb, 920° C
c) 18 kb, 880° C
d) 18 kb, 840° C
e) 18 kb, 890° C
f) 9 kb, 820° C

hypersthene association is typical of low pressure, high temperature metamorphic conditions (TURNER and VERHOOGEN, 1960).

As indicated in point (v) above the high pressure experimental work on the rhyodacite composition broadly supports the igneous crystallization origin of the almandine-rich garnets at great depth. However a comparison of the experimental and natural garnet compositions shows that the near-liquidus garnets crystallizing at 18 and 27 kb are significantly richer in grossular and poorer in almandine than the natural examples. The garnet crystallizing at 9 kb, 840° C in company with