pressure, garnet coexisting with ilmenite at 1040° C contains 1.4% TiO_2 but this decreases through runs at 1020° C, 1000° C to 0.8% TiO_2 at 900° C.

In the pyrolite (less-40%-olivine) composition, garnet coexisting with ilmenite contains 0.9–1.6% TiO_2 at 1100° C, 0.7–1.1% TiO_2 at 1000° C and 0.4% TiO_2 at 950° C (Table 1). The data suggest a decrease in TiO_2 content at lower temperatures but are not sufficient to evaluate possible systematic pressure or compositional effects as opposed to analytical uncertainty in giving rise to the rather large spread in TiO_2 at any one temperature.

We have evidence for compositional control on the amount of TiO_2 soluble in the pyrope-almandine solid solution in that garnet from pyrolite ($\sim Mg_{75}$) has lower TiO_2 content than that from basanite (Mg_{50-60}), crystallized at similar P, T conditions (Tables 1, 2 and 5).

(b) *Ilmenite*. The ilmenites analyzed from both pyrolite and basanite composition are characterized by high (Fe, Mg) TiO_3 contents and low degrees of solid solution of Cr_2O_3, Fe_2O_3 and Al_2O_3. This feature is very well illustrated in the TiO_2 vs MgO diagram utilized by Sobolev (1974) to illustrate variation in natural ilmenites from kimberlite pipes. This diagram can be contoured for Fe_2O_3 content of ilmenite and such contours are approximately correct for ($Cr_2O_3+Fe_2O_3$) solid solutions because of similar molecular weights of Cr_2O_3 and Fe_2O_3. The analyzed magnesian ilmenites (Mg_{42}—Mg_{48}) from the experimental runs on pyrolite-less-40% olivine composition have $<5\%\ Fe_2O_3+Cr_2O_3$ and the major substitution is Cr_2O_3 (1.4–2.3% Cr_2O_3) with minor Al_2O_3 and possibly very minor Fe_2O_3. In the basanite composition, Cr_2O_3 is not detectable in ilmenite and the more iron-rich ilmenites (Mg_{15}—Mg_{28}) require low Fe_2O_3 contents to satisfy structural formulae constraints.

In Fig. 1, the experimentally synthesized ilmenites are compared with natural ilmenites of various paragenetic associations occurring within kimberlite pipes. The synthetic magnesian ilmenites most closely resemble these ilmenites occurring in intergrowth with diamond and those occurring in intergrowth with garnet or within garnet peridotite. Most discrete ilmenite crystals within kimberlite have higher Fe_2O_3 contents, implying higher oxygen fugacity at crystallization than the conditions pertaining within the piston-cylinder apparatus. The ilmenite megacrysts occurring in basanite magmas in N.S.W. (Binns, 1969; Wass, 1971) are similar to but have slightly higher Fe_2O_3 contents than those crystallized experimentally from the basanite. One ilmenite megacryst occurring within a mantle-derived nepheline benmoreite magma (Green *et al.*, 1974) from S.E. Queensland has low MgO content and low Fe_2O_3 content, closely resembling the ilmenite crystallized from basanite at 900° C (i.e. after a moderately high degree of crystallization of the basanite liquid).

The data on ilmenite compositions synthesized in the presence of a water-rich fluid phase or with water dissolved in the silicate melt phase, demonstrate that the experimental techniques used maintain oxygen fugacity at low values, consistent with equilibrium with carbon (graphite or diamond) in the C—H—O system. Experiments in a basalt-H_2O—CO_2 system (Brey and Green, 1975) at 30 kb using the oxygen buffering technique have shown that at 30 kb, 1100 to 1200° C with f_{O_2} buffered by the magnetite—haematite buffer, titanomagnetite rather than ilmenite coexists with garnet, and the garnet contains andradite solid

Table 1. Compositions of coexisting garnets and ilmenites in the pyrolite less 40% olivine
$Ag_{75}Pd_{25}$ capsules except

Run conditions	35 kb 1500° C "Dry"	40 kb 1100° C 0.3% H_2O		29 kb 1100° C 0.3% H_2O	28 kb 1100° C 0.3% H_2O		21 kb 1100° C 0.3% H_2O	
Phase	Ga[a]	Ga	Ilm	Ilm	Ga	Ilm	Ga	Ilm
SiO_2	41.3	41.3	0.6	0.6	41.9	0.6	41.3	0.9
TiO_2	1.4	0.9	57.1	56.8	1.6	57.2	1.3	55.9
Al_2O_3	20.9	21.7	0.6	0.9	20.7	0.9	21.1	1.0
Cr_2O_3	2.1	1.7	1.6	2.0	1.9	2.1	1.9	2.3
FeO	7.2	10.2	27.4	26.5	9.7	27.0	10.3	27.2
MnO	—	0.3	0.2	0.3	0.2	0.2	0.3	0.3
MgO	20.7	19.0	12.9	13.6	18.5	13.7	17.9	13.0
CaO	5.0	5.2	0.4	0.4	7.1	0.3	7.2	0.4
Na_2O	—	0.2	—	0.3	—	0.3	—	0.2
Mol. proportions								
100 Mg/Mg + Fe	83.5	76.8	45.8	47.9	77.2	47.4	75.8	45.8
Ca	12.7	13.2	—	—	17.5	—	17.9	—
Mg	72.9	66.7	45.8	47.9	63.7	47.4	62.2	45.8
Fe	14.4	20.1	54.2	52.1	18.8	52.6	19.9	54.2
$K_{D(Fe, Mg)}^{ilm\text{-}ga}$		3.91			3.76		3.70	

[a] Presence of ilmenite not confirmed by electron probe, garnet coexists with olivine, enstatite,

Table 2. Compositions of coexisting garnets and ilmenites in olivine basanite at various
except column 1

Run conditions	30 kb 1280° C 4.5% H_2O	25 kb 1160° C 4.5% H_2O	25 kb 1140° C 4.5% H_2O	25 kb 1120° C 4.5% H_2O	30 kb 1050° C 4.5% H_2O		27 kb 1050° C 4.5% H_2O	
Phase	Ga[a]	Ga[a]	Ga[a]	Ga[a]	Ga	Ilm	Ga	Ilm
SiO_2	40.9	40.5	39.9	39.2	39.2	0.8	40.2	0.7
TiO_2	1.1	1.2	1.6	1.8	1.8	53.4	1.4	53.7
Al_2O_3	22.4	22.3	21.4	20.6	20.0	0.7	21.7	0.7
FeO	8.5	12.9	15.9	17.8	17.8	38.3	19.0	39.2
MnO	0.2	0.3	0.4	0.5	0.4	0.3	0.6	0.3
MgO	18.7	15.4	13.8	12.4	11.5	6.7	12.4	6.0
CaO	5.8	7.1	6.9	6.5	7.1	0.5	6.4	0.5
Na_2O	0.1	—	0.1	0.2	0.3	0.3	0.3	0.2
K_2O	0.1	—	—	—	—	—	0.1	0.1
Mol. proportions								
100 Mg/Mg + Fe	80.0	68.0	60.4	55.3	53.5	23.9	53.8	21.2
Ca	15.0	18.5	18.0	17.3	19.1	—	16.5	—
Mg	68.0	55.4	49.7	45.8	43.3	23.9	44.9	21.2
Fe	17.0	26.1	32.3	36.9	37.6	76.1	38.6	78.8
$K_{D(Fe,Mg)}^{ilm\text{-}ga}$					3.68		4.31	

[a] No ilmenite present, garnet coexisting with liquid and clinopyroxene.