important as a residual phase for water-saturated melting at lower pressures but more important at higher pressures (fig. 1). These relationships become important in seeking to interpret very magnesian dunites, wehrlites and harzburgites of the alpine-type ultramafic complexes as possible residues and accumulates from either island arc or mid-oceanic ridge magma genesis.

5.1.3. 10 kb, 1050°C

Olivine, orthopyroxene, clinopyroxene and liquid are primary phases at these run conditions. Analysis of the bulk composition shows that there has been no detectable Fe-loss (table 4). The increasing degree of crystallization of the charge is accompanied by decreasing forsterite content of olivine ($Fo_{88.5}$). The analyses of pyroxene 'pairs' at 10 kb 1020°C and 1000°C, and at 20 kb 1050°C, consistently yielded clinopyroxene with slightly higher Mg-value and slightly higher TiO_2 content than coexisting orthopyroxene. It appears probable that the analysis of clinopyroxene in the 10 kb 1050°C run includes a small proportion of quench clinopyroxene outgrowth giving slightly low Mg-value and high Al_2O_3 and TiO_2 contents (tables 4, 5, 6, 9).

The amphibole composition is that of a quench phase, on the basis of the Mg-value (too low for equilibrium with olivine or pyroxenes but probably correct for equilibrium with the glass composition), very high TiO_2 and low CaO contents and very high SiO_2 contents. In these respects the amphiboles of both the 1050°C and 1020°C runs are similar to one another and markedly different from the subsolidus amphibole at 970°C (table 7) or the amphibole (considered to be an equilibrium phase) at 1000°C (table 6). Because of the presence of quench amphibole, the Mg-value relationships between glass and crystals, and the evidence deduced

TABLE 4

	Olivine	Orthopyroxene	Clinopyroxene	Quench amphibole	Glass
SiO_2	41.2	56.6	54.0	53.1	65.0
TiO_2	–	0.2	0.8	3.8	0.9
Al_2O_3	–	1.5	3.9	13.3	21.0
FeO	11.1	7.6	4.0	6.4	2.7
MnO	–	–	–	–	–
MgO	47.5	32.4	16.3	14.8	1.5
CaO	0.15	1.3	20.1	5.4	8.7
Na_2O	–	–	0.3	$\gg$ 0.9	> 0.8
K_2O	–	–	–	0.6	0.6
Cr_2O_3	–	0.6	1.0	–	–
"H_2O"				(2%)	(~13.5)
$\frac{100\ Mg}{Mg + \Sigma Fe}$	88.5	88.5	88.0	80.5	51

Run conditions: 10 kb, 1050°C, 4 hr, $Ag_{75}Pd_{25}$ capsule. 100 Mg/(Mg + ΣFe) of sample after run: 85.2.

TABLE 5

	Olivine	Orthopyroxene	Clinopyroxene	Quench amphibole	Glass 1*	Glass 2*
SiO_2	40.5	55.1	53.7	53.5	56.2	64.0
TiO_2	–	0.2	0.6	2.1	3.8	0.7
Al_2O_3	–	1.1	2.0	11.0	17.7	21.0
FeO	12.3	7.6	3.8	6.4	5.9	2.4
MnO	–	–	–	–	–	–
MgO	46.8	33.8	17.7	15.3	7.4	2.5
CaO	–	1.3	21.2	8.8	6.4	8.3
Na_2O	–	–	0.2	0.3	> 1.1	> 0.7
K_2O	–	–	–	0.3	0.7	0.6
Cr_2O_3	–	0.6	0.9	0.3	0.7	–
$\frac{100\ Mg}{Mg + \Sigma Fe}$	87.2	88.8	89.3	81	69	65

Run conditions: 10 kb, 1020°C, 4 hr, $Ag_{75}Pd_{25}$ capsule. 100 Mg/(Mg + ΣFe) of sample after run: 85.3.

* Stationary electron beam giving low Na_2O value.

TABLE 6

	Olivine	Orthopyroxene	Clinopyroxene	Amphibole	Glass
SiO_2	40.5	54.5	51.5	44.6	Not analyzable
TiO_2	–	0.4	1.0	2.5	
Al_2O_3	–	4.1	4.6	11.0	
FeO	13.3	8.4	4.2	6.0	
MnO	–	–	–	0.1	
MgO	46.2	30.8	17.8	19.9	
CaO	0.1	1.1	19.5	10.9	
Na_2O	–	–	0.6	1.9	
K_2O	–	–	0.1	0.3	
Cr_2O_3	–	0.8	0.7	0.9	
$\frac{100\ Mg}{Mg + Fe}$	85.3	86.9	88.4	85.4	

Run conditions: 10 kb, 1000°C, 6 hr, $Ag_{75}Pd_{25}$ capsule.

in this and previous runs for outgrowth of quench clinopyroxene and olivine respectively, the highly siliceous glass is considered to be a non-equilibrium quench product and to bear no relation to the composition of an equilibrium melt at 10 kb 1050°C in water-saturated pyrolite composition.

It is not possible to deduce the composition of the equilibrium melt at 10 kb 1050°C without rather arbitrary assumptions about the degree of crystallization and the proportions of olivine, orthopyroxene and clinopyroxene. The decrease in Mg-value of crystalline phases between 1100°C and 1050°C implies a decrease in the amount of liquid present and the low Na and K values of the pyroxenes imply that these elements are concentrated in the liquid phase. These factors, and the increased proportion of pyroxenes (with 54–57% SiO_2) to olivine, all argue that the equilibrium liquid, with 100 Mg/(Mg + Fe^{++}) = 69–70 will have $SiO_2 < 56\%$ and high alkali contents.

5.1.4.10 kb, 1020°C

This run is similar to the 1050°C run in both the nature and compositions of its phases. Orthopyroxene ($Ca_{2.5}Mg_{86.5}Fe_{11}$) appears to be slightly high in CaO but the coexisting clinopyroxene ($Ca_{43.5}Mg_{50.5}Fe_6$) has low TiO_2, Al_2O_3 and very low Na_2O contents, and the composition is considered to be free of quench contamination. Both the amphibole and glass compositions show non-equilibrium characteristics as in the 1050°C runs, and the microprobe data, while confirming the presence of amphibole at 1020°C as observed optically [12], demonstrate that it is not an equilibrium phase at 1020°C. The glass appears to be more variable in composition in this run than in the higher temperature runs.

5.1.5. 10 kb, 1000°C

This experimental run contains olivine, orthopyroxene ($Ca_{2.2}Mg_{84.8}Fe_{13.0}$), clinopyroxene ($Ca_{41}Mg_{52}Fe_7$) and amphibole, all as major constituents and all with Mg-values consistent with the four phases being primary and in equilibrium with each other. This con-

TABLE 7

	Orhopyroxene * 1	Amphibole * 2	Orthopyroxene 3
SiO_2	53.9	44.0	54.0
TiO_2	0.4	2.1	0.2
Al_2O_3	3.7	12.0	3.3
FeO	8.9	5.6	8.9
MnO	0.2	–	–
MgO	30.5	18.1	31.2
CaO	<1.1	11.3	0.8
Na_2O	–	1.8	–
K_2O	–	0.5	–
Cr_2O_3	0.6	2.6	0.7
$\frac{100\ Mg}{Mg + Fe}$	86.1	85.3	86.4

Columns 1,2 – run conditions: 10 kb, 970°C, 5.5 hr, $Ag_{75}Pd_{25}$ capsule.

Column 3 – run conditions: 10 kb, 900°C, 6 hr, $Ag_{75}Pd_{25}$ capsule.

* The fine grain-size of the run product did not allow complete resolution of olivine (≥ $Fo_{85.6}$) and clinopyroxene (≥ 18.8% CaO) from surrounding crystals.