TABLE 2

Chemical compositions of orthopyroxene, clinopyroxene and olivine xenocrysts in olivine basalt. Analyses by electron probe microanalyzer

		Orthopyroxene		Clinopyroxene		Recrystallized rim
SiO_2		56.0	56.0	54.6*	52.9*	50.5
TiO_2		0.2	0.3	0.45	0.65	2.2
Al_2O_3		3.0	3.6	3.4	4.3	2.8
Fe_2O_3		—	—	—	—	1.3*
FeO		8.1	8.6	5.9	6.5	6.7
MgO		31.6	31.0	20.7	19.1	14.2
CaO		2.1	2.1	16.0	15.6	21.9
Na_2O		<0.1	<0.1	0.7	0.7	0.5
		101.1	101.7	101.7	99.7	100.1
Molecular ratios	Ca	4	4	32	33	46
	Mg	84	83	59	56	41
	Fe	12	13	9	11	13
$\frac{100\ Mg}{Mg+Fe^{++}}$		87.4	86.5	86.2	84.0	79.1

Partial analyses of olivines

a) Olivine partially enclosed by orthopyroxene xenocryst ($Ca_4Mg_{84}Fe_{12}$)

	FeO	CaO	Al_2O_3	$\frac{100\ Mg}{Mg+Fe^{++}}$
1. Part against orthopyroxene	12.8	0.1	0.1	86.9
2. Zoned edge against basalt	28.9	0.3	0.6	67.2

b) Olivine phenocryst – continuously zoned, strongly zoned on edge

	FeO	CaO	Al_2O_3	$\frac{100\ Mg}{Mg+Fe^{++}}$
1. Centre	18.8	—	—	80.0
2. Outer edge	29.6	—	—	66.5

* Values calculated from other elements assuming normal pyroxene molecules in solid solution.

A single olivine grain was observed to be partially enclosed by an orthopyroxene "xenocryst" and has closely similar $Mg/Mg+Fe^{++}$ value to the orthopyroxene (table 2). The crystal is not significantly zoned except at the margin contacting the basalt where a sharp compositional gradient leads to more iron-rich olivine with a minimum $Mg/(Mg+Fe^{++})$ value of 67.2. An euhedral olivine phenocryst has a core composition of Fo_{80} with very sharp marginal zoning to at least $Fo_{66.5}$ at the outer edge.

3. Experimental study of the crystallization behaviour of the olivine basalt

Anhydrous conditions: The experimental methods used have been described previously (GREEN and RINGWOOD, 1967a, 113–117). The starting material for the runs was a glass prepared from the analysed basalt and rechecked after fusion for FeO and Fe_2O_3 content. The effect of Fe-loss to the platinum capsule, previously shown to be of minor importance (op. cit. p. 115–117) and not significantly affecting the sample mineralogy, has been further minimised by shorter run times. As a further confirmatory measure, some runs were carried out in graphite capsules demonstrating the same sequence of appearance of phases at 13.5 kb. Runs in both platinum and graphite at 13.5 kb and at 1330 °C and 1320 °C all yielded orthopyroxene + clinopyroxene + liquid. The similarity of degree of crystallization and of the 100 $Mg/(Mg+Fe^{++})$ values (83.0) of the clinopyroxenes in both 1330 °C and 1320 °C runs in graphite suggests that there is no actual difference in degree of crystallization between these runs. The more magnesian compositions of the pyroxenes from the run in platinum at 1330 °C may be due to this run being nearer the liquidus or to some iron loss. The latter effect may also have caused the appearance of orthopyroxene (100 $Mg/(Mg+Fe^{++})$ = 86.4) alone in the one hour run at 1325 °C. Microdetermination of FeO (10.3%) and Fe_2O_3 (0.97%) in the 30 min. run at 13.5 kb 1320 °C in platinum confirms the relatively small change in chemical and normative composition produced by iron loss within the run times used. Microprobe methods and the accuracy of analyses are as previously described (GREEN and RINGWOOD, 1967a).

The crystallization behaviour of the Auckland Island olivine basalt is almost identical to that of the olivine basalt studied by GREEN and RINGWOOD (1967a). Comparison of the compositions shows higher normative olivine and Al_2O_3 in the previous composition but otherwise very similar chemical and normative compositions. Details of experimental runs are given in table 3. Olivine is the liquidus phase at 9 kb and is joined by clinopyroxene as the second phase. At 13.5 kb orthopyroxene and clinopyroxene occur together near the liquidus. Orthopyroxene is the major phase, or possibly the only phase on the liquidus, but at lower temperatures, clinopyroxene is more abundant. At 18 kb clinopyroxene appears to be the liquidus phase and orthopyroxene probably appears over a very restricted lower temperature interval. In comparison with the previous data on olivine basalt (GREEN and RINGWOOD, 1967) the present composition has a slightly more re-