is appreciably more iron-rich ($100\ Mg/Mg + Fe^{++} = 60$) than the olivine tholeiite composition ($100\ Mg/Mg + Fe = 72$). Analyses of alkali olivine basalts and basanites containing peridotite inclusions with the moderately high pressure mineralogy of olivine + aluminous pyroxenes + spinel show that these have $100\ Mg/Mg + Fe^{++}$ ratios between 60 and 70. These basalts, because of their transported xenolithic material, may be assumed to be derived, without fractionation of olivine, from depths greater than 20 km (BULTITUDE and GREEN, unpublished). Such basalts also have high normative olivine contents ($>15\%$). It is considered that the chosen alkali olivine basalt composition is consistent with the available geological evidence on the estimation of compositions of critically undersaturated basaltic liquids derived without fractionation from depths of 20 km or more.

The olivine basalt composition was calculated as the arithmetic mean of the olivine and alkali olivine basalt compositions. As was previously discussed, it was also chosen to lie along the fractionation trend of the olivine tholeiite between 12 and 18 kb.

The compositions and CIPW norms of the glasses as used in the experiments are given in Table 1. Also given are "eclogite norms" based on calculation of garnets of composition $Ca_{0.5}\ (Mg,\ Fe)_{2.5}\ Al_2Si_3O_{12}$ and assuming solid solution of the minor orthopyroxene in some compositions in the calcium-rich pyroxene. The "eclogite norms" contain olivine in all four compositions if TiO_2 is calculated as rutile but only the picrite contains significant olivine if TiO_2 is calculated as ilmenite. Both the olivine tholeiite and olivine basalt lie essentially on the garnet + pyroxene join with neither quartz nor olivine, but the alkali olivine basalt contains 2% olivine and the picrite contains 13% olivine in eclogite nineralogy. All three basaltic compositions lie close to, but on the olivine-poor side of, the suggested minimum melting composition at 40 kb, using the simple Di-Fo-Pyrope system as a guide.

Experimental Procedure

a) Preparation of Basaltic Glasses

The glasses of olivine tholeiite, tholeiitic picrite and alkali olivine basalt were prepared from natural analyzed Hawaiian basalts with added MgO and $Fe + Fe_2O_3$ to obtain the desired compositions. The olivine tholeiite and tholeiitic picrite were prepared from a quartz tholeiite of the Pololu Series, Hawaii, and, as a result, have the low K_2O and Na_2O contents typical of these particular flows. After adding the MgO, Fe and Fe_2O_3 in calculated proportions, the components were intimately mixed and then fused to a glass. The alkali olivine basalt was similarly prepared from an analyzed Hawaiian alkali olivine basalt. The olivine basalt composition was prepared entirely by reacting mixtures of A. R. chemicals, in the required proportions, then adding Fe in the required amount and fusing the mixture to a glass.

Fusion of the basaltic compositions was carried out in either platinum tubes or crucibles at temperatures of $1,400—1,500°$C. Oxidation was prevented by fusing in an argon atmosphere in contact with graphite at about $1,500°$ C. Loss of iron due to solution in the platinum containers during fusion was monitored in several control experiments and calculated amounts of Fe were added to compensate for this effect. After checking for homogeneity by examination in refractive index liquids, the glasses were finely ground and then analyzed in duplicate for FeO and Fe_2O_3 content. The compositions were calculated to 100% using the figures for FeO and Fe_2O_3 determined by analysis. The compositions obtained are listed in Table 1. In all cases the initial material was entirely glass — even the picrite was quenched without the formation of quench olivine.

b) Apparatus and Methods

The experimental runs were carried out using a single-stage, piston-cylinder apparatus similar to that described by Boyd and England (1960a, b, 1963). The techniques used have been described previously (Green and Ringwood, 1967). In the melting runs reported in this paper, exclusion of water from the sample is essential. This was attained by enclosing the sample in a platinum tube of 0.006″ wall thickness with both ends sealed by welding. In addition the furnace assembly used contained an inner boron nitride sleeve between the talc and graphite cylinders and the boron nitride, graphite and all ceramic components were dried for 1 hour at 1,000° C in an argon atmosphere. To minimise the loss of iron to the platinum capsule, the periods of runs were limited to 1 hour at temperatures less than 1,400° C and to shorter times at temperatures greater than 1,400° C. Temperatures were measured by a Pt-Pt10%Rh thermocouple in contact with the charge. Variation of recorded temperature during a run was smaller than $\pm 5°$ C whilst the temperature gradient across the sample was smaller than 10° C. No correction was made for the effect of pressure on the thermocouple EMF. Ignoring this latter factor, the maximum error in determination of charge temperature was 15° C. In practice however, the relative errors in series of runs were much smaller than this. Thus, experimental runs spaced 5° apart and carried out with identical procedures were internally consistent and yielded reproducible results. Sample pressures were calculated from the load pressure on the 3″ ram, assuming a -10% pressure correction for friction and imperfect pressure transmission in the furnace assembly (Green, Ringwood and Major, 1966). The absolute accuracy of pressure measurement is estimated at $\pm 3\%$.

c) Examination of Sample

Small portions of the sample were crushed and examined optically in refractive index liquids. This usually served to identify the phases present and the degree of melting. X-ray powder diffraction methods were used particularly to confirm the identification of olivine in the presence of clinopyroxene. Provided there was no access of water to the charge, little difficulty was found in quenching liquids to glass at pressures of 18 kb or lower. In some runs, particularly at 27 kb, there was patchy development of quench clinopyroxene (in part nucleating on primary crystals) but this was usually readily distinguishable from primary crystals by its feathery or fine-aggregate texture, by uneven extinction and by higher refractive indices than any primary clinopyroxene present.

Several fragments of most of the partial melting runs were mounted in epoxy resin and polished for use with the electron microprobe. These polished surfaces were excellent in showing the form and distribution of the primary phases, the quench clinopyroxene and the glass. Slight differences in hardness and in reflectivity were adequate to enable the phases to be clearly distinguished in reflected light.

d) Microprobe Methods and Calibration

An electron probe X-ray micro-analyser (Applied Research Laboratories model E.M.X.) was used for quantitative analysis for selected elements in olivine, enstatite, clinopyroxene and garnet in many of the experimental runs, particularly those near the liquidus. The electron beam of the microprobe was focussed to about 1 micron diameter, giving a volume of analysis (i.e. the volume from which characteristic X-rays were detectable) of 2—3 microns diameter and similar depth. An accelerating voltage of 12 kV, emission current of 60—100 mA and a specimen current of 0.04 micro-amps were used. Spot analyses were made at intervals of 1 to 10 microns with an integration time of 70 seconds. Analyses for Fe, Ca and Al were made simultaneously using K_α radiation. Corrections were made for specimen current fluctuations and for background but inter-element and matrix absorption and fluorescence effects were avoided by using calibration curves from glasses of known pyroxene composition. These glasses, prepared specifically for this project from carefully weighed A. R. chemicals, are enstatite (100 Mg/Mg + Fe = 90) with 2.0% CaO to which were added Al_2O_3 contents from 0—20% and a second series of aluminous hypersthene (100 Mg/Mg + Fe = 75; $Al_2O_3 = 8.0\%$) with variable CaO content from 0—8%. After fusion at 1,500—1,600° C and quenching to glass, these compositions were checked for iron content by analysis. The calibration curve for Fe was also based on analyzed olivines. Calibration curves for higher CaO contents in