

lated Volume and Refractive Index

Calculated: 50 kb		
		$(\Delta V/V_0)$
%	$(\Delta n/n_0)$ , %	$(\Delta n/n_0)$
b	2.0 <sup>c</sup>	-2.0
	3.0 <sup>c</sup>	-2.4
	4.7 <sup>c</sup>	-2.9
b	3.4 <sup>c</sup>	-3.0

above 10 kb, and it was necessary to high-temperature quadratic parameters, (to 600°C) from equations 6 and extrapolation to pressures above 10 kb equations 5 and 8. Since the initial compressibility decreases with pressure in the manner above 510°C, as shown by (7), pressure extrapolation at 600°C should be made, and, in fact, both the quadratic and Murnaghan equations give essentially the same volume compression along the 600°C

compressibility parameters used for the minerals at the indicated temperatures are in Table 1, together with the magnitude of the calculated volume and refractive index at 50 kb. The fractional volume change is seen to be of the order of 2 to 3 percent and the fractional index change for all three minerals and at both temperatures for SiO<sub>2</sub>.

#### CALCULATIONS FOR DIOPSIDE AND ALBITE

The refractive index was calculated as a function of pressure by using the Lorentz-Lorenz equation (3) and the  $V/V_0$  values from both the quadratic and the Murnaghan equations, under the assumption of constant molar refraction. (The quadratic and Murnaghan equations give identical results for diopside over

the small extrapolation range above 40 kb but deviate considerably for albite at high pressures.)

It should be noted that the *only* input data are the compressibility parameters  $a$  and  $b$  (Table 1) and the values of  $n_0$  (the index of the original uncompressed glass). The values of  $n_0$  measured by Boyd and England on the glass used for their compression runs are 1.488 for albite glass and 1.604 for diopside glass (they give 1.603 in text and 1.605 in their Figure 7; the average has been used). The calculated values of  $n_{LL}$  from 0 to 50 kb are shown in Figure 2, together with all measured values by *Boyd and England* [1963]. The errors shown on the measured data are their uncertainty limits of  $\pm 0.002$  on the indices and  $\pm 5\%$  on (load) pressure.

The fit of the calculated indices to the measurements is remarkably good, even for albite for which the compressibility parameter are measured only to 10 kb (solid part of the calculated curve). Although both compressibility equations (equations 5 and 8) fit the albite data surprisingly well, the Murnaghan equation is clearly superior, as would be expected from the comparisons given by *Anderson* [1966]. The average deviation of the measured points from the calculated curves is  $\pm 0.0010$  for diopside and  $\pm 0.0018$  for albite, and some of the deviation is clearly due to scatter in the observations, especially for the albite data, which will not fit any smooth curve exactly. The indices calculated from the Drude equation are lower for both substances; the differences increase with pressure and reach 0.01 at 50 kb. Indices calculated for the empirical refraction laws of Gladstone and Dale and of *Allen* [*Anderson and Schreiber*, 1965] were found to be the same for both laws and to be close to the mean of  $n_{LL}$  and  $n_D$  at each pressure, in agreement with the fact that the latter two indices are calculated from the limiting refraction laws. It is possible that  $\beta$  is actually somewhat less than the Lorentz-Lorenz value of  $4\pi/3$ , as the compressibility data used are for the crystalline phase and are thus close to, but lower limits for, the glass compressibilities (Figure 1). If the glass compressibilities are significantly greater, the calculated indices would be increased so that the curve from the Drude equation would approach the observations. To raise the calculated Drude curve to match the Lorentz-Lorenz

curve for diopside in Figure 1, the compressibility must be increased by 50%. However, this question cannot be decided until compressibility and density data for the glasses are actually measured over a range of pressure. What is important is that the crystal compressibilities are *lower limits* and the  $n_{LL}$  curve is an *upper limit* for any compressibility, so that improvements in the data will not change the fact that the observations can be fit by a molar refraction law (always under the assumption that the refraction itself remains constant, which is reasonable on the basis of the structural observations of *Bridgman and Simon*).

#### INTERPRETATION OF DIOPSIDE-ALBITE RESULTS

The diopside-albite glass measurements are by far the most carefully controlled experimental data available. According to *Boyd and England* [1963], the albite glass samples were prepared chemically by two different methods and carefully dried at high temperatures; the diopside glass used was also synthetic and was dried even more stringently. The albite samples were

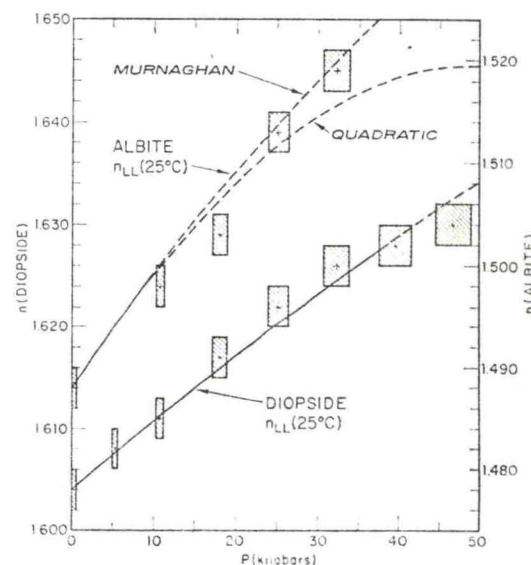


Fig. 2. Refractive indices of albite and diopside glass quenched from liquidus temperatures at the indicated pressures. The data of *Boyd and England* [1963] are shown by rectangles with dimensions according to their estimated precision. The curves are calculated from compressibilities that have been measured over the pressure range corresponding to the solid parts of curve and extrapolated into the dashed parts.