

$(dK_{0s}/dP)_s$  is obtained (Table 6). The inferred zero-pressure densities of  $MnO_2$  and  $SnO_2$  are in reasonable agreement with the true densities of these phases, considering the quality of the experimental data. *Clendenen and Drickamer* [1966] have observed the occurrence of 'apparent' phase transformations in these minerals under static high pressures. We conclude that the volume changes in these transformations are likely to be relatively small.

The transformation of  $SiO_2$  under shock conditions has been fully discussed by *Wackerle* [1962] and *McQueen et al.* [1963]. Their data, together with the recovery experiments of *DeCarli and Milton* [1965], provide strong evidence that the high-pressure phase produced during the shock was indeed stishovite. Our inferred zero-pressure density for shocked  $SiO_2$  is in excellent agreement with that of stishovite (Table 10). The behavior of titanium dioxide has been discussed by *McQueen et al.* [1967a], who concluded that transformation to a phase with a structure related to fluorite had occurred. Reduction of the shock data for rutile [*Anderson and Kanamori*, 1968] supports this interpretation (Table 10). The large density increase ( $\sim 30\%$ ) is caused by the increase in coordination of the titanium atom from 6 to 8.

*Syono and Akimoto* [1968], having observed that  $PbO_2$ , which has a rutile structure at low pressure, can be transformed into a fluorite structure under high pressure, suggest that stishovite may also transform to the fluorite structure at ultrahigh pressure. *Fujisawa* [1968] has suggested that the fluorite modification of  $SiO_2$  may be of significance in the earth's mantle. The shock data on  $SiO_2$  that extend to pressures greater than the pressures at the core-mantle boundary do not support this suggestion, since they imply that stishovite is stable over the entire pressure range. The pressures required to induce a small atom like  $Si^{+4}$  (radius = 0.42 Å) to transform from six-fold to eight-fold coordination with respect to oxygen are likely to be very much higher than the pressures required for the transformations of rutile and  $PbO_2$  to the fluorite structure ( $Ti^{+4} = 0.68$  Å,  $Pb^{+4} = 0.84$  Å) (see Figure 13). Furthermore, it should be

TABLE 10. Interpretation of Zero-Pressure Densities and Structures of Some Simple Oxides under Shock

Initial Density	Oxide	Calculated Zero-Pressure Density of Shocked Phase, g/cm <sup>3</sup>	Inferred Structure of Shocked Phase	Structure Density, g/cm <sup>3</sup>
3.99	$Al_2O_3$	3.94 <sup>a</sup> , 4.04 <sup>a</sup>	Untransformed	...
3.58	MgO	3.70 <sup>a</sup> , 3.82 <sup>a</sup>	Untransformed	...
5.23	$MnO_2$	5.09	Untransformed	...
6.99	$SnO_2$		Untransformed	...
4.25	$TiO_2$	5.71 <sup>b</sup>	Fluorite	5.5
2.65	$SiO_2$	4.34	Stishovite	4.28
5.27	$Fe_2O_3$	5.96	Perovskite	5.8

<sup>a</sup> See Table 3.

<sup>b</sup> Calculation by *Anderson and Kanamori* [1968].