the dominant source of change of grain shape. The conditions for this to occur and the constitutive relation that will result have yet to be found. It is expected however that such a liquid-solid system will display Newtonian viscosity.

Seismic velocity data in the mantle indicate phase changes to denser oxide structures occurring at certain critical depths. It is expected that plastic properties will be altered in the zone of transition between two phases. Such an effect has been observed in steel. When the transformation of austenite to either martensite or pearlite occurs under an applied deviator stress, extensive plastic deformation accompanies the phase change [*Porter and Rosenthal*, 1959]. A similar effect has recently been observed during the pressure-induced transformation of RbI from the fcc to the sc crystal structure (Davis and Gordon, unpublished data, 1970). This transformation involves a 13.5% reduction in volume and occurs at 3.5 kb [*Pistorius*, 1965]. When hydrostatic pressure is applied to a single crystal of RbI, its strength increases in the usual way at all pressures up to the transition pressure. Single-crystal experiments cannot be made on the high-pressure phase because the transformation to the dense phase always converts the single crystal to a polycrystal.

Observations of the strength properties during transformation can be made on polycrystalline samples. An experimental complication that must be overcome is the separation of dimensional changes due to the volume change on transformation from the dimensional changes due to plastic deformation. An experiment in which this separation is accomplished uses the test procedure illustrated in Figure 7. The sample is placed between the plattens of a compression test machine and is transformed to the dense phase at a pressure well above 3.5 kb. Pressure is slowly lowered while the plattens of the testing machine are separated in such a way that no compressive load develops on the sample owing to its volumetric expansion. When the transformation to the less dense phase commences (at a pressure near 3.5 kb, there is some hysteresis in the transformation pressure), the pattens are clamped. One dimension of the sample must then remain fixed. The force necessary to maintain the fixed plattens is measured. As the crystal transforms, its volume increases by 13.5%; it is therefore plastically deformed by an amount equivalent to compression of 4%. The clamping force increases by only a small amount. After transformation is completed, the pressure is reduced to zero and the fcc phase expands a further 1%. The required clamping force now increases by a much larger amount; this additional increase shows that the crystal is substantially weaker while the transformation is in progress than it is after completion of the transformation. From these data it is estimated that compressive strength is reduced by a factor of 7 during the transformation.

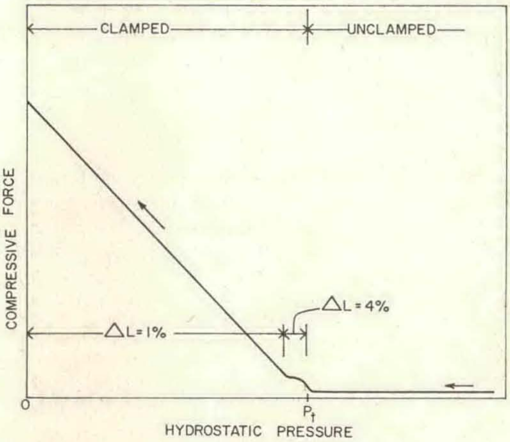

Fig. 7. Compressive loading experiment on a RbI polycrystal.

This reduction in strength is due to the removal of barriers to dislocation motion by the passage through the grains of interfaces between the two phases. In this sense the transformation is similar to recrystallization. Hence the reduction in strength will occur even when the crystal is being deformed in creep at $T/T_m > 0.5$. In the zones of the mantle where a high-pressure and a low-pressure phase coexist, the material present will be relatively weakened as long as the transformation between the phases continues. Continued transformation could result, for example, from the upward passage of deep mantle material through the transformation zones.

The occurrence of partial melting and of pressure-induced phase transformation in the mantle can result in zones in which the yield strength is substantially lowered as compared with the surrounding material. It is reasonable to expect strong inhomogeneities in the strength properties of the mantle and to suppose that the flow processes responsible for the observed motions are largely localized to these zones of low strength.

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