The σ values measured at pressures between 2.0 and 5.0 GPa are approximately one order of magnitude lower than single-crystal σ values previously reported for this material. Since the single-crystal data were at unknown oxygen fugacity (in argon), this difference may be the result of the reequilibration of the oxidation state of iron in the polycrystalline material during the sintering process in a tantalum capsule. The activation energy for σ in the polycrystalline olivine is about 1.0 eV, slightly higher than the 0.85 eV reported for the single crystal and consistent with a change in oxidation state of the iron. The σ measured over the pressure and temperature range reported here are the lowest values reported for natural polycrystalline olivine.

The present results are consistent with the high internal temperatures inferred for the interior of terrestrial planets based on single-crystal σ data measured under controlled oxygen fugacity. Furthermore, these results indicate that at these pressures and temperatures the influence of grain boundaries is not significant.

SCHOCK, R. N., Rock deformation at high pressures: models and physical properties, presentation at Hawaiian Institute of Geophysics, Honolulu, January 27, 1975. [UCRL-76551, Abstract]

As part of the seismic evasion and nuclear testing programs at LLL, we have carried out quasi-static deformation on a number of diverse rock types as part of an overall effort designed to develop predictive models for use in finite-difference computer codes. These data are combined with high strain-rate (gas gun or high explosive) data to examine strain-rate effects. From these deformation experiments, we have been able to reach several conclusions about the deformation of rocks for the general condition of equivalent intermediate and minimum principal stress: (1) the brittle failure surface is independent of loading path on compression, (2) the onset of dilatant behavior is path independent, (3) shear stress-enhanced compaction is, to a first approximation, initiated at a constant mean pressure, but, once initiated, is a direct function of shear stress. Furthermore, for these processes there is a simple constitutive relationship between shear stress (τ), mean pressure (P), and shear strain (and therefore with volume strain [ε_v]). For a granite, the observed data are very well modeled by an equation of the form

$$d\varepsilon_v = \exp\left[\frac{dP}{x(\tau)} - A(\tau)\right] \quad , \tag{1}$$