DEFORMATION OF SILICATES IN SOME FRA MAURO BRECCIAS; Hans G. Ave'Lallemant, Dept. of Geology, Rice Univ., Houston, Texas, 77001 and Neville L. Carter, Dept. of Earth and Space Sciences, S.U.N.Y., Stony Brook, 11790.

Breccias 14068,9, 14321,24, 140305,15, 14313,42 and 14301,83 have been examined in detail by optical methods for evidence of static and dynamic deformation of silicate crystals. There is no unequivocal evidence for static deformation in the olivines, orthopyroxenes, clinopyroxenes or plagioclases in the specimens studied but a wide range of effects due to shock deformation have been observed and the preliminary results are summarized below.

Olivine crystals are frequently fractured and one crystal contains kink bands parallel to (001) which have originated by inhomogeneous slip on {100}[001], the high strain rate - low temperature system observed in static experiments and in chondritic meteorites. Slip on {hko}[001] may also have occurred in this crystal. One olivine grain contains well-developed planar features (shock lamellae) parallel {110}. Several olivine crystals in the specimens have recrystallized to mosaics of new strain-free crystals. The relic host crystals of two such olivine grains that had not recrystallized entirely has been severely shocked as indicated by the shock mosaic structure. Recrystallization of this sort has been observed in olivine shocked experimentally to about 1 megabar and results from annealing during the period of high residual temperatures following intense shock deformation. The orientations of the recrystallized grains are closely related to that of the host with the various crystal axes being inclined at an average of 35° to similar axes of the host, a relationship that has also been observed for statically annealed silicates.

Orthopyroxenes in the specimens are commonly deformed as indicated by irregular zones of undulatory extinction and poorly defined kink bands. The external rotation axes lie near (001) and kink bands are nearly normal to c suggesting slip on {hko}[001]. One orthopyroxene crystal contains intergrown clinopyroxene with [010] opx $\parallel$ [010] cpx; [001] opx $\parallel$ [001] cpx; γ opx $\wedge$ γ cpx = 43°; $2V\gamma$ = 50°. However, the expected inversion of orthopyroxene to clinopyroxene has not yet been definitely established in the specimens studied.

Clinopyroxenes have deformed by mechanical twinning on {001}, fracturing, faulting and some show the shock mosaic structure. Planes of closely spaced cavities or inclusions near {001} in one crystal are interpreted to be partly annealed planar features. Similar structures in another crystal have been partly recrystallized, a feature observed previously for naturally shocked quartz. Because of the fine-grained nature of annealed clinopyroxenes, the orientations of the recrystallized

grains with respect to the host have not been determined as yet.

These breccia specimens contain many fragments of anorthosite with the plagioclases (ca.An_{90}) showing all degrees of shock deformation from zero shock through melting. Deformation twins according to the albite, pericline and, possibly, Ala laws have been recognized and are commonly associated with faults. Planar features and shock mosaicism are also commonly associated with fault zones along which intense crushing has taken place. Regions showing the mosaic structure are commonly bounded by irregular surfaces although some may be bounded by (010) and (001) segments. The external rotation axis between host and one mosaic subgrain is near [001] and the 30° disorientation may have occurred by predominant slip on (010)[$\frac{1}{2}$ c]. Networks of regular to irregular boundaries defined by cavities or inclusions in some of the crystals may be partially healed microfractures.

One anorthosite fragment, elliptical in shape and 1 mm in maximum dimension, contains a perfectly round hole near the center (see sketch below). Outlining the microcrater in an asymmetric fashion are prismatic crystallites with interstitial glass. The intensity of deformation diminishes away from the crater from intense shock mosaicism accompanied by fine-grained recrystallization - mosaicism - faults and cracks, some partially rehealed - sparse cracks - zero shock. Thus, in this single fragment we see all stages of shock deformation from zero shock (stresses less than ca. 10 kb) to melting (stresses of the order of 300 kb). The distance over which the shock intensity has decayed from ca. 300 kb to 10 kb is about 0.5 mm and if the crater radius (0.05 mm) is near the size of the projectile, the shock stress levels have attenuated approximately as $1/r^2$.