SHOCK METAMORPHIC EFFECTS IN MARTIAN METEORITE ALHA 77005; N.Z. Boctor1, Y. Fei1, C.M. Bertka1, C.M.O.D’Alexander2, and E. Hauri2, 1Geophysical Laboratory, Carnegie Institution of Washington, 5241 Broad Branch Rd., NW, Washington, DC 20015; USA, 2Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Rd., NW, Washington, DC 20015, USA.

Introduction
Shergottites are the most intensely shocked members of SNC meteorites. (1) gave a brief review of shock effects in the basaltic and lherzolitic shergottites. Individual shergottites were studied in some detail, e.g., shergotty (2), Lew 88516 (3), and EETA 79001 (4). Localized shock melting in shergottites occurred at shock pressures between 60 and 80 GPa, whereas the post stishovite phase transition in silica in shergotty apparently occurred at pressure >80 GPa, perhaps close to 90 GPa (5). In this investigation, we report deformation features, amorphization, high pressure phase transitions, and shock melting in the lherzolitic shergottite ALHA 77005 and use pertinent shock wave data to construct its shock metamorphic history.

Shock effects in olivine and pyroxene
Deformation features in ALHA 77005 is represented by fracturing and planar features in olivine and deformation lamellae in pyroxene. Mosaicism occurs in both olivine and pyroxene. Similar to olivine in EETA 79001, some olivine crystals in ALHA 77005 transformed into polygonal crystal aggregates of two distinct compositions (Mg0.85Fe0.17)SiO4 and (Mg0.58Fe0.42)SiO4. The two phases apparently nucleated within the pressure range of the mixed phase region deduced from shock wave data.

Amorphization of some olivine crystals apparently occurred. The diaplectic olivine glass devitrified into aggregates of interlocking spherules now composed of acicular olivine crystals radiating from the center of each spherule.

Shock effects in plagioclase
Feldspatic glass in ALHA 77005 is partly diaplectic as indicated by the preservation of the crystal form of the parent plagioclase. The glass shows thin plagioclase rims similar to those described by (6). Feldspatic glass produced by shock melting shows vesiculation and rarely a flow structure.

Impact melting
Localized whole rock impact melting occurred in ALHA 77005. Melt pocket mostly crystallized to olivine showing a spinifex texture. The interstitial regions between the olivine crystals contain two phases: skeletal crystals of pigeonite and residual glass. The spinifex olivine is more magnesian (Fo86.81) than the original olivine in ALHA 77005 (Fo71.65). The skeletal pigeonite (En57Fs35Wo18) is more iron rich than the low and high Ca pyroxene in the meteorite (En69Fs22Wo9) and (En56Fs17Wo27). The bulk composition of one of the melt pockets determined by electron microprobe analyses along a grid of 480 points given in wt.% is 0.33Na2O, 28.03 MgO, 2.37 Al2O3, 42.33 SiO2, 0.04 K2O, 4.50 CaO, 21.18 FeO. The bulk composition of the melt differs from komatiitic melts by virtue of its low alumina, low silica, and high FeO content.

Melt veins occur commonly in ALHA 77005 and some show vesiculation. They crystallized olivines of different morphologies reflecting changes in the cooling rates over distances of ~ 500 µm. At one end of the vein olivine skeletal crystals (Fo63) occur in a glass matrix (wt.% Na2O 2.06, MgO 3.02, Al2O3 14.38, SiO2 55.95, P2O5 1.19, K2O 0.08, CaO 14.61, FeO 6.76, TiO2 1.96). In the middle part of
the vein, the olivine is tabular (core $\text{Fo}_{64}$, rim $\text{Fo}_{41}$) with interstitial glass. At the other end of the vein, the olivine is idiomorphic and strongly zoned (core $\text{Fo}_{83}$, rim $\text{Fo}_{36}$) with virtually no interstitial glass.

**Discussion:**

The deformation features in olivine and pyroxenes would require peak pressure of $\sim 28 - 34$ GPa (7). Hugoniot data on olivine show a mixed phase regions between 500-100 GPa (8). Unlike the $\gamma$ spinel phase in thin shock veins in ordinary chondrites which is quenched and persist metastably after decompression, the $\gamma$ phase in ALHA 77005 inverted to the $\alpha$ phase, perhaps due to slow cooling and prolonged thermal annealing. In shock experiments diaplectic olivine glass was recovered when magnesian olivine ($\text{Fo}_{88}$) was shocked at a peak pressure of about 56 GPa (9). Hugoniot data on shocked anorthosite show that amorphization occurs above 30 GPa (10). Shock melting of plagioclase, however, would require a peak pressure of $\sim 45$ GPa (7). Melt pockets and veins require shock pressure of $\sim 80$ GPa. The similarities of the shock effects and the peak shock pressures registered in ALHA 77005, EETA 79001, Law 88516, and shergotty suggest that these meteorites may have been metamorphosed by the same impact event.