MIL 07273 is a melt breccia containing clasts of equilibrated H-chondrite set in a fine-grained (silicates <5µm across), largely crystalline igneous matrix. Chondrule clasts and fragments are “blackened” due to extensive veining (mainly by troilite), and coarse metal grains appear “fluidized”, with scalloped edges around adjacent silicates. Below: transmitted (left) and reflected (right) light images of thin section.

Two silicate melts stay separate:

Left: Map of phase chemistry. T = troilite; chr = chromite; ol = olivine; D = diopside; F/fel = feldspathic phase, px = pyroxene. Trolite/metal mix was early melt. Trolite was highly mobile; moving from rims on both large metal grains and metal droplets to form extensive veins cutting across existing silicates.

Pyroxene partially melts:

Left: Map of phase chemistry. T = troilite; chr = chromite; ol = olivine; D = diopside; F/fel = feldspathic phase, px = pyroxene. Trolite/metal mix was early melt. Trolite was highly mobile; moving from rims on both large metal grains and metal droplets to form extensive veins cutting across existing silicates.

Incomplete melting of metal:

Coarse metal grains are “fluidized”, entraining and surrounding silicates. Element maps (upper left) show diffuse variations in nickel. EBSD analysis reveals that coarse metal is dominantly martensite (mar) with remnant grains of kamacite (kam) and taenite (tae), as shown in the band contrast image in the upper right. The inset shows a Ni x-ray map. Martensite surrounding taenite is enriched in Ni. hyp = hypersthene; ab = albite

Matrix Silicates:

Melt matrix in chemical maps (above) and EBSD maps (below – GROD angle left; IPFx right). Matrix surrounds fragments of host ol and opx that are strained and recrystallized (below left) and metal/sulfide droplets. Crystalline matrix is composed of ol and low-Ca pyroxene grains which are undeformed and clearly crystallized from the melt. Matrix pyroxenes index as clinoenstatite and pigeonite, and are enriched in Na and Al, qualifying as omphacite. Clusters of matrix pyroxenes have the same crystal orientation (below right). Relatively iron-rich matrix olivine crystallized after pyroxene (as shown above).

Summary: Features observed in MIL 07273 can be explained by a shock event that produced brief heating at high pressure, a sudden pressure drop, with a slower drop in temperature, producing plastic deformation, brecciation, localized melting and crystallization. Matrix texture and composition suggests crystallization at high pressure followed by back-reaction of high-P polymorphs. Up to ~50% of MIL was melted. Yet, this appears to have had little effect on the composition of non-matrix silicates.