Meteorites, Fulgurites, and Test Sites – Quantifying Shock Effects in Geologic Materials

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Deformation in minerals at extreme conditions is important for studies of meteorites as an indicator of shock conditions on the meteorite parent bodies. Feldspars, particularly plagioclase, are common minerals in most meteorites, especially lunar and martian materials. They are also known to undergo a progression of deformation effects that scale with shock conditions. This includes fracturing, formation of dislocations parallel to major crystallographic orientations, solid-state amorphization, and eventually full melting.

This study utilizes the unique capabilities available at the TES (Tender Energy Spectroscopy) and XFM (X-ray Fluorescence Microprobe) beamlines at NSLS-II to study shock effects in geologic materials. The nuclear test site samples studied are unique in that the conditions undergone during the shock event (detonation) are well characterized, and there is a corresponding set of unshocked samples collected prior to detonation to act as a control for direct comparison. These samples have been well characterized and harbor no residual radiation. The fulgurite samples discussed here will be studied to compare the effects of pure thermal shock to pressure/temperature induced shock. In addition, we also have some preliminary data collected on an actual Martian meteorite sample (NWA 11288) that shows surprising textural and compositional relationships within the rock. The results of these studies will help to shed light on the potential conditions experienced by other shocked samples where the impact conditions and history are unknown, such as meteorites and terrestrial impact craters.