INVESTIGATION OF TISSINTITE FORMATION USING *IN-SITU* SYNCHROTRON X-RAY DIFFRACTION AND MULTI-ANVIL TECHNIQUES.

M. J. Rucks[1], T. D. Glotch[1], M. L. Whitaker and J. B. Parise[1], [1]Stony Brook University (melinda.rucks@stony-brook.edu)

Introduction: Pressures and temperatures induced during an impact event can give rise to the formation of mineral phases with unique properties. If the stability fields of these phases are determined, the presence of these minerals can be used to infer upper and lower bounds to impact conditions. Therefore, the study of high-pressure, high-temperature (HP-HT) phases through static and shock experiments is vital to our interpretation of impacts from meteorites and terrestrial impactites. Here we report findings of our initial investigation of the newly discovered phase, tissintite [1]. Tissintite is a clinopyroxene, Ca-analogue of jadeite, with a calcic-plagioclase composition and ~25% structural vacancies at the M2 site ($(Ca,Na,\_)AlSi_2O_6$). This phase has been interpreted by [1-2] to form within a tight P-T-t-X "Goldilocks Zone", suggesting the phases high potential to provide strict constraints to estimates of impact conditions.

Methods: We have performed HP-HT experiments coupled with in-situ energy dispersive X-ray diffraction measurements at the Argonne National Laboratory Advanced Photon Source using the large volume multi-anvil press with a D-DIA apparatus available on the 6-BM-B beamline. We used both a crystalline and amorphous plagioclase starting material of An60. The P-T range investigated here is 6 – 8 GPa and 1200 – 1350 °C. Two different heating protocols were used: stepped heating by increasing the temperature by 200 °C every 60 seconds, and spike heating to the peak temperature in ~1s and quenched after 60 seconds. The spike heating protocol was designed to imitate heating and cooling times of large (~1mm) impact melts. The samples were recovered as hard pellets. A portion of each was embedded in epoxy, thinly sliced and polished to produce thick sections. These samples were imaged and analyzed using scanning electron microscopy (SEM) and micro-Raman spectroscopic techniques. Raman spectra of the recovered samples were collected using the WiTec alpha 300R confocal imaging system, equipped with a 532 nm Nd YAG laser available in Center for Planetary Exploration at Stony Brook University. SEM images were collected at SBU with a LEO1550 SFEG-SEM with a Robinson backscatter detector operated at 20 kV and 8mm working distance.

Results: We observed through in-situ X-ray diffraction a jadeite-like structure form during heating in experiments using both crystalline and amorphous material around 1000℃. The Raman spectra, shown in Figure 1., collected for our samples are nearly identical to published data for natural tissintite [1]. Based on a comparison of Raman and X-ray diffraction data for known tissintite and our synthetic samples, we have produced a material that matches tissintite.

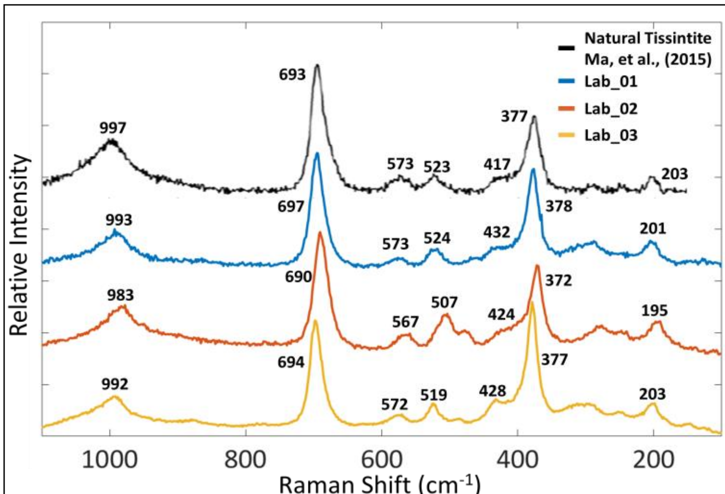

Figure 1. Representative Raman spectra of recovered samples compared to published Raman data for natural tissintite [1]

Future Work: In future work, we will expand our P-T range to higher pressures and temperatures to fully investigate the formation range of tissintite. Further, we will investigate these and subsequent recovered samples using Rietveld refinement and PDF analysis to refine a crystal structure, and identify the nature of possible structural vacancies.

References:

[1] Ma, C., et al., (2015) Tissintite, (Ca,Na,_)AlSi2O6, a highly-defective, shock-induced, high-pressure clinopyroxene in the Tissint martian meteorite. Earth and Planetary Science Letters, 422, 194-205.

[2] Walton, E., et al., (2014) Heterogeneous mineral assemblages in martian meteorite Tissint as a result of a recent small impact event on Mars. Geochimica et Cosmochimica Acta, 140, 334-348.