THE BEHAVIOR OF Ca-RICH PLAGIOCLASE UNDER IMPACT-RELEVANT CONDITIONS USING *IN-SITU* SYNCHROTRON-BASED MULTI-ANVIL TECHNIQUES AT BEAMLINE 6-BM-B OF APS AND ITS IMPLICATIONS FOR IMPACT THERMOBAROMETRY.

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Impact events induce extreme pressures and temperatures that can result in the formation of mineral phases with unique properties and stability fields that can be used to infer upper and lower bounds to impact conditions. Thus, the experimental synthesis of high-pressure, high-temperature (HP-HT) phases through static and shock experiments under impact-relevant conditions is vital to our interpretation of impacts from meteorites and terrestrial impactites. Here we report findings from our investigation of the mineral, tissintite. Tissintite is a clinopyroxene with a jadeite-type structure, a calcic-plagioclase composition, and an estimated 25% structural vacancies at the M2 site ($(Ca,Na,\_)AlSi_2O_6$). This phase has been interpreted to form within a tight P-T-t-X "Goldilocks Zone", suggesting the phase's high potential to provide strict constraints on estimates of impact conditions for rocks in which it occurs. The purpose of this study is to consider how Ca-rich plagioclase behaves under non-equilibrium conditions, i.e. the importance of kinetics during an impact event.

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 amorphous plagioclase starting material of An_{60} and An_{80} compositions and investigated the P-T range of 4.2 – 12 GPa and 800 – 1950 °C. We used our novel spike heating method in which the sample is raised to peak temperature in ~1s and quenched after 5 - 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, cut, polished, and then imaged and analyzed using confocal micro-Raman spectroscopy.

Here we have defined a "sweet spot" of formation conditions for tissintite from an amorphous An_{60} precursor to be within ~6 – 10 GPa, 1000 - 1400 °C and < 5 s heating residence times. We have found that the temperature residence time controls the phase assemblages produced and highlights the importance of the kinetic aspect in reactions that take place during an impact event. In addition, we investigated these conditions using an amorphous An_{80} composition material and found similar behavior and tissintite formation.

In previous experiments we observed tissintite formation accompanied by garnet and crystalline silica phases at pressures in excess of 8.5 GPa and temperatures > 1400 °C. This is indicative of a upper bound for pressure and temperature, as the natural occurence of tissintite is found with no coexisting phases. When extending to pressures ≤ 5 GPa, we observe either plagioclase only or a plagioclase + tissintite assemblage, indicative of a lower pressure boundary. In addition, we have observed a lower temperature boundary of ~ 1000 °C for the An_{60} precursor, and ~ 1200 °C for the An_{80} precursor, where only annealment of the glass precursor is observed. With this empirically defined "sweet spot", these results can be used to indicate a possible timeline of reaction during an impact event that produces tissintite, where tissintite likely forms during the decompression phase of the impact event. In addition, this study highlights the need for further study of mineral systems and phases commonly observed in shocked samples under non-equilibrium conditions as it is unwise to apply equilibrium phase diagrams to impact related samples.