SHOCK-METAMORPHIC MINERALS AND IMPACTS: FEW ANSWERS, MANY QUESTIONS.

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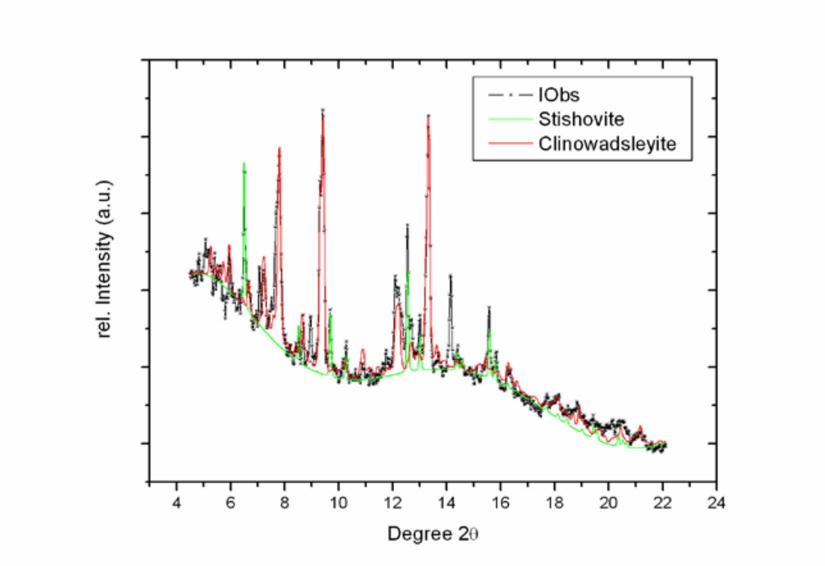
Introduction: Over the past fifteen years more high pressure minerals have been discovered in shock metamorphic rocks than in fifty years before. This amazing progress owns to important improvements in TEM techniques, the development of synchrotron micro-diffraction, powerful algorithms for structure analysis, improvements in micro-chemical analysis and in optical micro-spectroscopy. The augmented database of high-pressure minerals provides thermodynamic and crystal chemical information for the petrology of the deeper Earth. It also raises the question how to relate this mineralogical information with conditions during and immediately after impacts.

Peak shock pressures and temperatures of high-energy impacts extend into the 'warm dense matter' regime which is beyond stability of crystalline phases. Upon release temperatures remain generally too high to permit formation or conservation of high P-T phases. Existing record of high pressure minerals is mostly constrained to shock-melt veins and -pockets that occur in a matrix of much cooler shock-deformed bedrock at some distance from the impact melt lake and in a regime of decaying shock. Terrestrial impact events generate geologic record that often permits us placing shock-metamorphic mineralogical record into the context of the entire impact event. In case of meteorites we are constrained to characteristic deformation features in minerals and the record of high-pressure minerals in melt-veins or -pockets as they occur in a particular specimen of, usually, cm-scale.

This poses difficulties in placing P-T conditions of formation of such minerals into the context of an impact event. On smaller spatial scale the additional question arises if shock-induced deformation features in comparatively cold bed rock and high-pressure mineral phases in melt veins/pockets provide us with the same information about P-T and time.

Results: In my talk I focus on observations and issues that are directly related to shock-generated high-pressure minerals: a) How large is the offset between kinetic and thermodynamic phase boundaries: In case of bridgmanite, the offset is within rather narrow margins - but is this generally true? b) (Synchronous) occurrence of minerals of different pressure-stability along temperature gradients, e.g: ringwoodite/ahrensite - bridgmanite+wüstite in Tissint, c) (Synchronous) occurrence of such phases in apparent absence of T-gradients: ringwoodite, akimotoite, and bridgmanite in L-chondrite melt veins, d) Correlating crystal size with growth rates: Can we use data from low-stress rate static experiments to estimate shock-duration? e) Occurrence of high-pressure phases in bedrock far from melt veins. f) For our purposes high pressure mineralogy is actually insufficiently known.



The latter point may seem surprising. As an example I show here the diffraction pattern of a monoclinic wadsleyite-like phase observed at the border of a melt pocket in the Tissint shergottite. To my knowledge this is the first report of wadsleyite in Tissint. However, this wadsleyite contains noticeable amounts of Fe and Cr, thus extending into a chemical parameter space that has not yet been experimentally explored. At present, it would be difficult to correlate this occurrence of wadsleyite with pro- or retrograde shock metamorphism in Tissint.

Diffraction data were collected at beamline 13-IDD, GSECARS, APS.

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