DIASCoPE: A New Method for Fast Acoustic Velocity Measurements at High Pressure — Changing the Paradigm from Product to Process

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Understanding the properties and behaviors of materials and multi-phase aggregates under conditions of high pressure and temperature is vital to unraveling the mysteries of the deep Earth. Advances in *in situ* experimental techniques using synchrotron radiation at these extreme conditions have helped to provide answers to fundamental questions that were previously unattainable. Synchrotron-based ultrasonic interferometry measurements have proven to be especially important in determining acoustic velocities and thermoelastic properties of materials at high pressures and temperatures. However, due to relatively slow data collection times, it has been difficult to measure the effects of processes as they occur, and instead the measurement is made on the end product of these processes.

Until now.

DIASCoPE, which stands for Directly Integrated Acoustic System Combined with Pressure Experiments, is a new experimental system to measure elastic wave velocities in samples *in situ* under extreme conditions of pressure and temperature in a multi-anvil apparatus at Beamline 6-BM-B of the Advanced Photon Source at Argonne National Laboratory. This system allows for measurement of acoustic velocities via ultrasonic interferometry, and makes use of the synchrotron beam to measure sample densities via X-ray diffraction and sample lengths using X-radiographic imaging. This system is fully integrated into the EPICS software controls of the beamline and is capable of collecting robust data on elastic wave travel times in less than one second, which is an improvement of more than one to two orders of magnitude over existing systems. This allows for more careful study of time-dependent phenomena with tighter snapshots in time of processes that would otherwise be lost or averaged out by other acoustic measurement systems. This system also provides automation of controls and data acquisition, which allows for more structured and precise experimental protocols. DIASCoPE has been fully integrated into Beamline 6-BM-B and data collected using this powerful new system will be presented here. DIASCoPE's capabilities will allow us to change the focus of study from the product to the process itself, leading to a greater understanding of the materials and processes that shape the Earth and other terrestrial planetary bodies.