

**COMPRES: A COMMUNITY-BASED CONSORTIUM FOR RESEARCH ON MATERIALS PROPERTIES OF EARTH AND PLANETARY INTERIORS.** C. B. Agee, COMPRES President, COMPRES Central Office, University of New Mexico, agee@unm.edu.

**COMPRES (C**onsortium for **M**aterials **P**roperties **R**esearch in **E**arth **S**ciences) is a community organization with 63 U.S. member institutions and 48 foreign affiliates, that operates facilities at national laboratories, and develops new technologies, for research in the materials properties of earth and planetary interiors with particular emphasis on high-pressure science and technology and related fields. COMPRES is funded through a cooperative agreement with the National Science Foundation and is charged with oversight and guidance of several high-pressure facilities and beamlines at the following Department of Energy (DOE) National Laboratories: Advanced Light Source (ALS) Berkeley, Advanced Photon Source (APS/GSECARS) Argonne, and National Synchrotron Light Source-II (NSLS-II) Brookhaven (Figure 1).

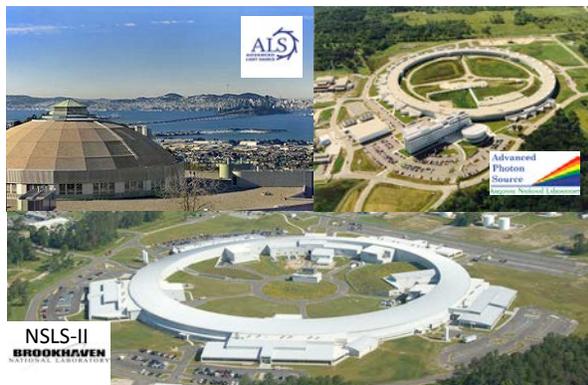


FIG. 1. Department of Energy synchrotrons at Lawrence Berkeley National Laboratory, Argonne National Laboratory, and Brookhaven National Laboratory where COMPRES offers user facilities.

The community-based organization of COMPRES is directly analogous to centralization of efforts in related fields, such as the coordination of seismic data distribution and instrument deployment orchestrated by IRIS, the Incorporated Research Institutions of Seismology. While COMPRES derives its primary financial support from the Instrumentation and Facilities Program in the Division of Earth Sciences of the NSF, it leverages the enormous investment of the DOE in constructing and supporting the operation of its national laboratories. In addition, members of the COMPRES community have been very successful in obtaining other funding from the NSF, DOE, NASA and DOD to enhance the opportunities for research in high-pressure mineral physics and planetary interiors. COMPRES

does not fund specific scientific projects. Rather, the role of COMPRES is to enable scientific investigations by providing world-class facilities and the best infrastructure possible for its community.

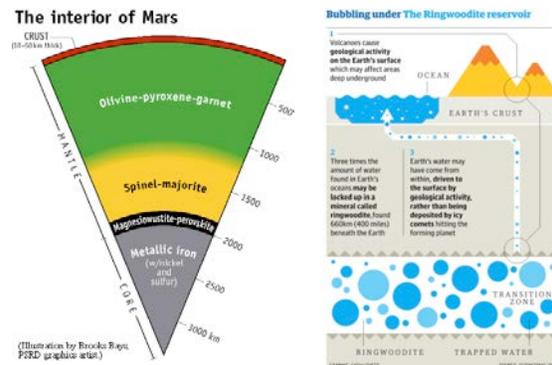


FIG. 2. (Left) Mineralogy of the Martian interior based on high pressure experiments [4]. (Right) COMPRES supported study [5] that discovered a major mineral (Ringwoodite) reservoir for water in the Earth's transition zone (applicable to other terrestrial planets).

**COMPRES and its Relationship to NASA:** The science goals [1,2] of the COMPRES community have very clear and strong connections to many of the important science questions described in the NRC Space Studies Board 2013-2022 Decadal Survey [2]. For example, accretion and internal differentiation of solar system bodies, impact processes, and the deep sequestration of water, carbon, and other volatiles in the Earth and terrestrial planets are major common science themes that both COMPRES and NASA share. We know from mineral physics experiments that Earth's deep interior likely contains more water, carbon and sulfur than exists at Earth's surface (figure 2) – this may also be true for Mars and other planets and moons. Our hydrosphere originated from degassing of the interior of the planet early in Earth history, possibly starting with a global magma ocean, and it continues to be cycled through the interior via subduction today. All of the scientific issues that have driven much of high-pressure Earth science research also apply to other planets in our solar system and their moons. Indeed, origin of the Earth cannot be separated from the origin of the Moon. Our models for the mantle and core of Mars are almost entirely derived from seismological measurements and mineral physics ex-

periments (figure 2) of the Earth's interior. The Decadal Survey calls out the importance of NSF-supported facilities to planetary science activities: "...NSF can make a huge impact on planetary science by supporting this vital area of research. The committee recommends expansion of NSF funding for the support of planetary science in existing laboratories, and the establishment of new laboratories as needs develop." The report goes on to note: "The acquisition of major laboratory instruments often involves joint funding by NSF and NASA. Such cooperative arrangements have proven very beneficial. Such coordination offers a unique opportunity to leverage funds and strengthen infrastructure support." We concur with these findings and believe there is much more that could be done to strengthen the synergy between the NSF-supported mineral physics community (e.g., COMPRES) and the NASA-funded planetary materials community.

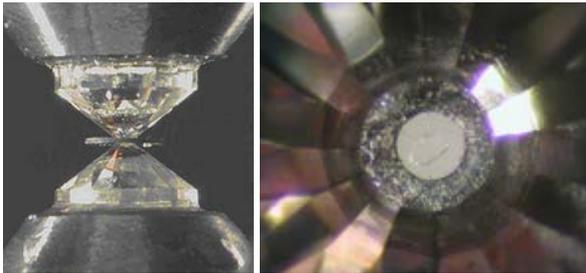


FIG. 3 (Left) Close-up view of the diamonds and metal gasket (center) within a diamond anvil cell. Vertical dimension of picture is  $\sim 1$  cm; total flat portion of the anvil tips is  $\sim 500$  microns. (Right) View through the diamond anvil into a pressurized sample. Grey speckled annulus is the metal gasket; the mineral sample (wadsleyite) (center oblong feature) is held within a liquid pressure medium. Sample diameter is  $\sim 200$   $\mu\text{m}$ . [2]

The strong track record that COMPRES-supported researchers have established in analyzing micro-scale samples, for example under high pressure in diamond anvil cells (DAC) (figure 3) on synchrotron beamlines, can have added benefit for NASA beyond understanding planetary interiors. DAC experiments are of very similar scale and have similar sample preparation and manipulation requirements as the sample handling and analysis will have during ground segment operations of future sample return missions. In fact, synchrotron radiation is already being used for studies of meteorites and other planetary materials (in particular x-ray tomography [6]), although there is not yet a comparable strong presence at the national labs as there is in mineral physics, materials science, and biological sciences. One of the keys to success for

COMPRES researchers visiting synchrotrons and other central user facilities has come from our investment in highly skilled and motivated beamline scientists who can ensure an excellent user experience with maximum science yield. We also continually invest in our facility hardware with upgrades and instrument development, driven by evolving research goals and questions. As NASA prepares for future sample return missions, plans for use of central facilities may benefit from collaboration with COMPRES or adopting some aspects of the COMPRES model for science community participation.

**References:** [1] Bass J., editor (2004) *Current and Future Directions in High-Pressure Mineral Physics*, Univ. Illinois, Urbana-Champaign, 28 pp. [2] Williams, Q., editor, (2010) *Understanding the Building Blocks of the Planet: The Materials Science of Earth Processes*. Report to the National Science Foundation. COMPRES Consortium, 68 pp. [3] Committee on the Planetary Science Decadal Survey (2011) *Space Studies Board, National Research Council* 382 pp. [4] Bertka, C.M. & Y. Fei (1997) *Journal of Geophysical Research*, 102, 5251-5264. [5] Schmandt, B. et al. (2014) *Science*, 13, 1265-1268. [6] Ebel, D. S. & M. L. Rivers (2007). *Meteoritics and Planetary Science* 42: 1627-1646.