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EARTH'S MYSTERIES AND THE ADVANCED PHOTON SOURCE

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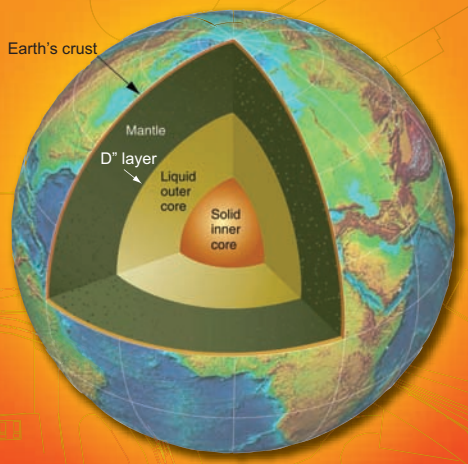

Courtesy of Lawrence Livermore National Laboratory

Deep inside the Earth—2,900 kilometers (1,800 miles) below the surface, between our planet's mantle and outer core—is the D″ layer. The D″ layer has long mystified geologists because it exhibits characteristics very different from the rest of the Earth's interior. High-pressure/high-temperature research at the Argonne Ad-vanced Photon Source (APS) and other synchrotron x-ray light sources is uncovering the secrets of the D″ layer, which may hold clues to the origins of seismic disruptions such as volcanoes.

For instance, x-ray research carried out at the APS by scientists from the Carnegie Institution of Washington; The University of Chicago; the Massachusetts Institute of Technology; Princeton University; and the University of California, Berkeley indicates that the D″ layer is probably composed of a recently-discovered crystalline mineral phase called a "post-perovskite."

Moreover, recent studies at the APS by scientists from the Argonne and Los Alamos national laboratories, the Carnegie Institution of Washington, and The University of Chicago indicate that patches of the post-perovskite lying just above the outer core may be enriched in iron, accounting for the "ultra-low-velocity zones" in the D″ layer, where the velocity of seismic waves is strongly depressed relative to neighboring areas.

Scientists are using x-ray beams from the APS to "travel" down into the interior of the Earth. This journey of discovery is achieved by utilizing sophisticated tools such as diamond anvil cells and high-powered lasers to replicate the pressure and temperature conditions (respectively) found near the center of our planet, applying those conditions to materials thought to exist deep inside the Earth, and then employing APS x-ray beams to collect data for analysis.

See other side for more information

The Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory provides this hemisphere's brightest x-ray beams for research. Scientists and engineers using the APS help assure a bright future for our nation by carrying out research that promises to have far-reaching impact on our technological and economic competitiveness, our health, and our fundamental knowledge of the materials that make up our world.

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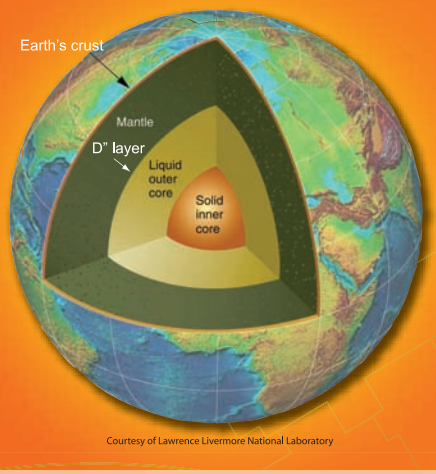

Courtesy of Lawrence Livermore National Laboratory

Post-perovskite experiments carried out by researchers from The University of Chicago, the Carnegie Institution of Washington, and the High Pressure Collaborative Access Team (HP-CAT) using the 13-ID-D (GSECARS) and 16-ID-B (HP-CAT) beamlines at the APS [1]; and the Massachusetts Institute of Technology; Princeton University; the University of California, Berkeley; and The University of Chicago using the GSECARS 13-ID beamline at the APS [2].

[1] See: Wendy L. Mao[1,2], Yue Meng[3], Guoyin Shen[1], Vitali B. Prakapenka[1], Andrew J. Campbell[1], Dion L. Heinz[1], Jinfu Shu[2], Razvan Caracas[2], Ronald E. Cohen[2], Yingwei Fei[2], Russell J. Hemley[2], and Ho-kwang Mao[1,2,3], "Iron-rich Silicates in the Earth's D″ Layer," Proc. Natl. Acad. Sci. U.S.A. **102**, 9751 (12 July 2005).
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See also: "Iron at the D″ Layer?," *APS Science 2005*, the annual report of the Advanced Photon Source at Argonne National Laboratory, ANL-05/29 (May 2006) p. 110.

[2] See: S.-H. Shim[1], T.S. Duffy[2], R. Jeanloz[3], and G. Shen[4], "Stability and Crystal Structure of $MgSiO_3$ Perovskite to the Core-Mantle," Geophys. Res. Lett. **31**, L10603 (2004).
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See also: "What Lies at the Earth's Core-Mantle Boundary?," *APS Science 2005*, the annual report of the Advanced Photon Source at Argonne National Laboratory, ANL-05/29 (May 2006) p. 111.

Ultra-low-velocity zone research by scientists from Los Alamos National Laboratory, the Carnegie Institution of Washington, Argonne, and The University of Chicago using the GSECARS 13-ID-D and the HP-CAT 16-ID-B beamlines at the APS.

See: Wendy L. Mao[1]*, Ho-kwang Mao[2,3], Wolfgang Sturhahn[4], Jiyong Zhao[4], Vitali B. Prakapenka[5], Yue Meng[3], Jinfu Shu[2], Yingwei Fei[2], and Russell J. Hemley[1], "Iron-Rich Post-Perovskite and the Origin of Ultralow-Velocity Zones," Science **312**, 564 (28 April 2006). DOI: 10.1126/science.1123442
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See also: "Is an Iron-rich Silicate the Key to Ultra-low-velocity Zones?," *APS Science 2006*, the annual report of the Advanced Photon Source at Argonne National Laboratory, ANL-06/23 (May 2007) p. 113.