The Advanced Photon Source

Diamond Impurities Indicate Water Deep in Earth's Mantle

Groundbreaking research at the U.S. Departmrnt of Energy's Advanced Photon Source (APS) and Advanced Light Source (ALS) found that diamonds pushed up from the Earth's interior had traces of unique crystallized water called Ice-VII, a high-pressure form of water ice that is stable above 2.4 GPa. Ice-VII is recognized as a mineral by the International Mineralogical Association.

The researchers used diamonds that surfaced from inside the Earth in Orapa (Fig. 1), Namaqualand, Shandong, Zaire, and Sierra Leone. The diamonds were examined via x-ray diffraction at the GeoSoilEnviroCARS (GSECARS) 13-ID-D beamline at the Argonne National Laboratory APS, and x-ray micro-fluorescence at the GSECARS 13-ID-E beamline. Additional diffraction data were collected at High Pressure Collaborative Access Team (HP-CAT) 16-ID-B beamline, also at the APS. Characterization by infrared spectroscopy was carried out at Caltech, and at the ALS bending magnet beamline 1.4 at Lawrence Berkeley National Laboratory. (The APS and ALS are Office of Science user facilities.)

Scientists theorize the diamonds used in the study were born in the mantle under temperatures reaching more than 1,000° F. The mantle — which makes up more than 80 percent of the Earth's volume — comprises silicate minerals containing mostly magnesium, and smaller amounts of iron, aluminum, and calcium among others.

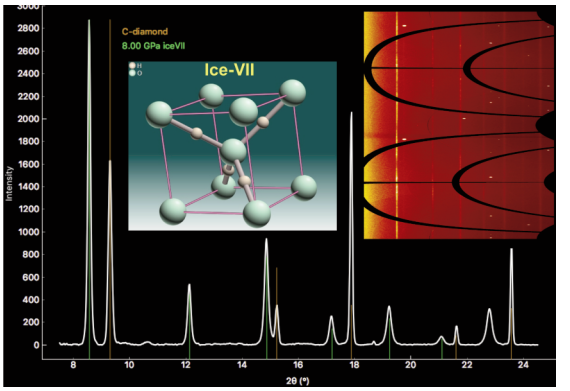

Fig. 1. Diffraction pattern of ice-VII in diamond M57666 from Orapa.

And now we can add water to the list.

The discovery of Ice-VII in the diamonds is the first known natural occurrence of the aqueous fluid from the deep mantle. Ice-VII had been found in prior lab testing of materials under intense pressure. The team also found that while under the confines of diamonds found on the surface of the planet, Ice-VII is solid. But in the mantle, it is fluid.

These discoveries are important in understanding that water-rich regions in the Earth's interior can play a role in the global water budget and the movement of heat-generating radioactive elements, and can help scientists create new, more accurate models of what is occurring inside the Earth, specifically how and where heat is generated under the Earth's crust.

See: O. Tschauner, S. Huang, E. Greenberg, V.B. Prakapenka, C. Ma, G.R. Rossman, A.H. Shen, D. Zhang, M. Newville, A. Lanzirotti, and K. Tait, "Ice-VII inclusions in diamonds: Evidence for aqueous fluid in Earth's deep mantle," Science **359**, 1136 (9 March 2018).
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Call for APS General-User Proposals

The Advanced Photon Source is open to experimenters who can benefit from the facility's high-brightness hard x-ray beams.
General-user proposals for beam time during Run 2018-3 are due by Friday, July 6, 2018.
Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mills, DMM@aps.anl.gov, 630/252-5680.

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