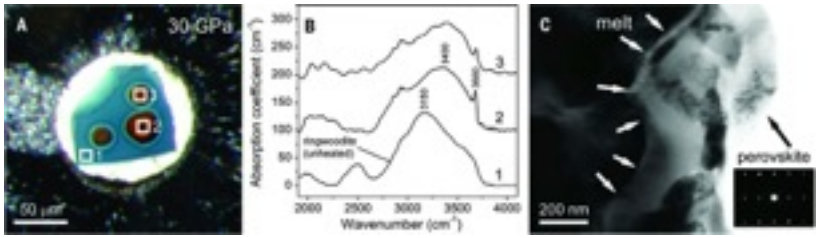
New Evidence for Oceans of Water Deep in the Earth

Scientific Achievement

First direct evidence of water trapped in the "transition zone" of Earth's mantle, 400 miles beneath the surface; potentially oceans worth of water bound in deep rock, which may represent planet's largest water reservoir

Significance and Impact

Findings help scientists understand how Earth is formed, what its current composition and inner workings are, and how much water is trapped in mantle rock



A blue crystal of ringwoodite containing around one percent of H2O in its crystal structure is compressed to conditions of 700 km depth inside a diamond-anvil cell. Using a laser to heat the sample to temperatures over 1500C (orange spots), the ringwoodite transformed to minerals found in the lowermost mantle. Synchrotron-infrared spectra collected on beamline U2A at NSLS reveal changes in the OH-absorption spectra that correspond to melt generation, which was also detected by seismic waves underneath most of North America.

Research Details

- Water from the Earth's surface can be driven deep within the mantle by plate tectonics, eventually causing partial melting of rocks within the mantle.
- Used a laser to heat a sample of lab-grown mantle minerals and small gem diamonds as hard anvils to compress the sample to deep-Earth conditions, and used x-rays, electrons, and infrared light to study chemical reactions within the sample.
- Seismic waves were used for direct observation and imaging of the interior of the Earth, where similar processes to those observed in the lab are happening. That process — called dehydration melting — happens as a rock carrying H2O moves from the Earth's transition zone to the lower mantle, which forms a high-pressure mineral called silicate perovskite, which cannot absorb water in the same way. The released water is then trapped in the transition zone.

B. Schmandt, S. D. Jacobsen, T. W. Becker, Z. Liu, K. G. Dueker. *Science*, **v. 344 no. 6189,** pp. 1265-1268 (2014)

Work was performed at Brookhaven National Laboratory and Argonne National Laboratory.

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