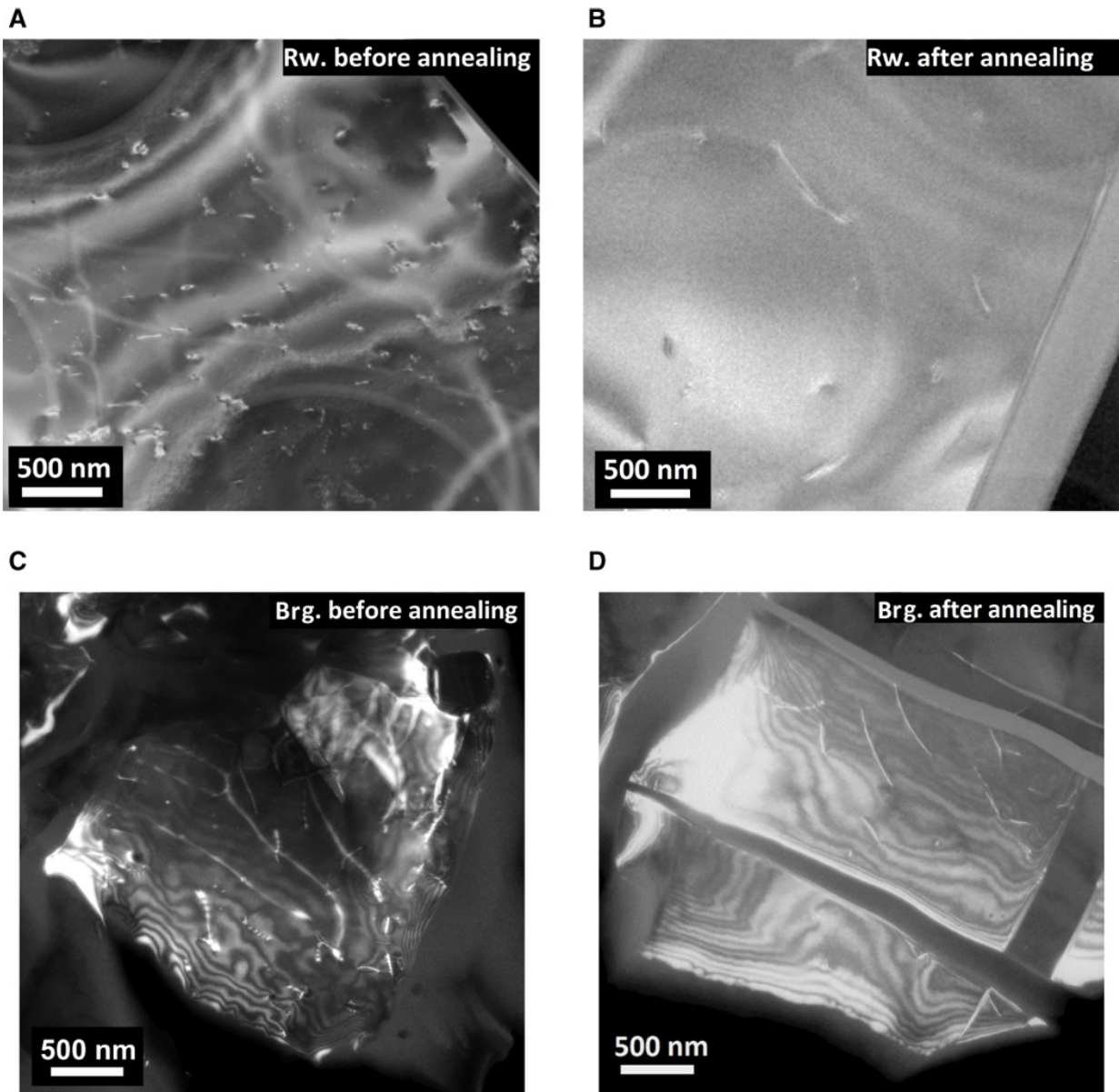


Study suggests mid-mantle holds as much water as Earth's oceans

June 8 2017, by Bob Yirka



TEM images of ringwoodite and bridgmanite before and after annealing. (A) Inverted bright-field image of ringwoodite before annealing ($\rho_i = 11.0/\mu\text{m}^2$). (B) Inverted bright-field image of ringwoodite after annealing for 12 hours at 2000 K ($\rho_f = 0.87/\mu\text{m}^2$). (C) Dark-field image of bridgmanite before annealing ($\rho_i = 8.43/\mu\text{m}^2$). (D) Dark-field image of bridgmanite after annealing for 24 hours at 1600 K ($\rho_f = 4.32/\mu\text{m}^2$). Rw., ringwoodite; Brg., bridgmanite. Credit: *Science Advances* 07 Jun 2017: Vol. 3, no. 6, e1603024, DOI: 10.1126/sciadv.1603024

(Phys.org)—A team of researchers affiliated with several institutions in Japan and Germany has found evidence that suggests the middle of Earth's mantle holds as much water as the planet's oceans. In their paper published on the open access site *Science Advances*, the group describes their theory and their experiments to try to prove them correct.

Scientists are convinced that the uppermost part of the mantle and lower part closest to the core are relatively [water](#) free. This is because the materials they are made of can't to store water very well. The layer in between (at 410 to 660 kilometers below the surface), however, has been a topic of debate, with some believing it is also nearly water free and others suggesting it could harbor massive amounts of water. This is because the mid-mantle is dominated by the minerals wadsleyite and ringwoodite, which are known to be able to hold a lot of water. In this new effort, the researchers sought to settle the debate by using logic and [lab experiments](#).

The team notes that prior research has shown that the viscosity of the middle zone of the mantle is lower than that of both the [upper mantle](#) and [lower mantle](#). To figure out if the middle zone is holding water, the researchers used this information and conducted lab experiments meant to replicate such conditions. They created synthetic ringwoodite to represent the middle mantle and bridgmanite to represent material from the lower mantle. They then used a technique that involved measuring

dislocation mobility to infer viscosity and then added water to the ringwoodite. They report that doing so reduced its viscosity and matched measurements taken of the real mantle—this suggests that the real-world middle mantle does, indeed, hold water. By adjusting the amount of water added to their synthetic mantle and calculating changes in [viscosity](#), they were able to estimate how waterlogged the real-world minerals are. They then used that information to calculate how much water is in the entire mid-mantle. They report that it is very nearly equal to the amount of water in all of the world's oceans.

More testing will have to be done, of course, but if scientists can prove without doubt that the middle [mantle](#) is filled with water, it calls into question theories that suggest water arrived on Earth from comets.

More information: A nearly water-saturated mantle transition zone inferred from mineral viscosity, *Science Advances* 07 Jun 2017: Vol. 3, no. 6, e1603024, [DOI: 10.1126/sciadv.1603024](https://doi.org/10.1126/sciadv.1603024), advances.sciencemag.org/content/3/6/e1603024.full

Abstract

An open question for solid-earth scientists is the amount of water in Earth's interior. The uppermost mantle and lower mantle contain little water because their dominant minerals, olivine and bridgmanite, have limited water storage capacity. In contrast, the mantle transition zone (MTZ) at a depth of 410 to 660 km is considered to be a potential water reservoir because its dominant minerals, wadsleyite and ringwoodite, can contain large amounts of water [up to 3 weight % (wt %)]. However, the actual amount of water in the MTZ is unknown. Given that water incorporated into mantle minerals can lower their viscosity, we evaluate the water content of the MTZ by measuring dislocation mobility, a property that is inversely proportional to viscosity, as a function of temperature and water content in ringwoodite and bridgmanite. We find that dislocation mobility in bridgmanite is faster by two orders of

magnitude than in anhydrous ringwoodite but 1.5 orders of magnitude slower than in water-saturated ringwoodite. To fit the observed mantle viscosity profiles, ringwoodite in the MTZ should contain 1 to 2 wt % water. The MTZ should thus be nearly water-saturated globally.

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