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A super-aluminous phase D stable within subdacting oceanic crust in the Earth's lower mantle.

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High-pressure experiments have identified a number of dense hydrous magnesium silicate (DHMS) phases that are potentially stable in the cool interiors of subducting slabs. These phases may be responsible for the subduction of H_2O deep into the Earth's interior. The highest pressure DHMS phase yet identified has been termed phase D, with the ideal formula $MgSi_2H_2O_6$. Phase D is stable at pressures equivalent to those in the lower mantle but dehydrates at temperatures at or above approximately 1400 °C and would therefore not be stable in the ambient lower mantle. This, combined with the recognized low solubility of H_2O in nominally anhydrous minerals that make up the bulk of the lower mantle, implies that H_2O might be forced into fluid or melt phases in the lower mantle.

A new Al-rich form of the dense hydrous magnesium silicate phase D has been synthesized at 1600 °C and 26 GPa. Initial multianvil experiments employing a simplified hydrous MORB bulk composition in the system H-Fe-Mg-Si-Al-O produced silicate perovskite with the formula $Mg_{0.59}Fe_{0.42}Al_{0.34}Si_{0.65}O_3$ coexisting with a minor amount of an Al-rich hydrous phase. The composition of this phase was used to derive a second starting composition comprised of oxides and hydroxides, which was equilibrated at 1600 °C and 26 GPa in a Pt capsule. The run produced single crystals with the formula $H_{1.9}Mg_{0.2}Fe_{0.2}Al_{1.8}SiO_6$ of up to 100 microns in largest edge length. The unit-cell lattice parameters determined with a Huber four-circle diffractometer using 20 reflections are the following: a = 4.7704(2) Å, c = 4.2896(2) Å, V = 84.540(7) $Å^3$. Structural refinements show that this phase has a structure similar although not identical to that of the $MgSi_2H_2O_6$ phase D end-member. Significant amounts of Al-Si disorder among the cation sites has been suggested based to the similar bond lengths and distortion of the coordination octahedra. The Raman spectrum of this phase displays very broad absorption bands both in the region of lattice vibration and in the region of the O-H stretching mode.

The high temperature stability of this phase and its coexistence with phases in a simplified MORB bulk composition are strong grounds to argue that it could be a host for H_2O in the Earth's lower mantle. H_2O in the ambient lower mantle may therefore become preferentially concentrated in recycled portions of oceanic crust.