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Early burial of water in Earth's deep mantle

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Earth's water was likely acquired early, when our planet was developing deep magma oceans that may have extended to the lower mantle, as a result of large to giant impacts. How such early water was retained and distributed within a crystallizing mantle remains unclear. This is primarily determined by the partitioning of water between mantle minerals and silicate melt. However, early attempts to constrain water partitioning were largely restricted to minerals stable under conditions of the upper mantle, transition zone, or the topmost lower mantle. In this study, we investigated water partitioning between the major lower mantle minerals (e.g., bridgmanite) and coexisting melt through systematic laser-heated diamond anvil cell experiments relevant to deep magma ocean conditions (>30 GPa, >3000 K). Our results demonstrate that the lower mantle minerals could hold much more water than previously estimated, by a factor of ~5 to 100. Thus, appreciable amounts of water may have been retained in the lower mantle after its crystallization. Circulation of such early stored water in earth's interior could have modulated mantle dynamics and influenced the transition of early earth to a habitable planet.