Hydrogen isotopic compositions of Archean sea water and isotopic evolution

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The isotopic evolution of seawater may reflect the hydrogen cycle in Earth's ocean and atmosphere through time. We analysed hydrogen and oxygen isotopic composition of Archean seafloor basalt and gabbro to constrain the isotopic evolution of seawater. A 3.2 Ga Archean ophiolite from Cleaverville Formation, Western Australia showed clear correlation between metamorphic grade and H and O isotopic compositions. Also, the observed δD values are positively correlated with H_2O content as observed in modern seafloor basalts, though the δD values are significantly lower than for the modern seafloor. The observed correlation implies that the basalts have preserved the record of hydrothermal alteration at Archean seafloor and subsequently went through dehydration during metamorphism. Based on this result, we estimated that the 3.2 Ga seawater was depleted in deuterium by about 16‰ compared to the modern seawater (i.e., δD = –16‰). In order to explain the isotopic difference, we have modelled the H escape into space and interaction between seawater and, mantle, As a result, the estimated 16‰ deuterium depletion can be caused by interplay with methanogenesis and efficient H escape via CH_4 that results in loss of seawater about 3% of modern ocean volume.