Insights into the Proterozoic water cycle: D/H ratios of water from fluid inclusions trapped in halite

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Deuterium content was measured in water present in tiny primary fluid inclusions trapped in Mesoproterozoic (≈ 1.4 Ga) and Neoproterozoic (≈ 0.8 Ga) halite crystals. While the hydrogen concentrations range from 300 to 1500 ppm for the whole sample collection, δD values range from -74 to -54‰ (V-SMOW) for the Mesoproterozoic halite sampled from the Sibley Group, Ontario, Canada, and from -71 to -38‰ for the Neoproterozoic halite from the Browne Formation, Officer Basin, southwestern Australia. Laboratory experiments revealed that the amount of evaporation required to precipitate halite is accompanied by a D-enrichment of 90 to 120‰ depending on ambient parameters such as air temperature, relative humidity and wind velocity. It means that the original aqueous solutions had δD values lower than -150‰. In both Proterozoic depositional environments, the salt was most likely deposited in a littoral environment under the influence of marine and fresh waters. Considering the estimated paleolatitudes for those geological periods, seawater that mixed with freshwater was most likely significantly D-depleted relative to modern seawater. Such interpretation is at variance with conclusions inferred from published δD values of Proterozoic ophiolitic rocks. However, it may be conciliated with some modelling outputs of the long-term water cycle in which a progressive D-enrichment of the oceans is calculated through the continuous addition of D-rich extraterrestrial water (cometary dust) and the loss of H through the process of water photodissociation by ultraviolet radiation in the upper atmosphere.