



Oxygen isotope composition of the Archean seafloor and its implication of early seafloor spreading

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The recent suggestion that the Archean oceans were hot has ignited a lively controversy not only of the temperature but also the $\delta^{18}\text{O}$ of ancient oceans. The $\delta^{18}\text{O}$ of Archean cherts are known to be very low. It has been argued that they have not been reset and precipitated from a very warm to hot Archean ocean, a conclusion incompatible with some models of atmosphere and seawater compositions. Critics of a hot Archean invoke moderate temperatures but a very low $\delta^{18}\text{O}$ ocean (-13 per mille SMOW) as the explanation for the low $\delta^{18}\text{O}$ cherts.

The $\delta^{18}\text{O}$ of the ocean is held at its present value by a balance of low and high temperature water rock interactions primarily linked to plate tectonic processes. Ophiolites and VMS ore deposits of all ages show no secular trend in $\delta^{18}\text{O}$ indicating a constant $\delta^{18}\text{O}$ even in the Archean, implying a more or less modern style plate tectonics operating on the early earth. In contrast, most brachiopods and sediments do show a secular trend of decreasing $\delta^{18}\text{O}$ which some explain as reflecting an ever lower $\delta^{18}\text{O}$ ocean. If the ancient ocean was indeed much depleted in $\delta^{18}\text{O}$ than a different geodynamic regime must have been operating.

A -13 per mille ocean would impose a clear signal on any product of rock alteration by seawater, with a more obvious impact at higher alteration temperatures. Here we report new $\delta^{18}\text{O}$ data for Archean seafloor rocks from Barberton (3.5 Ga) and Isua (3.8 Ga). Pillows at both locations show $\delta^{18}\text{O}$ variation on the outcrop and pillow scale indicating no isotopic overprinting. Pillow interiors have values as high as 9.9, but the chilled margins tend to be near 6. No interaction of the 3.8 Ga seafloor with a low

$\delta^{18}\text{O}$ ocean is evident. Our new data is in agreement with previous studies on pillows from Pilbara, Barberton and Kid Creek. All data from the Archean ocean crust shows that the suggestion of a very low $\delta^{18}\text{O}$ ocean is untenable and modern style seafloor spreading may have been operating in the Archean.