Hydrothermally altered ocean crust constrains the oxygen isotope composition of ~3.2 Ga seawater, Pilbara Craton, Australia

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A number of important Earth System events mark the Paleoarchean Eon, including evidence for emergent continents and weathering, and the appearance of a recognizable rock record. Placing these events in a geochemical context remains difficult due to a poorly preserved sedimentary record and great age. For example, some sedimentary archives of ocean temperature (O isotopes from cherts [1]) suggest ocean temperatures up to 50-60 ºC. However, the chert oxygen isotopes may have been altered during diagenesis [2]. An aditional possibility is that the ocean has evolved its oxygen isotope composition through time [3], complicating paleothermometer calculations.

To address the oxygen isotope conundrum (i.e., hot oceans, alteration, or evolving ocean isotope composition), we use an alternative archive of Paleoarchean seawater chemistry: hydrothermally altered oceanic crust. Specifically, the Panorama district in the Pilbara craton contains a minimally deformed area preserving ancient hydrothermal circulation through oceanic crust and VMS deposits [4]. The area preserves a ~7 km thick cross-section of crust, from surface pillow lavas, which are primarily basaltic andesite, down to a contemporaneous granitic intrusion which provided heat for hydrothermal circulation. Alteration patterns, and hydrothermal flow paths are preserved in alteration mineral assemblages [4]. In addition, a number of existing geochemical measurements, including oxygen isotopes, provide a basis from which to interrogate this area.

We have used a existing O-isotope measurements, combined with inverse geochemical modeling (Least squares solution to linear matrix, [5]), to recreate a flow field. From this field, which can be corroborated by field mapped alteration, we can estimate the oxygen isotope composition of incoming Paleoarchean seawater. This will allow us to assess the temperature and oxygen isotope composition of the Paleoarchean ocean.

References:
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