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Early Earth's hydrosphere: insights from the hydrothermally altered submarine lavas of the Eoarchean Saglek-Hebron Complex, Canada

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Estimating Earth's earliest hydrosphere conditions, including its temperature and isotopic composition, requires a rock whose protolith is robust enough to broadly preserve the O isotope data for billions of years despite isochemical metamorphism [1,2]. Numerous studies use zircon isotopic compositions [3] although zircons provide indirect and distant evidence of interaction between Hadean and Eoarchean rocks and the ancient hydrosphere. We here offer a direct investigation of rare outcrops of Hadean-Eorchaean age in Saglek-Hebron Complex in Northern Labrador, Canada ~3.8 Ga. We investigated a multitude of coeval rocks (basaltic pillows, dikes, sediments) mapped and previously well characterized compositionally and isotopically. These rocks are interpreted to represent submarine basalts and peridotites, with possible metakomatiites, are currently metamorphozed to amphibolite to granulite facies, and covered by metasedimentary rocks. We performed modeling of the metamorphic cycle on O and H isotopes and discuss the spatial distribution of O isotopic values.

Measured ^{18}O values range from 2.90 to 8.82‰, Δ^{17}O from –0.001 to –0.089‰, and D from –74.2 to –10.71‰. Although these are overlapping in values with concurrently measured triple O isotopes in Oman ophiolite in the same lab, triple O isotope equation solving provides insight into the Earth's ancient seawater-derived altering fluid composition: ^{18}O = –6.5 ± 3‰, Δ^{17}O = 0.001 ± 0.0005‰, and temperature of protolithic water/rock interaction ranging from 54 to 152 ºC. The input of these parameters into our numerical model of oxygen isotopes' behavior during seawater alteration of basalt and its subsequent metamorphism (up to amphibolite facies) resulted in values well corresponding to actual measurements. The results of the study suggest the Eoarchean oceanic water has a lighter oxygen isotopic composition compared to the modern oceans, providing slightly lower values than those previously reported [2] for Nuvvuagittuq Belt (4.3-3.8 Ga).

[1] Pope et al. (2012), *PNAS* 109, 4371. [2] Bindeman and O'Neil (2021) *EPSL* 586, 117539. [3] Spencer et al. (2014) *Geology* 42, 451.