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Stable Isotope Constraints on the Evolution of the Oceans: From Ophiolites to Archean Greenstones

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Karlis Muehlenbach's [1-4] initial stable isotopic studies of seafloor rocks was the beginning of a revolution that changed geologic perspectives on the chemistry of seawater [4]. Plate tectonics brought the competition between chemical weathering and high temperature alteration at midocean rigdes [4,5,6] to the forefront. Seawater was now a dynamic quasi-steady state solution not in chemical equilibruim with any particular rock. Ophiolite complexes provided new insights on the depth of penetration of seawater into the cooling lithsophere and the isotopic and mineralogic changes as a function of depth [7,8,9,10] These geometric constraints confirmed the Muehlenbachs and Clayton hypotheses on the ^{18}O-buffering of the oceans by hydrothermal alteration at midocean ridges. The combined ophiolite and submarine Archean greenstone records show that the oldest greenstone belts (the Pilbara, Isua, Barberton, and Singhbum [12,13]) all indicate the existence of a modern day type ocean in the Archean through the Proterozoic terms of $^{18}O/^{16}O$ and D/H. Oxygen isotopes of the ocean becomes a proxy for the existence of seafloor spreading even when there is no oceanic crust or ophiolitic rock preservation. The constancy of the hydrogen isotope record into the Archean argues for a constant volume ocean which has profound effects the evolution of the continental crust [14].

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