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Triple Oxygen Isotopic Compositions of Ocean Water from Mariana Trench

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High precision triple oxygen isotope data on 40 water samples (5 to 10,923 m depths) collected from Mariana Trench at the vicinity of 10ºN140ºE are reported in this study. The analyses yield mean values of –0.084 ± 0.224 ‰ (1σ), –0.061 ± 0.117 ‰(1σ) and –17 ± 5 ppm(1σ) for $\delta^{18}O$, $\delta^{17}O$ and $\Delta^{17}O$, respectively. The range of $\delta^{18}O$ (–0.480 to 0.544 ‰) is consistent with NASA Global Seawater Oxygen-18 database for Mariana Trench (Figure 1). The average $\Delta^{17}O$ value of –17 ppm at Mariana Trench is statistically different from the average $\Delta^{17}O$ value of –5 ppm for 38 water samples collected at depths of 2-5390 m from Atlantic, Pacific, Mediterranean, and northern Red Sea [1]. The slope of the three-isotope-plot, λ, of Mariana Trench water is 0.5206 ± 0.0032 (Figure 2), indicating kinetic diffusion including molecular diffusion and turbulent/eddy diffusion (θ_k = 0.5142) as the dominant processes in ocean body. The $\Delta^{17}O$ of –17 ppm is identical to the ocean steady-state isotope mass balance model prediction of modern ice-free world [2]. The fluxes associated with major geological processes controlling the total oxygen budget of the oceans via lithosphere-hydrosphere interactions from pioneering studies [3, 4] would have to be modified significantly in order to obtain model predictions of seawater $\Delta^{17}O$ = –4 ppm for modern ice-free world and $\Delta^{17}O$ = –5 ppm for modern world. The triple oxygen isotopic compositions of seawater from this study can contribute to the advancement of isotope thermometry based on mineral-water equilibrium, to the understanding of ocean isotope mass balance, and potentially contribute to the replenishment of international measurement standards based on ocean water.

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Figure 1. Depth profile of seawater $\delta^{18}O$ at Mariana Trench and comparison to other datasets

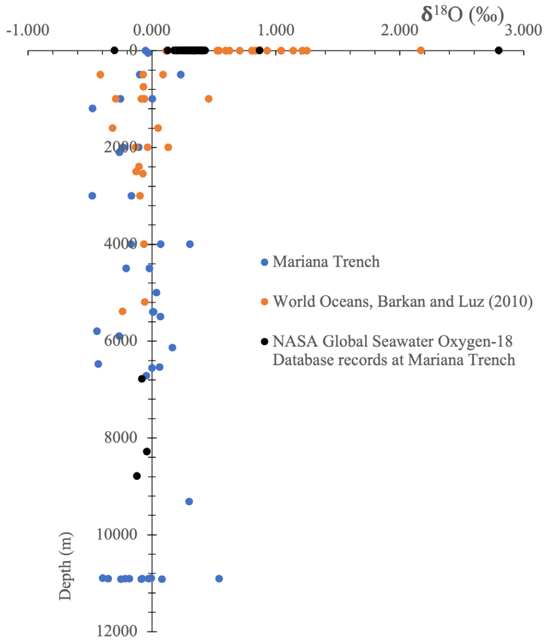

Figure 2. Oxygen three-isotope-plot of Mariana Trench water samples