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Water mass structure in the Challenger Deep and implications for the abyssal circulation within the Mariana Trench in the western Pacific Ocean

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We present dissolved inorganic radiocarbon ($DI^{14}C$) ages of seawater collected from the Challenger Deep in the Mariana Trench. Our results reveal a triple-layered structure for the abyssal water masses from the depth of 2000 m. The lowest $\Delta^{14}C$ values occur in the range of 2000-3500 m with a core around -233.4‰, giving rise to the oldest age of 2080±20 years. Below 3500 m, two layers can be recognized. The upper 3500-5000 m has a mean $\Delta^{14}C$ of -207.5‰ corresponding to a ^{14}C age of ~ 1800 years. Below 5000 m, even higher $\Delta^{14}C$ values around -200.3‰ are found, yielding a younger ^{14}C age of 1700±20 years for the deepest seawater sample at 8727 m. The older ^{14}C ages occurring in the upper part of the water column are interpreted as reflecting the mixing of the Upper Circumpolar Deep Water (UCDW) with the North Pacific Deep Water (NPDW). Despite of the contrasted topography in the Challenger Deep, the deeper water below 5500 m can retain the distinct characteristics of cold, saline, rich dissolved oxygen, especially high $\Delta^{14}C$ of the Lower Circumpolar Deep Water (LCDW) sourced from the Southern Ocean. Such a structure of water masses constrained by the radiocarbon suggests that the topographic flows in the hadal zone have limited effects on the diapycnal mixing, lending a support to the view that westward flow along the trench dominates the Challenger Deep without significant cyclonic circulation in the trench. It also allows an estimate of less than 300 years for the transient time of the bottom water from the Southern Ocean to the North Pacific Ocean.