Provenances, distribution, and accumulation of organic matter in the southern Mariana Trench rim and slope: implication for carbon cycle and burial in hadal trenches

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Hadal trenches, which represent the deepest portion of the hydrosphere on Earth, have been speculated to be traps and depocenters of organic matter. Here we examine the contents of total organic carbon (TOC) and total nitrogen (TN), as well as the $\delta^{13}C$ values of TOC in three gravity cores, two box cores, and three grab samples with water depth from 4900 to 7118 m, in order to reveal the provenances of organic matter, spatial distribution and accumulation rates of particulate organic carbon (POC) in the southern Mariana Trench rim and slope. Although the deepest area was not sampled, trench rim and slope is also of importance in terms of transportation and accumulation processes of organic matter. A vast majority of the sediment samples have bulk TOC/TN molar ratios and $\delta^{13}C$ values of TOC ranging from 4.2 to 11 and from -21.8 to -18.9‰, respectively, implying that the organic matter was primarily sourced from marine algae. Two exceptions have been found at 101 cm and 201 cm depths of core GC05 with a possible input of terrestrial material suggested by an abrupt increase in TOC contents and TOC/TN molar ratios accompanied by marked decreases in $\delta^{13}C$ values of TOC. Moreover, TOC contents in surface sediments basically increased with water depth. By fitting the published excess ^{210}Pb profile, the sedimentation rate in the southern Challenger Deep (6037 m) was estimated to be 0.02 cm yr^{-1}. This much higher sedimentation rate compared to the globally averaged values in deep ocean sediments coupled with the trend of increasing in TOC contents with water depth may serve as evidence for the lateral transport of sediment particles within the trench. The average POC accumulation rate roughly amounts to 1.5×10^{-5} g cm^{-2} yr^{-1}, equivalent to about a seventh of the globally averaged POC accumulation rate in deep-ocean seafloor. To our knowledge, POC accumulation in hadal trenches has been quantified for the first time, and we highlight that organic matter degradation in deep hadal trenches should not be neglected and may represent a significant component of the global carbon cycle.

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