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Organic matter and methane dynamics in the Japan Trench sediments

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Hadal trenches have been proposed as depocenters for organic matter and hotspots for microbial activity due to the prevalent lateral and downslope transport of sediment particles toward the trench axes. In addition to normal hemipelagic sedimentation, the Japan Trench experiences pulses of rapid sediment deposition and organic matter burial triggered by frequent subduction zone earthquakes. Here, we present porewater geochemical data from 15 holes cored during International Ocean Discovery Program (IODP) Expedition 386, with the aim of characterizing anaerobic organic matter mineralization and methane dynamics along the Japan Trench. The substantial downcore increases in alkalinity and ammonium concentrations indicate active organic matter degradation. Most of the sulfate profiles exhibit a shallow sulfate-methane transition zone (SMTZ, ~3-10 mbsf) that is comparable to those in continental margin sediments, reflecting relatively high rates of anaerobic oxidation of methane (AOM). At the SMTZ, $\delta^{13}C$ of dissolved inorganic carbon (DIC) is significantly higher than the $\delta^{13}C$ of organic matter and methane, which suggests an important supply of ^{13}C-enriched residual DIC due to intense in-situ methanogenesis from below.

Combined with porewater data of two previous R/V Sonne cruises (SO191 and SO251) in the Japan Trench, we will determine trench-wide organic matter mineralization and methane turnover rates using reaction-transport modeling. Our preliminary results show remarkable spatial variations in the rates of organoclastic sulfate reduction, AOM, and methanogenesis. The model predicted that an increase in anaerobic organic carbon mineralization rates is caused by an increase in the sedimentation rates, which in turn leads to an increase in AOM rates and shallowing of the SMTZ. We emphasize that rapid sedimentation triggered by slope instability associated with earthquake activity transports substantial amount of relatively labile organic matter into the trench bottom and subsequently stimulates intense organic matter mineralization and rapid methane turnover. We show that the event-triggered sediment mobilization plays a critical role in governing organic matter and methane dynamics, as well as in the deep biosphere microbial activity in hadal trench settings.