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Subseafloor biosphere in plate boundary of Japan Trench forearc

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The 11 March 2011 (Mw 9.0) Tohoku-oki earthquake source exhibited a compound rupture. The amount of slip increased up dip from the hypocenter to where the maximum slip of more than 50 m occurred near the trench. Large slip near the trench caused the strong impulsive peak of the tsunami. The Japan Trench Fast Drilling Project (JFAST) sailed April 1 to May 24 and was a rapid-response IODP expedition (IODP Exp 343) with a primary scientific objective to identify slipping fault(s) by LWD and retrieving core samples from across the plate boundary. The IODP Exp 343 had another objective as well. It was to justify the possible existence of earthquake-sustained subseafloor biosphere in the seismogenic subduction systems that had been hypothesized based on previous observations and laboratory experiments of abundant mechanochemical hydrogenogenesis by fault activities.

Since many geophysical observations predicted that the 3.11 Tohoku-oki earthquake provided the large seafloor displacement probably induced by large fault slip(s) along certain fault(s) in somewhere of the deep subseafloor environment at the Site C0019, we predicted that the possible earthquake-induced H2 concentration anomaly occurred at the time of slipping and was still preserved in the core sample of the Site C0019 even 14 months after the Tohoku-oki earthquake. A great spike in H2 concentration at around 700 m below seafloor (mbsf) may represent the earthquake-induced H2 concentration anomaly followed by the fault slipping caused by the Tohoku-oki earthquake. The LWD measurement and other pore-water chemistry data also suggested the existence of fault.

Not only H2 but also CH4 and other pore-water chemical characteristics in the core samples were of great geochemical and biogeochemical interest because the core samples that covered the whole sequence of plate boundary zones in the forearc regions of the subduction systems. There have been known only 3 forearc regions in the history where the ODP-IODP operation recovered the whole sequence of core samples penetrating the inter-plates boundary. Our pore-water chemistry demonstrated very unique profiles of abundance and isotopic composition of CH4, other hydrocarbons and sulfur compounds. These chemical profiles predicted the possible incidence and functions of novel subseafloor biosphere associated with spatially extended faulting structures and hydrothermal circulation of fluids in the deep inter-plates boundary.

Keywords: subseafloor biosphere, plate boundary, forearc, fault slipping, methane, molecular hydrogen