Press Releases

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JAMSTEC
Tokyo Institute of Technology
Yokohama City University
The University of Tokyo

Identified Hadal/Trench Biosphere
-Microbial Communities in Hadal Water Masses in Mariana Trench-

1. Overview

A joint study group by Dr. Takuro Nunoura, Research and Development Center for Marine Biosciences, Japan Agency for Marine-Earth Science and Technology (JAMSTEC: President Asahiko Taira), Tokyo Institute of Technology, Yokohama City University and The University of Tokyo identified trench microbial communities in water masses (a body of oceanic water characterized with a distinctive temperature and salinity) in the Challenger Deep, the Mariana Trench (6,000 ~10,257 m) for the first time. Being distinct from abyssal microbial communities, they clearly demonstrated existence of unique microbial ecosystems in hadal trench waters.

Although microbial explorations for hadal sediments began in the 1950s, the hadal water has been the least-explored microbial biosphere. In June 2008, the study group took water samples during the JAMSTEC's research vessel *Kairei* KR08-05 cruise using a remotely operated vehicle (ROV) ABISMO at a station on the Challenger Deep (11–22.25'N, 142–42.75'E, at the depth of 10,300m). Then, molecular ecological and geochemical analyses were carried out.

As a result, it became clear that microbial community compositions and functions in hadal waters (below 6000m) are distinct from overlying bathyal and abyssal microbial communities (at depth of 2,000-5,000m) with dominance of heterotrophic bacteria[*1], whereas other physical and chemical conditions such as temperature, salinity and dissolved nutrients are comparable to those in abyssal oceans. It provides absolutely new insight into understanding of marine microbial communities.

Since the Mariana Trench is geographically and hydrotopographically isolated from other trenches, there cannot be organic matters completely different from those in the upper abyssal waters, including possibility of flux from other trenches. It is, therefore, considered that these microbial ecosystems associated with the hadal trench waters are supported by endogenous recycling of organic matter from trench slopes disrupted due to earthquakes, etc. In other words, hadal/trench biosphere is likely to be associated with formation of trench topography as an ecosystem.

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These study results have been posted on a scientific journal, *Proceedings of the National Academy of Science* of the United States of America on February 24 (JST).

Title: **Hadal biosphere: insight into the microbial ecosystem in the deepest ocean on Earth**

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*1 Heterotrophic bacteria: Living organisms that use organic compounds for obtaining carbons necessary for nutrition. All animals and fungi as well as many bacteria and archaeon are heterotrophic. Heterotrophic bacteria cannot fix carbon so needs organic compounds synthesized by other living organisms. In contrast, plants are autotrophs.

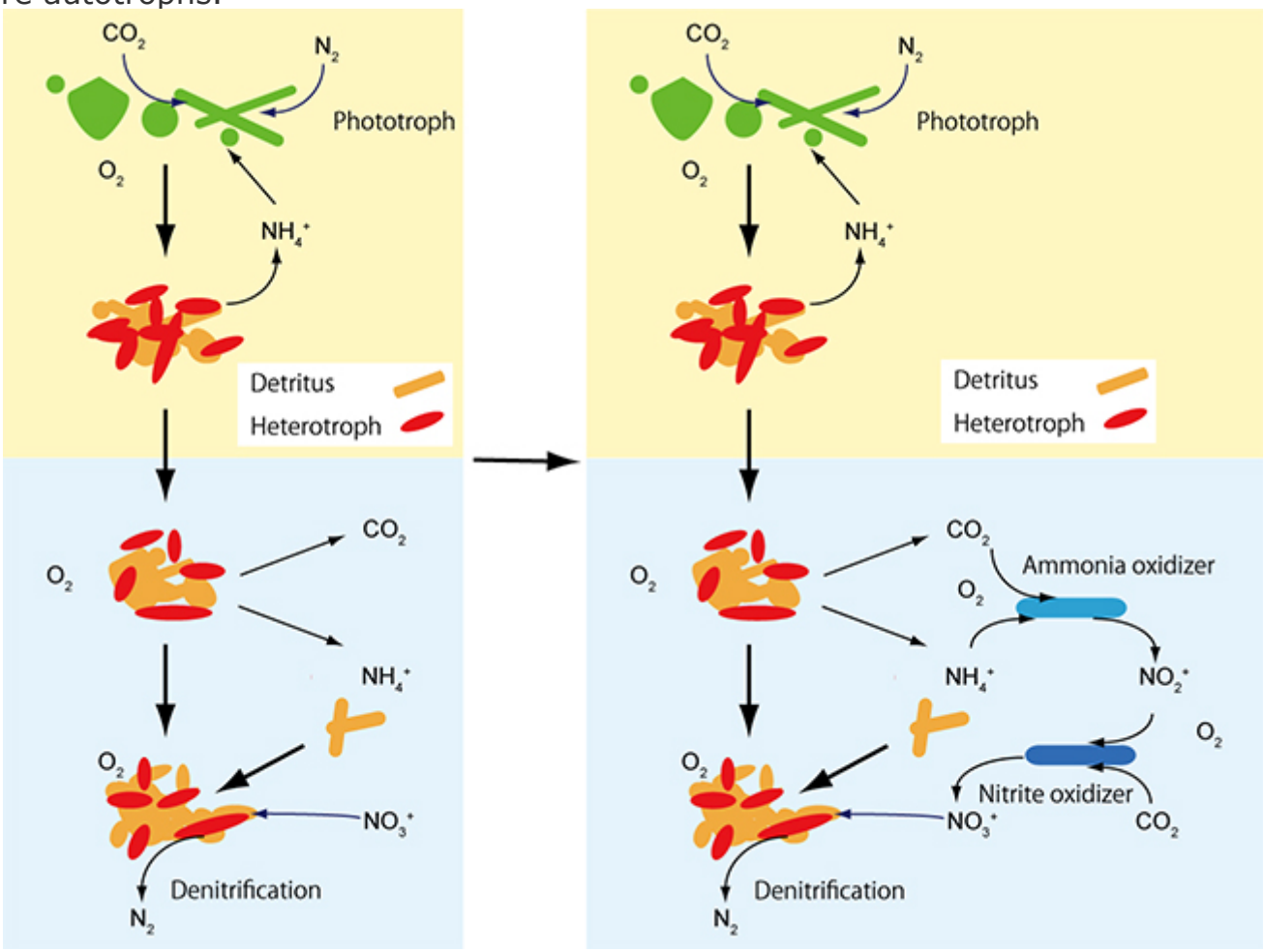

Figure 1: Diagram showing deep water ecosystems
The left shows an image based on traditional ideas, while the right based on recent new insight. At present, chemolithotroph, which uses reductive sustances such as ammonia and compound of sulfur generated by organics decomposition as its principal energy source, is recognized as an important component in deep water microbial communities.

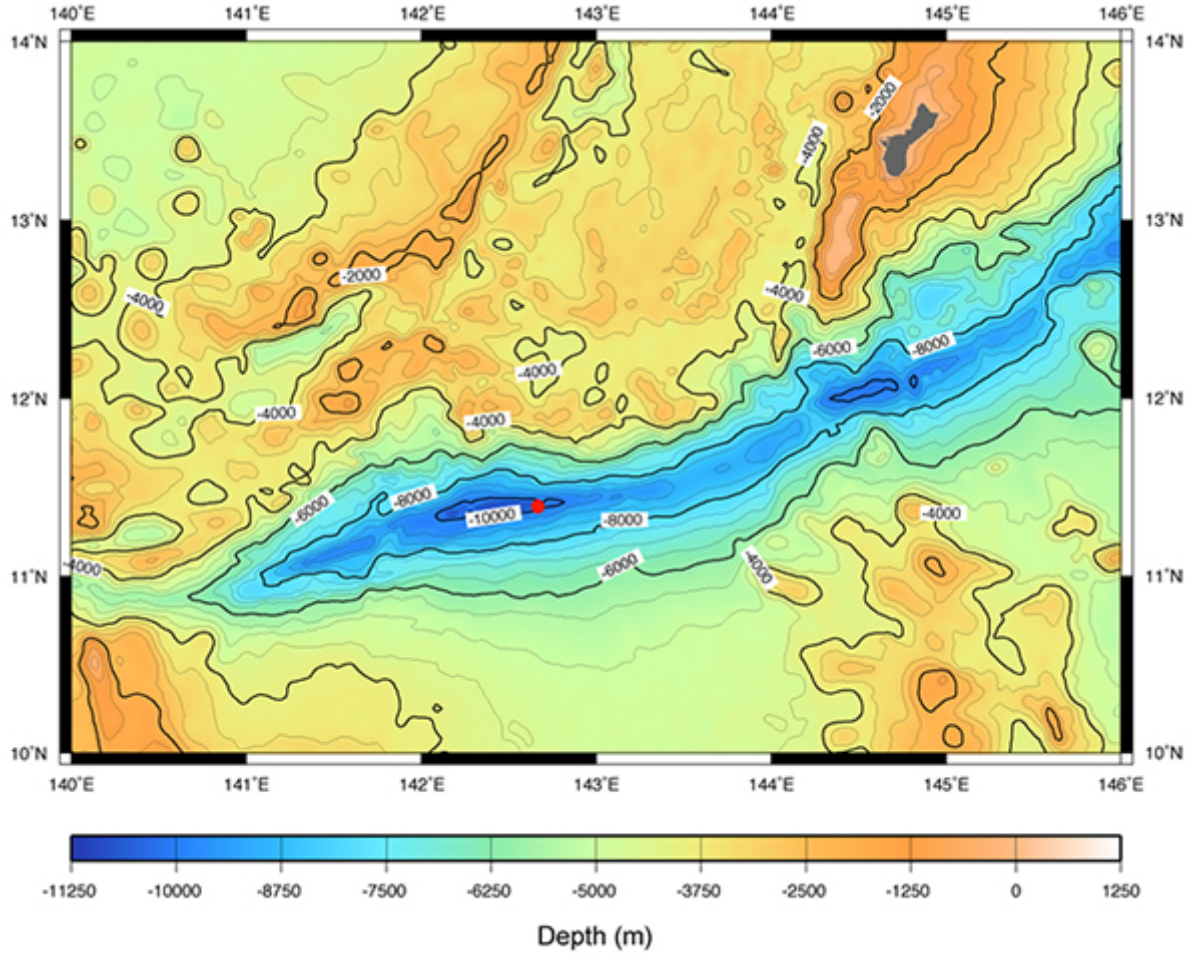

Figure 2: Ocean floor topography of the Challenger Deep, Mariana Trench
The red circle shows the sampling site. This data was prepared by JAMSTEC based on NOAA data.

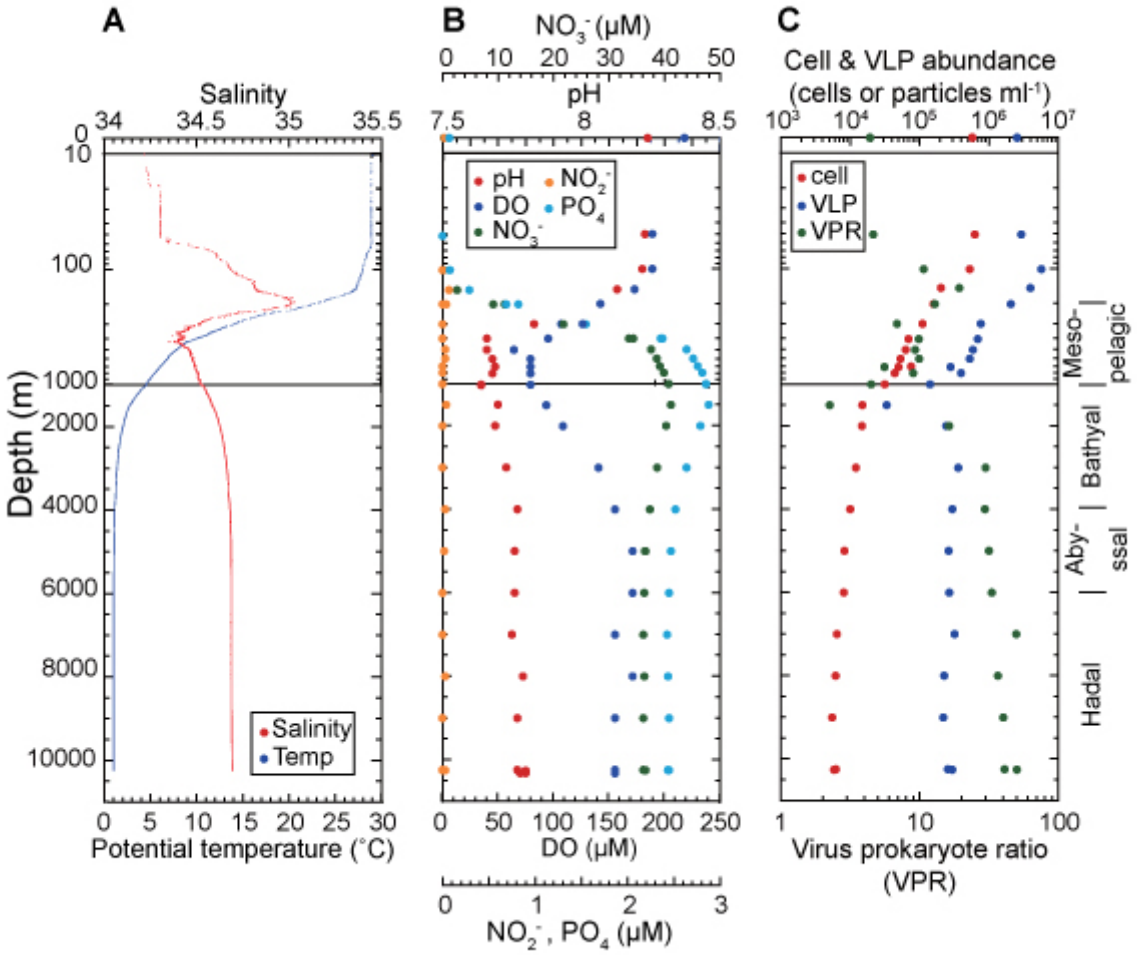

Figure 3: (A)Temperature and salinity (B)oxygen, nitrate, nitrite, and phosphate concentrations and pH, and (C) the abundance of prokaryotic cells and virus-like particles (VLPs) and VLP prokaryote ratio (VPR) along the water column in the Challenger Deep.

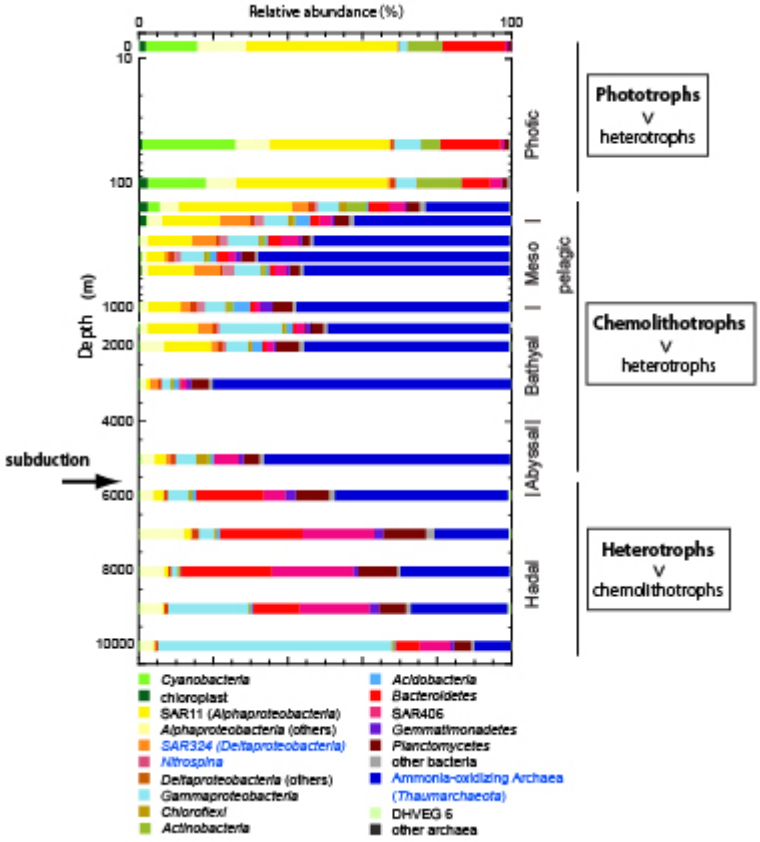

Figure 4: Prokaryotic SSU rRNA gene community composition along the water column in the Challenger Deep. Representative chemolithotrophic groups are shown by blue font.

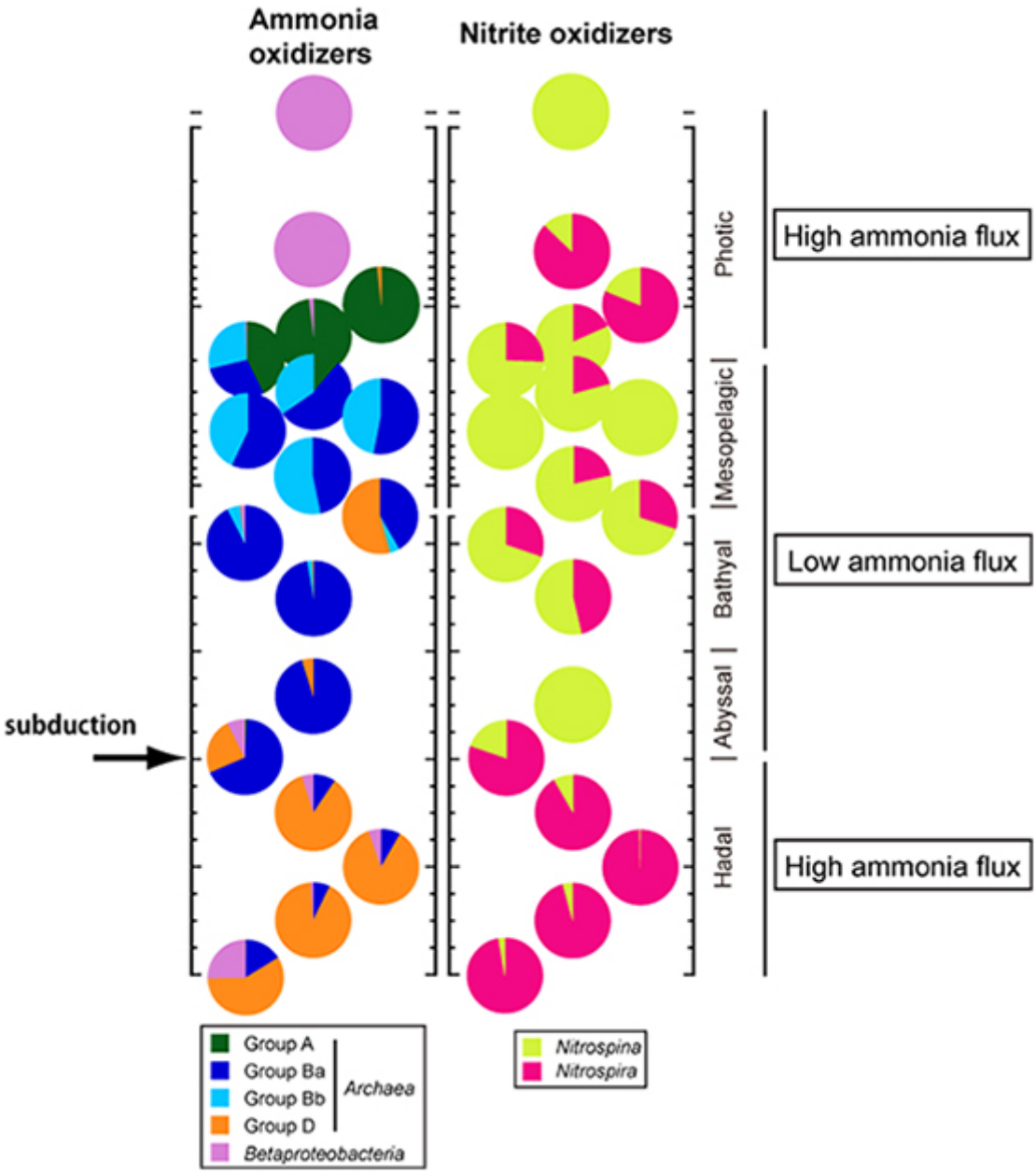

Figure 5: The abundance of subgroups of *amo*A (gene of ammonia monooxygenase subunit α) of ammonia oxidizers (ammonia-oxidizing *Archaea* and *Betaproteobacteria*) and SSU rRNA genes of nitrite-oxidizing bacteria (*Nitrospina* and *Nitrospira*) along the water column in the Challenger Deep.
Each group's preference to electron donors is considered to be the following order of high concentration: 1) Ammonia oxidizers: *Betaproteobacteria* > Group D > Group A > Group B; and 2) Nitrite oxidizers: *Nitrospira* > *Nitrospina*

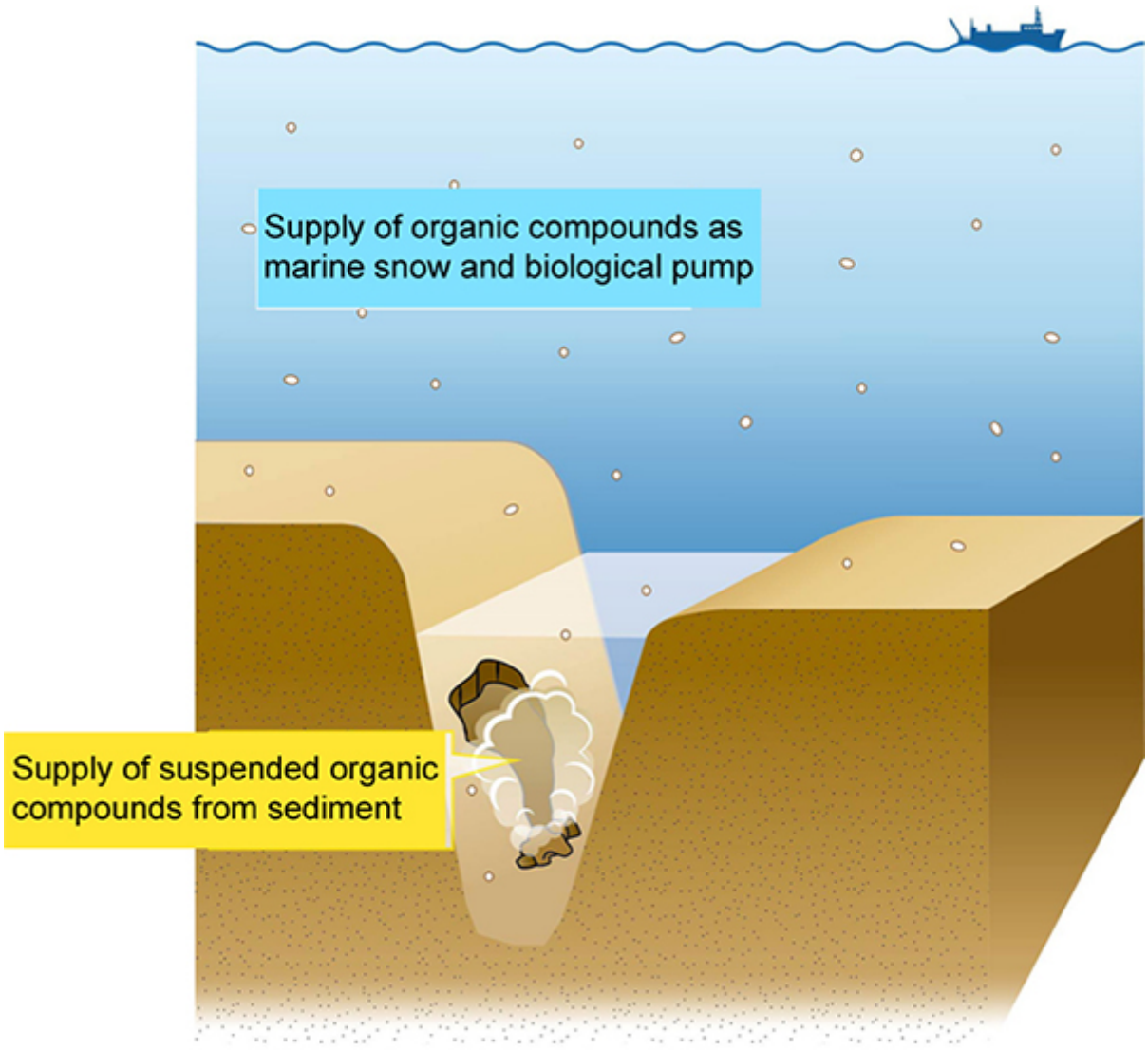

Figure 6: Diagram showing hadal trench biosphere

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