

Requirements on deep biosphere and paleo-environment: toward comprehensive knowledge between past and present

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Introduction

Deep marine subsurface sediments represent a novel biosphere with unknown physiology with Archaea [e.g., Biddle et al., 2006; Lipp et al., 2008] and Bacteria [e.g., Schippers et al., 2005]. Recent evidence of intact polar lipids from the marine sediment suggested significant contribution of heterotrophic archaea relied on past primary production (Figure 1). Although carbon isotopic signatures of archaeal membrane polar lipids from archaea-dominated sediments indicate utilization of sedimentary organic carbon by the living archaeal community, putative heterotrophic processes are still unconfirmed. Here I would like to reconsider about our next requirements on IODP initial science plan from both aspects of past and present sequences in the sub-seafloor sediment.

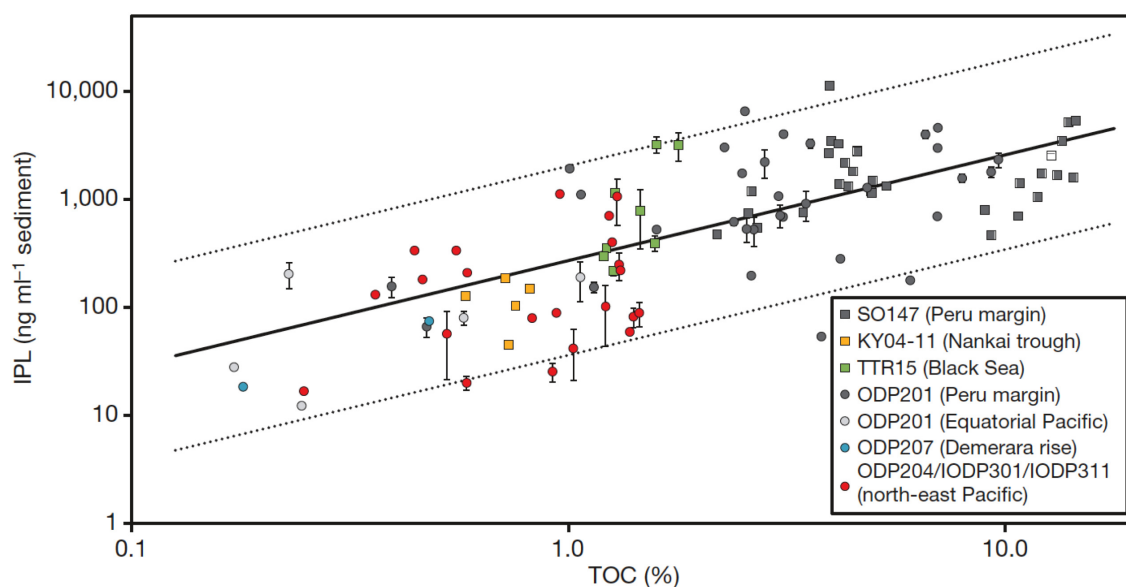


Figure 1 Total organic carbon and intact polar lipids by global scale IODP sampling (Lipp et al., 2008).

Requirements

(1) Multi-evidence about the prolonged big issue: living or fossils (dead) ?

So far we could estimate the biomass and distribution of the majority of unseen prokaryotes in deep sub-seafloor environment [e.g., Inagaki et al., 2006], on-shore laboratory studies remain problematic to understand putative heterotrophic / autotrophic processes because most of them are viable but non-cultureable [e.g., Teske and Sorensen, 2008]. Therefore, we need to overcome this limitation of peculiar microbial characteristics by using novel biogeochemical tools including compound-specific isotope analysis (CSIA), enantiomer-specific isotope analysis (ESIA: Takano et al., 2009) and position-specific isotope analysis (PSIA), together with *in-situ* experiment and sampling at bore-holes or during drilling. The advantage of *in-situ* method is setting up same physico-chemical conditions including temperature (°C), pressure (atm.), and chemical gradient (DO, pH, nutrient, others).

(2) Elucidation of a linkage between past and present

On the basis of positive correlation between total organic carbon and intact polar lipids showing labile microbial biomass [see Lipp et al., 2008], we could recognize the significant linkage between past primary production and present microbial biomass (Figure 2).

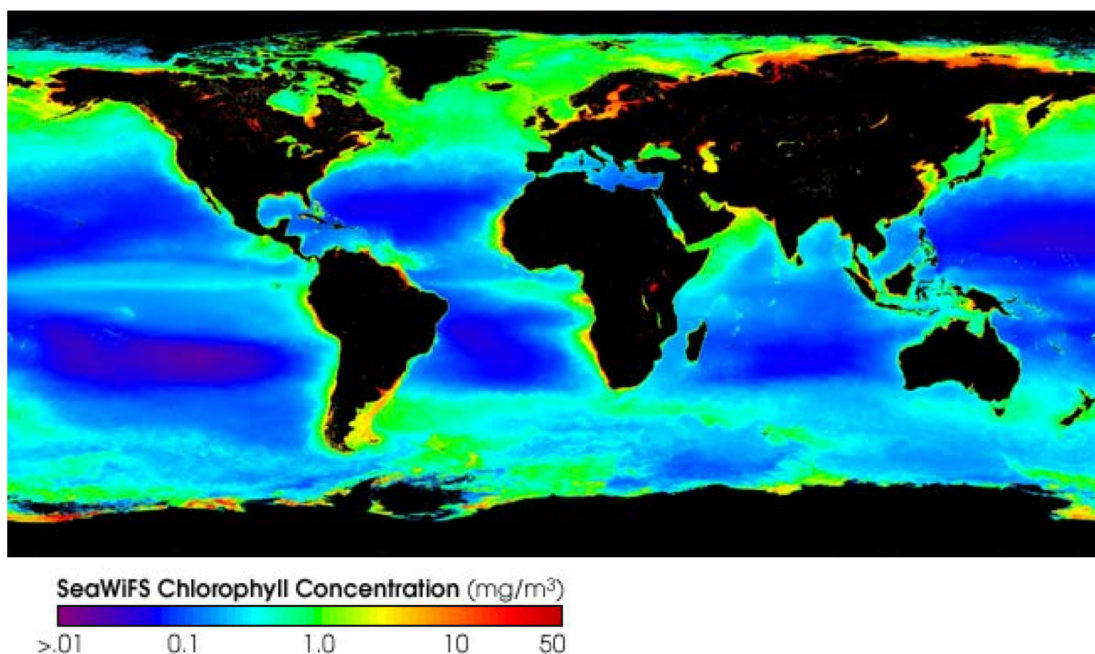


Figure 2 Spatial profile of primary production defined as chlorophyll (www.nasa.gov).

This result means present prokaryotes are living in the past sequences of marine sediment by some heterotrophic/autotrophic processes. In the oceanic subsurface water (>200m), one of the phyla of the Archaea are dominant while Bacteria mainly occupied the sea surface. However, extant archaea including *Crenarchaeota* and *Euryarchaeota* are also reproducing as main players of deep-biosphere. Hence we have to take care of prokaryotic geochemical paleo-proxies since they are mixing signals derived from planktonic (sediment as past) and benthic biota (sediment as present activities). The both communities of deep-biosphere and paleo-environment need to communicate each other on same discussion table toward comprehensive knowledge of sub-seafloor environment.

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