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Variations in microbial utilization of organic compounds across a tectonic transition in the South China Sea

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Methane hydrates are distributed throughout the South China Sea (SCS), and the total abundance of methane hydrate in the SCS is estimated to be 42.8 Gt C. It has been revealed that the tectonic transition in the SCS may affect the origin of methane deposited in sediments. Because the sediment communities in the active (FWCR) and passive (FR) margins off southwestern Taiwan were shifted and diversified as burial progressed, we hypothesized that microbial differentiation would vary the fate of organic matter utilization and impact the origin of methane. In this study, we supplied ^{13}C-labelled methanol, methylamine, acetate, and glucose as carbon sources with slurries from three depth intervals (5, 50, and 120 mbsf) sampled from both FWCR and FR to reveal the connections between community structures and potential metabolic pathways. We found that methyl-based methanogenesis only occurred in the incubation from 5 mbsf in FR, which possessed an increased proportion of *Methanococcoides* spp. In contrast, the newly produced methane was not detected in other incubations. By capturing the accumulation of $^{13}CO_2$ in other groups, we inferred that fermentation was the primary process consuming methyl compounds. Moreover, parts of methyl compounds were assimilated and accumulated in microbial biomass with rates ranging from 7.87×10^{-5} to 2.14×10^{-2} mg C/day and 2.85×10^{-4} to 3.27×10^{-4} mg C/day in incubations from FR and FWCR, respectively. By visualizing the growth form of *Methanococcoides* spp., we found that they usually formed aggregates with bacteria, but some aggregates were only composed of *Methanococcoides* spp. themselves. In the groups supplying acetate and glucose, regardless of sites and depths heterotrophs such as *Fusibacter* spp. and *Marinobacter* spp. were the dominantly enriched groups, yet their enriched proportions were distinct. Our current work demonstrates that the variable microbial communities between tectonic settings affect the degradation rates and metabolic pathways of organic matter in marine sediments. In situ methanogenesis is one of the sources of methane in the passive margin, while the source of methane in the active margin may rely on thermogenic methane from the deep reservoir.