

Influence of gas hydrate dissociation and methane seeps in the geochemistry of sediments of Joetsu Basin

Antonio Freire^{1*}, Ryo Matsumoto¹, Fumio Akiba², Toshihiko Sugai¹

¹University of Tokyo, ²Diatom Minilab Akiba Co. Ltd.

The Holocene sediments of the Joetsu Basin are characterized by high TOC content, low TOC/TN and TS/TOC ratios, and heavier $\delta^{13}\text{C}_{\text{org}}$ values, which indicate a predominance of marine organic matter deposited under oxic conditions at the seafloor, probably due to warming and inflow of warm ocean currents and coastal currents along the East China Sea. These currents carried abundant phytoplankton from the Pacific Ocean as a result of the sea level rise. On the other hand, the LGM sediments are characterized by low TOC content, high TOC/TN and TS/TOC ratios, and lighter $\delta^{13}\text{C}_{\text{org}}$ signatures, which are characteristics of terrestrial organic matter deposited under anoxic seafloor conditions, probably due to seaward migration of shorelines and strong input of freshwater with terrestrial materials during the LGM that created seawater stratification. This terrestrial influence decreased gradually from the LGM to the Holocene because of the sea level rise and consequent increase in the marine organic matter content. At seep sites however, seafloor sediments from depths lower than two meters were strongly depleted in $\delta^{13}\text{C}_{\text{org}}$ values followed by high TOC/TN and TS/TOC ratios in a disagreement to the surrounding Holocene sediments. Sulfate-methane interface promotes the anaerobic oxidation of methane and the consequent precipitation of sulfides, which can explain the elevated TS/TOC ratio observed. Moreover it cannot explain the anomalous values of $\delta^{13}\text{C}_{\text{org}}$ and the high TOC/TN ratio, characteristics of terrestrial organic matter. One possibility is proposed in this study, and can potentially explain such properties at methane seep sites: the ascension of sediments that includes organic matter from deeper horizons like mud volcanoes, followed by the erosion of the top of mound-seep sites and the consequent appearance of older and deeper sediments from the LGM in the seafloor.

Keywords: Carbon isotope, Gas hydrate, Joetsu Basin, Methane seeps, Organic matter, TOC/TN and TS/TOC ratios