Constraints on the dynamic of gas hydrates in Niger Delta sediments from U/Th dating of cold-seep carbonates

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We report ^{230}Th/U ages of carbonate-cemented mudclast breccias collected in several sediment cores raised from a gas hydrate-rich province on the Niger Delta. Such carbonates result from the microbial oxidation of methane in cold seep environments. Our aim has been to investigate the dynamic of gas hydrates in this area over the last few thousand years.

Our major focus has been on one sediment core, in which massive nodules of gas hydrates at sediment depths greater than 3.6 m were observed during opening on-board. In this core, numerous carbonate breccias occur within a well-defined sediment horizon, between 30 cm and 180 cm depth. U/Th dating of several concretions from this sediment horizon has shown that aragonite formation started at the end of the Younger Dryas (~11 kyr), and proceeded throughout the Holocene thermal maximum, until ~8.5 kyr ago.

The depth-integrated methane flux necessary to account for authigenic carbonate formation in our studied core has been calculated. Estimated rates of methane consumption during the Holocene thermal maximum (~ 12 mol/m^2/yr) are two-orders of magnitude greater than the present-day upward CH_4 flux in that core (~ 0.13 mol/m^2/yr), based on observed pore-water SO_4^{2-} profiles.

We have also modelled the pore-water sulfate profile, corresponding to our estimated Early Holocene methane flux. This modelling indicates that anaerobic oxidation of methane (AOM) proceeded at a few centimetres below the seafloor between ~ 11 and 8.5 kyr BP, at much shallower depths than the present day AOM location (~ 2.6 m).

Overall, our results show that gas hydrate layers at this location migrated towards the seafloor and/or dissociated during the Holocene thermal maximum. This suggests that the gas hydrate reservoir in Niger Delta sediments may have responded to environmental changes related to the Late Quaternary climate, perhaps an increase in bottom-water temperatures.