



Morphology and formation mechanism of AOM induced authigenic pyrites and carbonate mineralization: Evidence from the Eastern offshore regions of India (Bay of Bengal)

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We report the occurrence of authigenic pyrites and carbonate mineralization from 12 long (30-50 m) piston cores collected in the gas hydrate bearing sediments of the Krishna-Godavari basin and Mahanadi offshore regions, Eastern continental margin of India. The cores were retrieved during R/V Marion Dufresne cruise (MD-161, May 2007) using a Giant Calypso piston corer at water depth range between 414-1866 m. X-Ray diffraction (XRD) studies confirm the presence of pyrites with authigenic carbonate cement. Spatio-temporal studies show that at site 17 (northern K-G offshore) authigenic carbonates are abundantly occurring with fewer amounts of pyrites while sites 18-27 (Mahanadi offshore) show appreciable amounts of pyrites followed by authigenic carbonates. Authigenic pyrites range in size from 1 mm to 6 cm and display various morphologies like chimneys, nodules, thin crusts, tubes and rod-like structures etc. From the cores, 78 authigenic sulphide samples have been investigated for spatio-temporal distribution along with their morphology, mineralogy and stable isotopic composition. Scanning Electron Microscopy (SEM) along with energy dispersive spectrum (EDS) studies reveal biofilm-like feature with pyrite crystals cemented with tiny rhomb-shaped carbonate crystals suggesting bacterial mediation. The sulphur isotopic ratios ($\delta^{34}\text{S}/\delta^{32}\text{S}$) range between -27.05 to 60.18‰ and the stable carbon isotopic composition ($[\text{U}+\text{F}064]13\text{C}$) of the carbonates are around -50 ‰ VPDB. Highly depleted stable isotopic compositions of authigenic carbonate that occur along with pyrites suggest that the carbon source for the formation of authigenic carbonates were gas hydrates below and the carbonates were formed by the oxidation of methane. The abundance of pyrites with fewer amounts of authigenic carbonates in Mahanadi offshore region suggest that the bacterial sulfate reduction is very strong with less intense Anaerobic Oxidation of Methane (AOM), whereas K-G offshore sediments are dominated by authigenic carbonates with fewer amounts of pyrites suggesting the AOM is very strong. In view of the fact that the pyrite precipitates are cemented with authigenic carbonates, it is inferred that these pyrites were formed authigenically in the AOM influenced sedimentary environment due to early diagenesis involving coupled sulphate reduction and AOM.