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Inhibition of carbonate grain dissolution within shallow water carbonate sediments impacted by Fe-rich terrigenous input, Discovery Bay, North Jamaica.

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Introduction

The chemical dissolution of skeletal carbonate grains has recently been identified as a significant diagenetic process operating within shallow water, tropical carbonate sediments. Such dissolution has been associated with the generation of sulphide during the earliest phases of bacterial sulphate reduction. Oxygen penetration into the sediments, through diffusion or bioturbational irrigation, leads to oxidation of this sulphide and the generation of acidity, which is neutralised within sediment pore waters by carbonate dissolution. Such dissolution processes have been recognised within Holocene carbonate sediments on the Florida and Bahama platforms and, in particular, in areas characterised by high rates of sediment turnover (e.g., *Callianassa* bioturbated sites) where they are inferred to result in significant loss and/or cycling of carbonate [1]. Whilst these dissolution processes have been shown to be of sedimentological significance within 'clean' carbonate systems, we have previously shown that inputs of terrigenous (Fe-rich) sediments have the potential to significantly modify carbonate diagenetic reactions. Firstly, high iron levels leads to a switch in early diagenesis from bacterial sulphate reduction to bacterial iron reduction, minimising sulphide production and subsequent oxidation. Secondly, iron "soaks-up" any sulphide produced, again minimising sulphide oxidation.

Results

In order to test the effects of Fe-rich sediment input upon diagenetic carbonate dissolution we have recently examined a number of sites within Discovery Bay, Jamaica, a carbonate-dominated embayment in which we have previously documented that iron inputs have modified early diagenetic reactions in the manners stated above. Areas in the south and south-west of the bay have been subject to the input of bauxite dust since 1965 when a loading terminal was constructed. In the most heavily impacted areas of the bay non-carbonate content of the sediments is now up to $\sim$35% [2]. Cores from non-impacted ('clean') areas of the bay that are subject to significant bioturbation show evidence of active sulphate reduction within the upper 10cm of the sediment column. Associated petrographic and detailed SEM observations of carbonate grains (specifically *Halimeda* and *Amphiroa*) show clear morphologic evidence of dissolution throughout the sediment column. Although this results in widespread alteration of grain surface textures and loss of some carbonate it is questionable whether complete degradation of skeletal grains occurs. The grains do however preserve evidence of an important diagenetic process that is most active within the upper parts of the sediment column.

In contrast cores from sites subject to significant bauxite sediment inputs (up to 7500 ppm Fe) show evidence of very different pore water processes and very different diagenetic reactions. Evidence of active iron reduction occurs in the top 5-10cm of the sediment column and there is no evidence of active sulphate reduction. Carbonate grains from these same sites show little evidence for active dissolution and instead grains are characterised by often pristine surface morphologies. This is evident in all cores from the impacted sites throughout the depth zones of bauxite influence. Interestingly, samples from the deeper sections of each core, which contain 'clean' carbonate and which thus pre-date any bauxite influence, commonly show morphological evidence of dissolution implying that this was a significant process prior to the input of the Fe-rich bauxite sediments.

Conclusions

The presence of iron-rich terrigenous material in these sediments minimises chemical dissolution of carbonate grains during earliest diagenesis, by modifying pore water chemistry. These data not only clearly document the significant role that the presence of iron plays in controlling the style of carbonate grain diagenesis within shallow water carbonate sediments, but also the potential consequences of increasing terrigenous sediment input on diagenetic reactions within nearshore carbonate environments.

References

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