



Marked shifts in chemical diagenesis in Recent carbonate sediments in response to inputs of terrigenous sediment, Discovery Bay, Jamaica.

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Introduction

The increase in terrigenous sediment input into tropical coastal carbonate systems, whilst controversial, has been suggested to impact on ecological functioning of these environments. An additional impact that has not been considered is that of perturbations in chemical diagenesis as a result of these inputs, but such perturbations are likely to be significant when iron-bearing sediment is input into otherwise iron-poor systems. The sediments of Discovery Bay, a carbonate-dominated tropical coastal embayment, have been subject to localised inputs of iron-rich bauxite sediment as a result of the mining and transport of this material. This has led to areas of the embayment undergoing marked compositional shifts in the last 30 years, resulting in dilution of carbonate material by terrigenous material [1]. The research presented here sets out to determine the impact that this compositional change has had on early chemical diagenesis in the sediment.

Results

Diver-placed sediment cores were taken from a range of sites within the bay, from both impacted and non-impacted sites. Porewaters were separated under nitrogen and subsequently analysed for pH, Eh, Fe(II), Ca^{2+} , Cl^- , SO_4^{2-} , and alkalinity. Sediments were analysed for CaCO_3 content and total metals.

Within non-impacted sites sediment cores are dominated by CaCO_3 (up to 99% by weight). Porewaters from some of these cores show evidence for active sulphate reduction (reduced SO_4/Cl ratios near the surface), and minor dissolution of CaCO_3 (increased Ca/Cl ratios in the upper parts of sediment cores). This is consistent with observations made by other researchers on similar carbonate sediments [2], whereby sulphide produced through sulphate reduction is oxidised, in the absence of Fe, to produce acidity which is neutralised by CaCO_3 dissolution. At impacted sites, the sediment is composed of up to 15% non-carbonate material and contains up to 6000 ug/g Fe. Within these sediments, porewaters show no evidence for sulphate reduction, but show marked levels of Fe(II) in porewaters. The presence of Fe(II) in porewaters indicates that bacterial Fe(III) reduction is actively taking place within these sediments.

Discussion and Conclusions

The evidence for active sulphate reduction in non-impacted sediments and for Fe(III) reduction in impacted sites indicates that there has been a clear shift in chemical diagenesis as a result of the input of terrigenous sediment. It is not known whether this also indicates a shift in bacterial composition, as it is known that sulphate reducers can reduce Fe(III) under certain conditions. The potential implications of this shift in chemical diagenesis are far-reaching. In pristine carbonate sediments, sulphide oxidation has been shown to result in significant dissolution, and thereby regeneration, of primary carbonate production [2] and also lead to the resetting of isotopic signatures of carbonate grains [3]. Under conditions in which iron is present, and Fe(III) reduction dominates, sulphide oxidation is not a significant process, and as a result early diagenetic dissolution of carbonate is not observed. Considering that previous studies suggest that sulphide oxidation-driven dissolution can be as much as 50% of primary carbonate production in localised platform environments [2], this has significant implications for carbonate budgets and cycling in terrigenous-impacted carbonate environments, and the preservation of carbonate grains and isotopic signatures in these sediments.

References

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