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Sediment records of anthropogenically-sourced terrigenous sediment input in a tropical embayment: effects on reef sediment stratigraphy and geochemistry

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Discovery Bay, a carbonate-dominated embayment in north Jamaica, has been subject to inputs of iron-rich bauxite sediment since the mid-1960's. These are associated with the local mining and transport of processed bauxite, a proportion of which escapes during loading onto boats within the embayment. The trace metals Fe, Zn and Mn are significantly enriched within sediments (Fe – 13,701 ppm, Mn – 237 ppm, Zn – 74 ppm), with highest contaminant levels occurring to the north-east and north-west of the bauxite loading terminal. Sites of high sediment contamination are negatively correlated with % $CaCO_3$ and at high contamination sites $CaCO_3$ levels are reduced to $\sim$60%. Cores recovered from sites on the western side of the bay provide a stratigraphic record of this history of bauxite contamination across water depths from 5 to 25 m. The bauxite-influenced upper sediment horizons are clearly visible in each core from the distinctive red-brown colouration of the sediment. These sediments are composed of approximately 10 % non-carbonate (bauxite) and have Fe contents of up to 7000 μg/g. The thickness of this upper bauxite-contaminated sequence increases down transect (from approximately 18 cm in the shallowest core, to around 47 cm in the deepest core), and in each core overlies a sequence of 'clean' lagoon carbonates. These typically are poorly sorted carbonate sands with variable amounts of coral rubble. Down-core data on $CaCO_3$ and Fe content provide a chemical record of decreasing sediment contamination with depth, with the lower 'clean' carbonates composed of only around 2% non-carbonate and $<$700 μg/g Fe.

Down-core sediment-constituent data also indicate significant changes in sediment production at the shallowest sites. At depths of 5 and 10 m, sediment assemblages have shifted from diverse assemblages of coral, mollusc, *Amphiroa* and *Halimeda* in the clean lagoon sands, to assemblages dominated by *Halimeda* and *Amphiroa* within the surficial sediments. At the deeper sites, no major down-core shifts in sediment constituents occur. These sites thus record a rather complex history of changes in sediment composition and chemistry. Clear shifts in chemistry and stratigraphy occur in all the cores and reflect progressive bauxite contamination in the near surface horizons. These inputs, however, do not appear to have directly affected carbonate production, since the major constituent changes appear to be a response to more regional declines in coral community and reef status. Modified substrate compositions also appear to have impacted sediment pore water chemistry. In contrast to clean, low Fe sites, where pore waters show evidence for active sulphate reduction and $CaCO_3$ dissolution, pore water samples from Fe-rich sites show no evidence for sulphate reduction, but marked levels of Fe(II), suggesting that bacterial Fe(III) reduction is active. This has a clear impact on bioclast diagenesis and carbonate cycling within these sediments.