A Biogeochemical Model for Reconstructing Quaternary Shelf Sea Dynamics

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It is hypothesised that the supply of settling organic matter which constrains microfaunal assemblages provides the key to reconstruction of the structure and dynamics of tidal shelf seas during the Quaternary. Supply of organic matter to the seabed is dependent on the interaction of water column structure and plankton production. On tide-dominated shelves, water column structure is characterised by seasonally stratified and mixed waters separated by frontal zones governed by tidal current velocity and water depth. Summertime plankton distributions are sensitive to light and nutrients and are constrained by water column structure. New observations in the Irish and North Seas show that the size of suspended aggregates is determined by specific protistan plankton during blooms. The size of aggregates is also linked to turbulent energy dissipation such that enhanced aggregation occurs in the thermocline. These biological and physical processes ensure a rapid flux of organic matter to the seabed. The resulting benthic fluff, variable in time and space, is a key component in organic supply to the benthos. Given the interdependence of dynamics, productivity, and vertical organic flux, it follows that contemporary particulate organic supply to the seabed varies laterally across frontal zones and has varied during the Quaternary in response to changing sea levels. This variation should be reflected in benthos productivity. It is known that Quaternary frontal positions can be reconstructed using stable oxygen and carbon isotopic analyses of benthic foraminifera on the assumption that the forams are indicative of lateral temperature gradients across frontal zones. Forams and other microbenthos should also reflect lateral nutrient supply gradients across frontal zones. The new observations reinforce the view that microfaunal assemblages should provide powerful diagnostic evidence of Quaternary shelf sea dynamics.