Factors controlling the burial of organic carbon in laminated and bioturbated sediments off NW Mexico

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Carbonaceous facies in geological records deposited at shallow palaeodepths exhibiting the combination of high carbon contents, laminations and high hydrogen index (HI) values have been typically interpreted as reflecting conditions of enhanced preservation of organic carbon under an intense oxygen minimum. However, recent investigations on the distribution of organic carbon on continental margins have failed to reveal significant differences in HI values between contemporary sediments that have accumulated within, above and below the oxygen minimum in a given geographic region. This discrepancy between the depositional conditions typically inferred for carbonaceous facies in rocks and the modern environments that are supposes to provide an analogue is critically examined.

Factors controlling the burial of organic carbon on the NW Mexican margin in late Quaternary and Recent sediments are assessed using a suite of box and piston cores, strategically located on the shelf-slope-rise with respect to the intense oxygen minimum in this region. An array of sedimentary parameters was determined to evaluate organic carbon quantity (wt.% organic carbon (TOC) and nitrogen), quality (Rock-Eval parameters, $C_{organic}/N_{total}$ ratio, $\delta^{13}C_{organic}$, lignin biomarkers, $I/C_{organic}$ ratio), variations in biogenic components (wt.% opal and Ba/Al ratio) and texture (sand content, Si_{nonbio}/Al ratio and Zr/Al ratio). In late Quaternary sediments, the lowest HI values occur concurrently with large increases in grain size on the upper-slope . This hydrocarbon impoverishment is attributed to increased degradation of organic material due to sediment reworking during glacial periods. This conclusion is supported by the presence of winnowed coarse-grained organic-poor shelf deposits which are depleted in hydrocarbons (<300 mg HC/g TOC). In contrast, high HI values (>300 mg HC/g TOC) are observed in the fine-grained deposits that correspond with the broad organic carbon maximum that characterizes much of the Mexican continental slope. Thus, the degree of winnowing is the primary factor affecting the preservational quality of organic matter deposited on this margin.

Over the last 140,000 years, the rates of accumulation of organic carbon and opal, and in certain cores biogenic baryte concentrations, are all higher in the interglacial intervals when compared with the glacial deposits. Despite the cyclic change in predominantly marine organic matter accumulation, matrix-corrected hydrogen index (HI) values in the mid- and lower-slope cores are invariant and are similar to values in the laminated intervals from the oxygen-minimum site. This suggests that the cyclic changes in organic carbon accumulation on this margin during the late Quaternary are controlled by productivity variations and are not due to differential preservation induced by variations in bottom water oxygen concentrations.

A comparison of matrix-corrected HI values from sediments of late Quaternary to Recent age from several continental margins and euxinic basins reveals that in general the organic matter preserved in these environments corresponds to Type II, irrespective of bottom water oxygen concentrations. Therfore, the preservation of Type II 'oil-prone' kerogen in productive continental margin settings does not appear to be restricted to sediments deposited under conditions of low bottom water oxygen concentrations as envisioned in models of petroleum source-rock deposition.