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Organic Carbon, Total Nitrogen and Reactive Silica Associations in Mississippi River and Delta Sediments

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Rivers deliver organic carbon from multiple sources to their estuaries and deltas where, it is mixed with in-situ formed marine organic matter and eventually deposited in deltaic sediments. It is estimated that $\sim$ 40 % of organic carbon burial in the oceans takes place in deltaic environments. Diatoms constitute a significant component of riverine, estuarine and marine organic matter.

In deltaic sediments, reverse weathering diagenetic reactions, involving rapid interactions between detrital material and biogenic silica are also important. These reactions can result in the complete reconstitution of diatom frustules and/or the formation of amorphous/poorly crystalline aluminosilicate coatings on biosiliceous and clastic particles. To date, associations of biogenic and authigenic Si with organic carbon, especially during burial in deltaic sediments, have received little attention.

Here we present results from total reactive silica (ΣSi), total organic carbon (T.O.C.), total nitrogen (T.N.) measurements and carbon isotopic measurements in: a) Mississippi river suspended matter b) sediments deposited in two Mississippi river stations and c) Mississippi deltaic sediments from 4 off-shore stations, sampled with kasten cores (core lengths 160 to 250 cm). Reactive Silica measurement is based on a mild acid pre-leach followed by a time-dependent extraction in a hot alkaline solution (O.1M Na_2CO_3, 85^{o}C) and includes a correction for Si released from crystalline detrital siliceous phases. ΣSi (the sum of silica extracted with mild acid and hot alkaline solution) represents Si from amorphous, biogenic silica and other amorphous/poorly crystalline aluminosilicate phases.

ΣSi shows no correlation with T.O.C. or T.N. in river suspended matter or river deposited sediments in the upstream river station in Venice. In South-West Pass station, located at the point were the western branch of the Mississippi discharges to the Gulf of Mexico, there is a weak (r=0.43) but significant correlation between ΣSi and T.O.C. In South-West Pass, riverine sediments (average δ^{13}C value = -24.5 ‰) were deposited in high salinity waters (porewater salinities $>$29 psu). SEM observations show extensive aluminosilicate coatings on diatom frustules.

ΣSi and T.O.C. values are not correlated in the top 40 cm from two off-shore stations (MSS2, St. 80m) with high sedimentations rates($>$ 3 cm y^{-1}) (average δ^{13}C values: MSS2= -22.9 ‰ St 80m= -22.2 ‰). Below 40 cm (average δ^{13}C: MSS2= -22.9 ‰ St 80m= -21.6 ‰), T.O.C., T.N. and ΣSi correlate strongly. In the upper 40 cm of sediment in Station 95m, (average δ^{13}C value= -21.5 ‰ sedimentation rate $\sim$0.7 cm y^{-1}) the data show strong correlations between, T.O.C., T.N. and ΣSi. Below 40 cm (average δ^{13}C values= -22.5 ‰ sedimentation rate $\sim$1.4 cm y^{-1}) there are moderate correlations between T.O.C., T.N. and ΣSi. In Distal station, with a low sedimentation rate ($\sim$0.19 cm y^{-1}), sediments from the top 40 cm (average δ^{13}C value= -21.9 ‰) show strong correlations between T.O.C., T.N. and ΣSi. No correlation is found below 40 cm (average δ^{13}C value= -22.4 ‰).

The data from river suspended matter and river sediments from Venice indicate that riverine material delivered to the Gulf of Mexico does not have an association between operationaly defined reactive silica, organic carbon and total nitrogen. The weak correlation between T.O.C and ΣSi in South-West Pass may derive from diagenetic alteration of riverine material upon burial in high-salinity porewaters and the subsequent formation of aluminosilicate coatings on particles.

The significant correlations between T.O.C., T.N. and ΣSi in stations MSS2, St. 80 m, St. 95 m, below 40 cm suggest that organic matter burried in areas with higher sedimentation rates is associated with reactive silica.

Formation of authigenic aluminosilicate coatings on biosiliceous or terrigenous particle substrates may provide a mechanism that links burial and preservation of particle-bound organic carbon with reverse weathering reactions in Mississippi and other deltaic depositional environments.