Investigation of Sediments from NY/NJ Harbor, San Diego Bay, and Venice Lagoon

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Introduction: Here we report the results of our continuing effort to investigate the nature and distribution of organic contaminants at a grain-size level in sediments from several locations: NY/NJ Harbor, San Diego Bay, and Venice Lagoon. There are two goals. The first is to provide data that will be useful in devising improved methods for removal of toxic organic and inorganic contaminants. The second is to provide data that can be used as the foundation of realistic transport models for understanding and predicting the movement of contaminants through the sediments on a microscopic scale.

Methods and Materials: The work was carried out using a Fourier transform infrared (FTIR) spectrometer (Nicolet Magna 860) coupled with an infrared (IR) microscope (Nicolet Nic Plan). The spatial resolution for the measurements was 10 μm x 10 μm. The samples were prepared by preparing samples in a dilute aqueous suspension and then depositing and drying drops placed on IR reflecting slides. The approach is limited to investigation of particles less than about 20 μm because of excessive IR absorption at larger sizes.

Results: FTIR point spectra obtained for the humic and fulvic acid standards show that these materials are heterogeneous on the micrometer-size scale. Hence, care must be taken in applying the results in the interpretation of the sediment spectra. The spectra obtained for the raw sediments indicate the presence of compounds of anthropogenic origin including aromatic and polyaromatic compounds - mono-, di-, tri-substituted benzenes, anthracenes and/or phenanthrenes, chloroalkenes and aryl-chlorinated compounds, and alkyl cyclohexanes. Measurements were also made on sediments from NY/NJ Harbor that had been subjected to a cleaning process developed by BioGenesis Inc. Their technology used a high-pressure water jet to strip organic coatings from the sediments combined with the use of chelators, oxidizers, and surfactants. All of the contaminant groups observed in the untreated sediments were significantly reduced or not observed at all in the untreated sediments.

Another group of results relates to the type and distribution of contaminants obtained by acquiring spectra in a point-by-point map over a single sediment particle with dimensions of about 30 μm x 160 μm. The FTIR spectra show that: (1) there is a heterogeneous distribution of the contaminants, preferentially concentrated on one side of the particle, (2) association of aromatic, possibly chlorinated compounds, and sulfoxide-containing compounds with a $CaCO_3$-rich region, and (3) association of substituted benzenes and/or phenyl- and NH_2-containing groups with $MgCO_3$-rich and alkoxysilanes/cyclic aromatic siloxane-rich region of the particle. A typical map of demonstrating heterogeneity is shown in **Figure 1**.

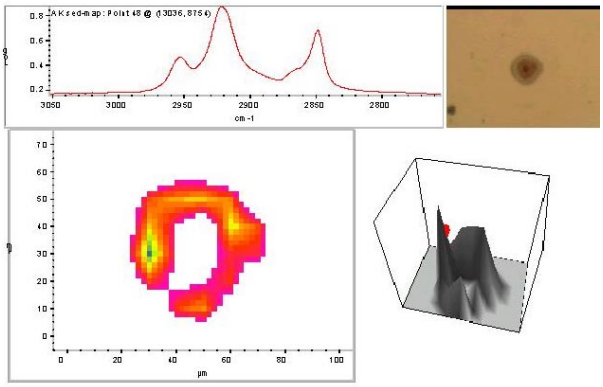

Figure 1. Map of contaminant distributions found for a single sediment particle. The particle appearance found using IR microscopy is shown at the upper right. The region of interest used for the maps is shown at the upper left. Two types of display for the results are shown in the other plots at the bottom of the figure. The heterogeneity of the distribution is evident as is the effect of excessive sample thickness at the center of the sample.

Conclusions: The results obtained demonstrate that the distribution of organic compounds in sediments is not uniform on a micrometer-size scale. It is suggested that this type of experiment is necessary for developing sophisticated transport models that include fluid/solid interactions and for optimizing methods for chemical removal of organic compounds from the sediments. The similarity of results from the different sediment locations also shows that a microscopic understanding will be generally useful.

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