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Application of FTIR Techniques of Characterization of Contaminated Sediments

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Beamline(s): U2B

Contaminated estuarine sediments in the NY/NJ Harbor pose an important environmental problem. As a result, the disposal of the approximately 3,000, 000 cubic meters of dredged material removed from the Harbor in essential navigational and maintenance dredging project each year has become a problem of pressing concern. One solution to the problem is to decontaminate the sediments and then use the cleaned material to produce a useful product. Knowledge of the nature of the natural and anthropogenic organic and inorganic compounds associated with the sediments is essential as a starting point for work on the development and improvement of decontamination methods. The present work is specifically aimed at measurements on the major organic compounds present in the sediments since there is evidence that they will contain major amounts of both organic and inorganic toxic compounds. In particular, we investigated sediments from the NY/NJ Harbor and related materials, such as humic and fulvic acid standards, San Diego Bay, the Venetian Lagoon, and kerogens from China, using both regular attenuated total reflection (ATR) infrared spectroscopy and synchrotron infrared microspectroscopy. ATR spectroscopy was used to measure differences in the relative abundance of functional groups found in the sediments and other materials. High spatial-resolution Fourier transform infrared spectroscopy (FTIR) at the U2B beam line was used to investigate the functional groups found in individual sediment particles. The results presented in Figures 1-3 indicate that, in the NY/NJ Harbor region, petroleum products may be a biomarker for major organic compounds of anthropogenic origin. This information will be used to devise improved methods for sediment decontamination using sediment-washing techniques.

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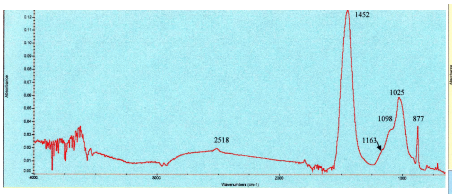

Figure 1.

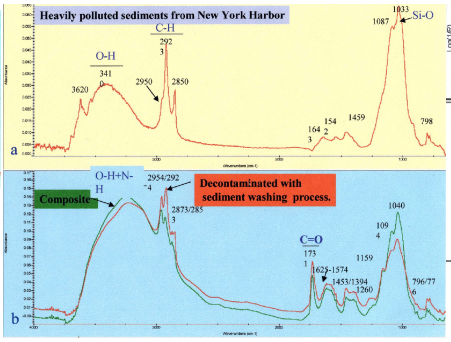

Figure 2.

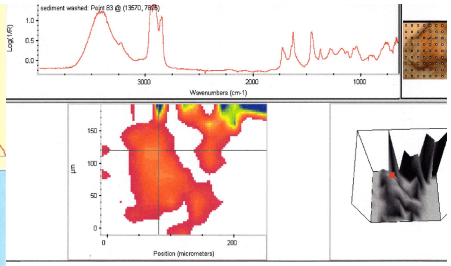

Figure 3.

Figure 1. FTIR-ATR spectra of uncontaminated clay sediments form a depth of 4-4.7 m in the Venice Lagoon, Italy. The estimated age of the material is 10,000 years. This spectrum mainly shows features of clay minerals and indicates there is little organic matter in these sediments.

Figure 2. FTIR-ATR spectra of contaminated sediments from the Port of NY/NJ. The top spectrum shows that these sediments are characterized by very strong C-H stretch bonds associated with long chain aliphatic hydrocarbons. The bottom spectra show the changes found in less contaminated sediments or in sediments cleaned by a washing process.

Figure 3. Synchrotron FTIR image of C-H stretch (2800-3000 cm^{-1}) peaks obtained from water/methanol extraction from the contaminated sediments. FTIR maps of the region shown at the upper right of the figure indicate that there is inhomogeneity in the functional groups found in the extract. Two displays of the map of the C-H stretch group are shown at the bottom of the figure.