Do Chemically Contaminated Subaqueous Soils Present a Challenge for Classification?

DEPARTMENT OF ENVIRONMENTAL SCIENCE & TECHNOLOGY

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ABSTRACT

Subaqueous soils that have been heavily contaminated with synthetic chemicals such as oils, greases, and tars may present a challenge to soil classification and taxonomy. While the concentration of these chemicals may be reduced quickly after initial contamination, a refractory fraction can remain that will affect soil properties for decades or longer. These pollutants can coat particles, fill pore space, or occur as layers either on top of or within a soil profile. Soil Taxonomy is unclear as to whether or not such fluid contaminants meet the definition of artifacts. Even if they do, their presence would not result in the classification of an anthropic epipedon in many subaqueous soils because an anthropic epipedon must have an *n* value less than 0.7, a requirement that many subaqueous soils do not meet. Unless these contaminants are considered to be soil material or parent material, they do not fall clearly within the definition of human-transported materials. No extragrade subgroups exist that adequately describe such a contaminated soil. Present Soil Survey Manual description of such contamination is limited to noting a petrochemical smell or including general notes on observed contaminants. These contaminants can be both chemically and physically hazardous to human health and the health of aquatic organisms, and their presence is one of the most significant features of any soil in which they occur. Their presence may indicate a broad history of other pollution in a subaqueous landscape, as is the case in Bear Creek, a heavily urbanized tributary of the Patapsco River near Baltimore, MD. It is reasonable to expect that some other industrialized regions will contain such contaminated subaqueous soils. For the time being, we have no appropriate way to capture some of the most significant features of these soils in their taxonomic names.

Objective

This poster has grown out of a collaboration between pedology and aquatic toxicology. Heavily contaminated soils have historically not been mapped as such by soil scientists, but have long been studied (though not as soils per se) by the toxicological community. Our purpose is therefore to present an unusual subaqueous soil that challenges some of our existing soil concepts with the hopes of generating further discussion about such soil bodies and how they can best be understood.

Figure 1

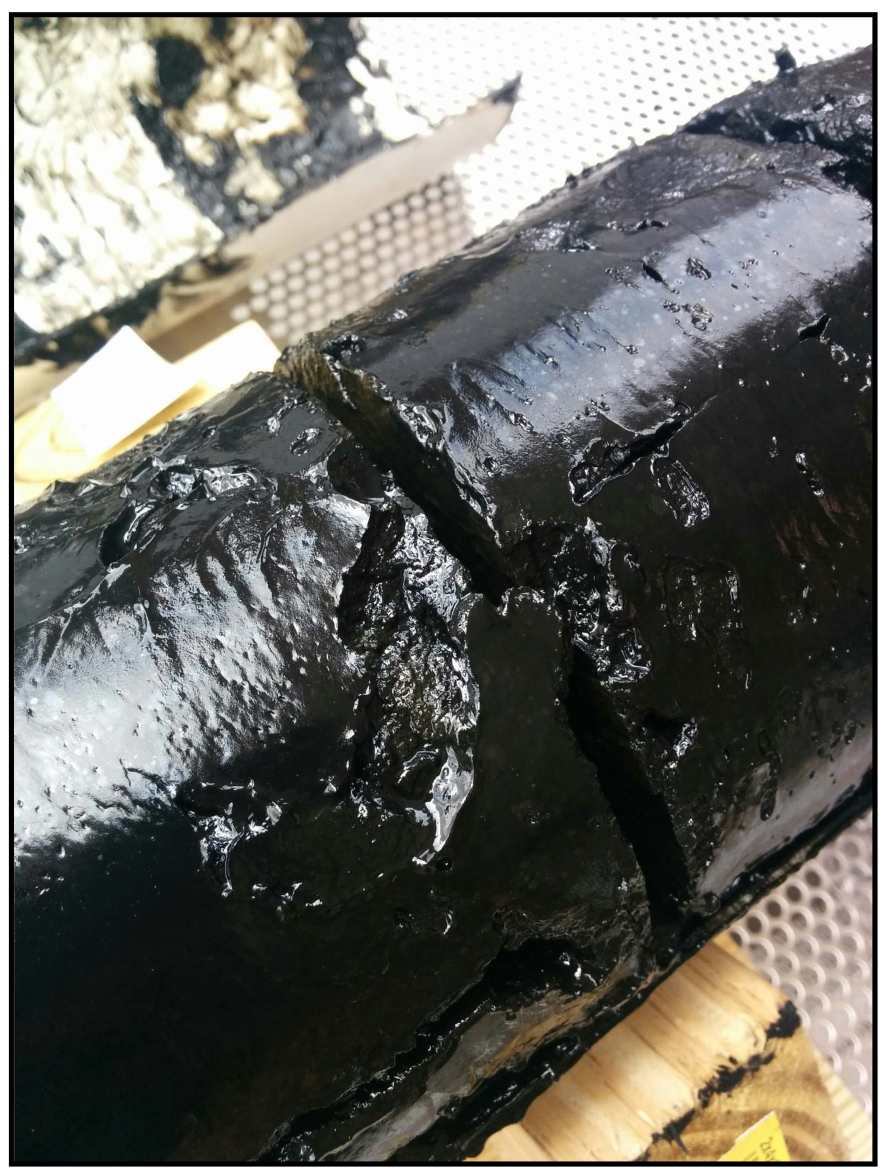

Figure 2

Cores

Cores were collected via piston-coring for toxicological analyses to depths of approximately 90 centimeters. Only limited morphological descriptions could be conducted without degrading the quality of an existing toxicological study. Material was almost uniformly jet black and oily, difficult to color with a Munsell book but recorded as N 2.5. Horizons could be identified based on density changes, which did not always increase uniformly with depth, as well as by the abundance of oily spots in a horizon. When cores were cut open, oil spots could be observed forming on the soil surface as oil migrated through the core. These spots were nearly ubiquitous, but were far more prevalent in certain horizons. All cores had a very strong petrochemical smell and had to be opened outside. Structure was massive but some cores contained extensive gas pockets that gave the appearance of subangular blocky structure in some places (Figure 1). Other cores showed very abrupt horizon distinctions where, we speculate, a change in sedimentary regime was prevented from being bioturbated due to the toxicity of this material (Figure 2). All black material tested was violently effervescent when reacted with 30% hydrogen peroxide. All material was moderately fluid or very fluid and sand grains were only rarely felt. Laboratory particle size analysis was not conducted due to material availability and a concern that lab equipment would be permanently contaminated by working with this material.

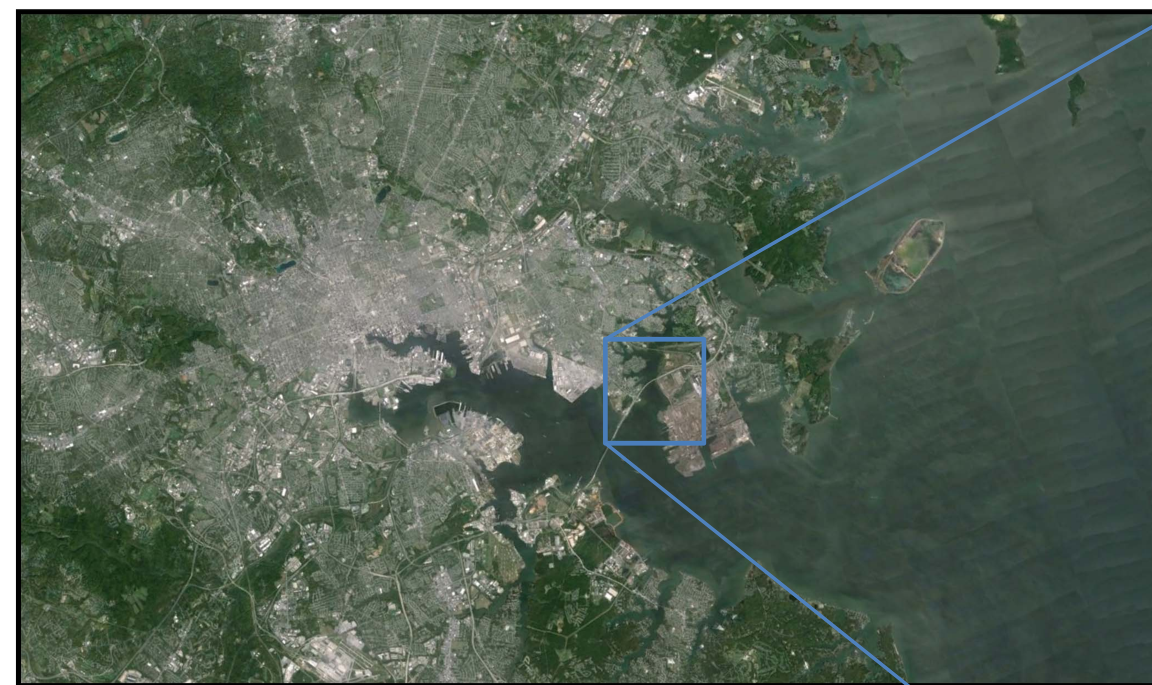

Figure 3

Figure 4

Sample Sites

Chemically contaminated subaqueous soils occur throughout much of Bear Creek, a subestuary within a heavily urbanized watershed of the Chesapeake Bay. It is located in the community of Dundalk, MD, which is a town on the outskirts of Baltimore (seen in Figure 3). Dundalk is a old industrial community with a long history of anthropogenic activity including the operation of steel mills and landfills.. Sample sites, marked with triangles in Figure 4, span an area of approximately one square mile.

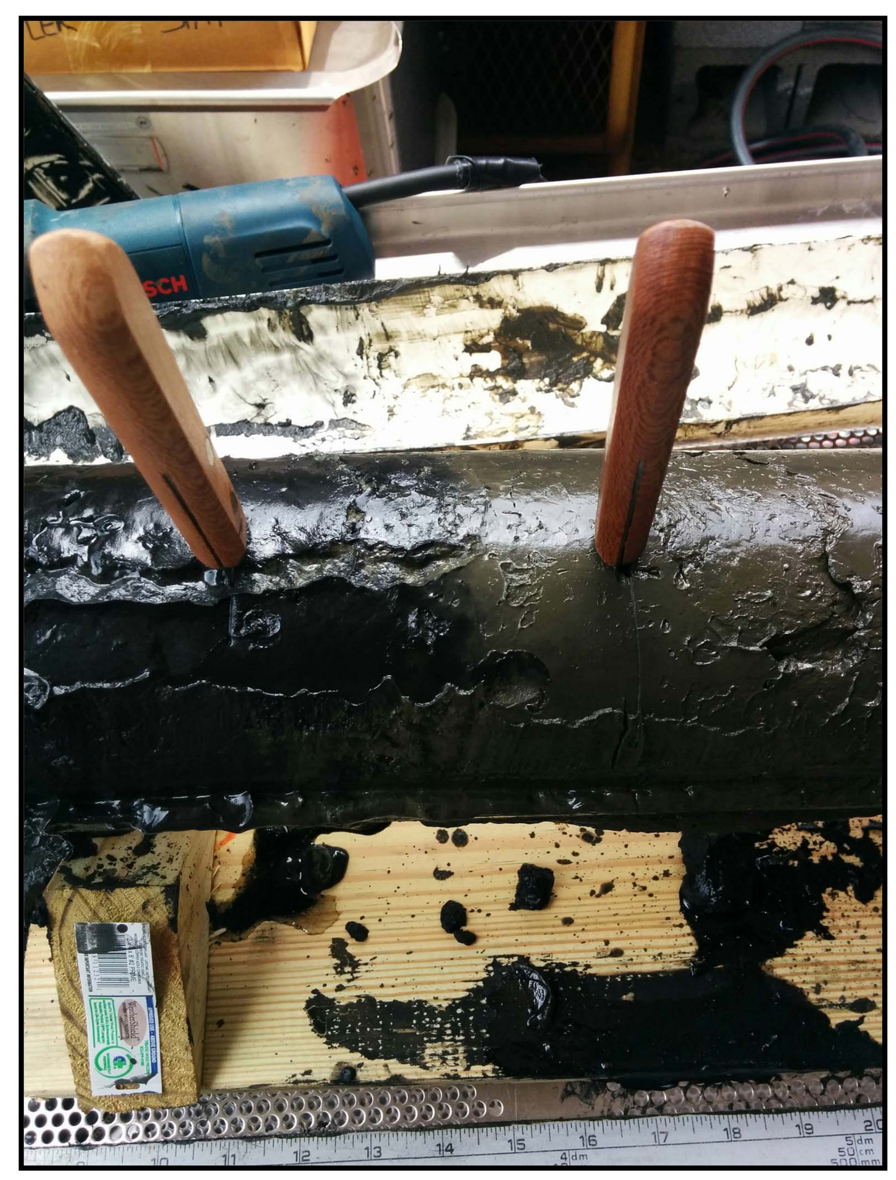

Figure 5

Figure 6

Figure 7

Remediation or Sequestration?

While some have argued that these contaminated sediments/subaqueous soils are naturally remediating the pollutants that they contain, they may simply be burying the contaminated horizons with less-toxic sediment now that environmental regulations have slowed the flow of such materials into our waterways. One core did penetrate into a lighter colored horizon, though it is unknown at present if this material predates industrial contamination or if it the contamination has been remediated by natural processes (Figures 5-6). Several peat-auger samples showed 1-5 cm thick deposits of relatively uncontaminated material on the soil surface (Figure 7), and small living clams were found living in some of this material. Recent sedimentation may form a habitable veneer of material, but the buried contaminants seem likely to remain soil features for years to come.

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