Engineer Research and Development Center

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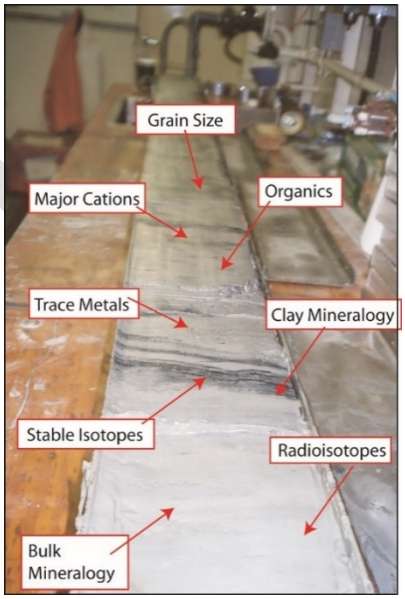
Geochemical Fingerprinting of Sediment

A Guide for Using Geochemical Methods in Dredged Material, Sediment Tracking, and Sediment Budget Studies



Effective regional sediment management has the potential to significantly reduce operating costs for the US Army Corps of Engineers (USACE), but only if the ultimate sources and sinks of coastal sediment are fully quantified. Geochemical sedimentary markers provide a well-established methodology for "fingerprinting" the various sources and time frames over which sediment accumulates in regions of concern. When used effectively, geochemical markers can be used to "fingerprint" the various sources of sediment being transported to and/or deposited within regional sinks (e.g. Walling, 2005; Davis and Fox, 2009). Geochemical fingerprinting has the potential to quantify sediment dynamics at local to regional scales at resolutions currently unavailable to the USACE. Researchers at ERDC's Coastal and Hydraulics Laboratory (CHL) and Environmental Laboratory (EL) have developed a protocol to use natural geochemical markers to aid in distinguishing sediments for projects with a wide variety of goals. These goals include quantifying the fate of dredge-suspended sediment; tracking the migration of nearshore berm or dredge-material placements; and performing large-scale sediment budgets.

Problem

Quantification of sediment erosion, transport, and accumulation in aqueous regions is a critical component of the USACE's missions. Improperly managed sediment can be incredibly costly for the USACE, but efficient use of geochemical fingerprinting can help reduce costs associated with sediment management. Specifically, geochemical fingerprinting will help:

- Improve USACE's ability to quantify a sediment budget for a region.
- Identify the sources and infilling rates of accumulating sediment within a navigable region. This information could improve or develop local sediment management practices that minimize sedimentation and thus reduce related dredging costs.
- Better quantify the impact of dredging on ecosystem health by, for example, tracking the fate of dredge-suspended sediment at significantly higher spatial and temporal resolutions than are commonly employed.
- Improve tracking of the downstream transport and deposition of sediment after dam removal.
- Quantify the source, transport pathways, and deposition of terrestrial sediment on offshore resources.
- Discern and quantify natural sources of sand on beaches vs. sand added to a beach via a subareial or nearshore placement. This allows for better quantification of the effectiveness, and more accurate cost-benefit analysis, of the nourishment.
- Improve our ability to identify and track the transport of sediments impacted by contamination from active and abandoned military test ranges.

What We Can Do

In general, once a project has been identified (e.g. a need to quantify the source of sediment infilling a navigation channel), the following steps are taken:

- Available historical sediment data are analyzed for trends that might yield initial insight into sediment pathways and sinks.
- ERDC's Geochemical Fingerprinting Team will then help assess what geochemical markers will be most useful for quantifying the sediment dynamics in question.
- Once the appropriate geochemical fingerprints have been identified and measured, quantitative interpretation of the data ranges from the simple calculation of radioisotope-based accumulation rates to a more comprehensive principle component analysis (PCA).

Why You'll Want to Work with Us

The use of geochemical fingerprinting to identify sources and sinks of suspended and accumulating sediment, and to quantify the rate and processes by which sediments accumulate, has been accepted as standard practice by the greater scientific community for decades. ERDC researchers have identified the primary geochemical markers that are of most use to the USACE's various sediment-related missions in order to greatly increase the benefits that the additional analyses will provide to the USACE. Most of the laboratory analyses are performed at ERDC itself, and the Geochemical Team are all experts on using geochemical markers to elucidate specific sediment challenges.

Success Stories/Testimonials

Our Team's first employment of geochemical fingerprinting was performed to discern sources of sediment in the Lake Calumet-Calumet River system near Chicago, IL. Bottom samples from the region were collected in May of 2014 (sample location map provided to the right). A full suite of markers were analyzed including grain size, sedimentary organic content, radioisotope activities, light element analysis, trace element analysis, bulk mineralogy, sedimentary electrical conductivity, and pH. Additionally, results from historical geochemical analyses (including levels of metals and organic contaminants) performed previously by the District from 1967 to 2007 were also examined. All results underwent Principle Component Analysis (PCA) to statistically determine different sources of sediment to the region. Analysis of the historical data from previous dredging operations showed that the geochemical signature of the sediments in the Calumet River have changed significantly over the course of time. Impacts of the passage of the clean water act could be seen in the data, as markers of industrial and agricultural contamination declined with the passage of time. Additionally, the statistical analysis performed on the 2014 bottom samples not only successfully distinguished the potential source sediments from each other, but also identified contaminants (Cu and Zn) in the Calumet River samples that distinguished them from surrounding sediments. The identification of these key contaminants could help identify possible sources of those metals and allow for controls to be implemented to reduce contamination in the river.

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