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ENVIRONMENTAL RESTORATION NEWS

IN THE NEWS

ISSUE 7

NAVFAC Program Perspective

Improving the In-House Project Delivery Portfolio

Improving the capacity for delivering the projects in-house is one of the most effective tools for improving and maintaining the workforce technical competency, as well as advancing the talent and initiative of our highly capable, diverse workforce. It is the core of the "*Enhance Technical Competency*" focus area. Another significant benefit in delivering the projects in-house is the cost saving.

The project milestones and sub-milestones within the Environmental Restoration (ER) Program where the in-house project delivery capacity can be improved upon are:

Project Management:

- Site Management Plan (SMP) Update
- Community Involvement Plan Update
- Community Support

Preliminary Assessment/Site Inspection

- Summary of Use Report

Remedial Investigation/Feasibility Study

- Remedial Action Alternative Analysis
- Engineering Evaluation/Cost Analysis (EE/CA)
- Focused Feasibility Study (FFS)
- Action Memorandum

Decision Documents

- Proposed Plan, also known as the Proposed Remedial Action Plan (PRAP)
- Record of Decision (ROD)
- No Further Action Decision Document

Remedial Action Design and Construction

- Developing conceptual design
- Remedial Action Closeout Report (RACR)

Radiocarbon Allows Direct Determination of Fuel and Industrial Chemical Degradation at ER Sites

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The Department of Defense is faced with multi-million dollar expenditures for environmental cleanup in the United States. The Navy has over 1,700 waste sites contaminated with fuel and petroleum-derived industrial products such as chlorinated solvents. Although much progress has been made in waste site assessment, cleanup and closure, significant challenges still exist - primarily confirming conversion of contaminant to a harmless end-product (CO_2) using indirect physicochemical measures. There are currently around 70 or so "lines of evidence" measures for indicating contaminant turnover. They vary considerably in analysis cost and difficulty; and due to inherent uncertainties, may not fully support decision-making. A main methodological limitation for all current technologies is the inability to conclusively link contaminants, daughter products, electron acceptors, hydrogeological parameters, and in some cases, biological activities to actual contaminant conversion to CO_2.

Recently, radiocarbon analysis has been used to track contaminant conversion directly to CO_2. This is possible because petroleum products are completely devoid of radiocarbon ($^{14}CO_2$) - it decays with a half life of roughly 6,000 years. Natural soil organic matter contains measureable $^{14}CO_2$, usually dateable between modern and 10,000 years old. This difference allows a two end-member mixing model to be applied (natural organic matter vs contaminant organic matter). As such, the contribution of contaminant carbon to the CO_2 pool (complete conversion) can be measured directly. The measurement is definitive as fractionation, which impacts stable carbon isotope analysis, can be ignored (radioactivity is not biased by biological cycling, physical forces, or any site conditions).

The Naval Research Laboratory has evaluated this solution to Naval Installation Restoration (IR) sites in Norfolk, Virginia and more recently, San Diego Naval Air Station North Island (NASNI). At Norfolk, aged fuels impact the groundwater and vadose zone. Soil gas CO_2 was collected and analyzed for radiocarbon. Sampling background sites with similar conditions allowed a mixing model to be applied. Gas sampling wells in unimpacted regions had distinct CO_2 radiocarbon signatures (entire site is covered with asphalt), but wells over the plume were almost completely devoid of $^{14}CO_2$ indicating biological fuel degradation to CO_2 gas. Concentrations were also elevated *(Figure 1)*. These results were communicated with regulators and incorporated into the site remediation plans as concrete evidence for biological fuel degradation.

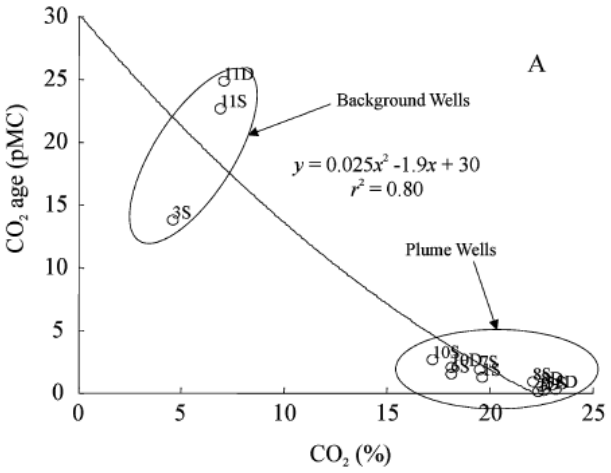

Figure 1. Typical carbon isotope ratios (Δ14C) on the per mil scale showing analytical resolution between soil CO2 and petroleum-derived CO2.

At NASNI, this solution was demonstrated at two sites - one with fuel contamination and one with a former landfill and primarily chlorinated solvent contamination. CO_2 radiocarbon content was measured in groundwater at the fuel farm site adjacent to San Diego Bay. These results were communicated to the Regional Water Quality Control Board as confirmation for fuel degradation on-site. Results were also published in peer-reviewed literature further validating the solution *(Figure 2)*.

Most recently, the solution was applied along with CO_2 evolution rate measurements at IR Site 5 at NASNI. This Strategic Environmental Research and Development Program project was undertaken to couple proportion from contaminant measurements with actual CO_2 conversion rates. This solution applied over spatial scales allowed calculating the mass contaminant removal per unit volume and unit time. A zone of influence model determined the spatial scale for CO_2 collection at each groundwater well and calculated mass removal per unit area and time *(Figure 3)*. Given contaminant mass estimates, a conversion rate to CO_2 for the remaining contaminant pool was calculated at a minimum of 16 years. This estimate encompasses only a "dry season" sampling for the site. Results are expected to be different during a "wet season" sampling (likely to be higher). Follow-on funding is being sought to continue analysis at this site.

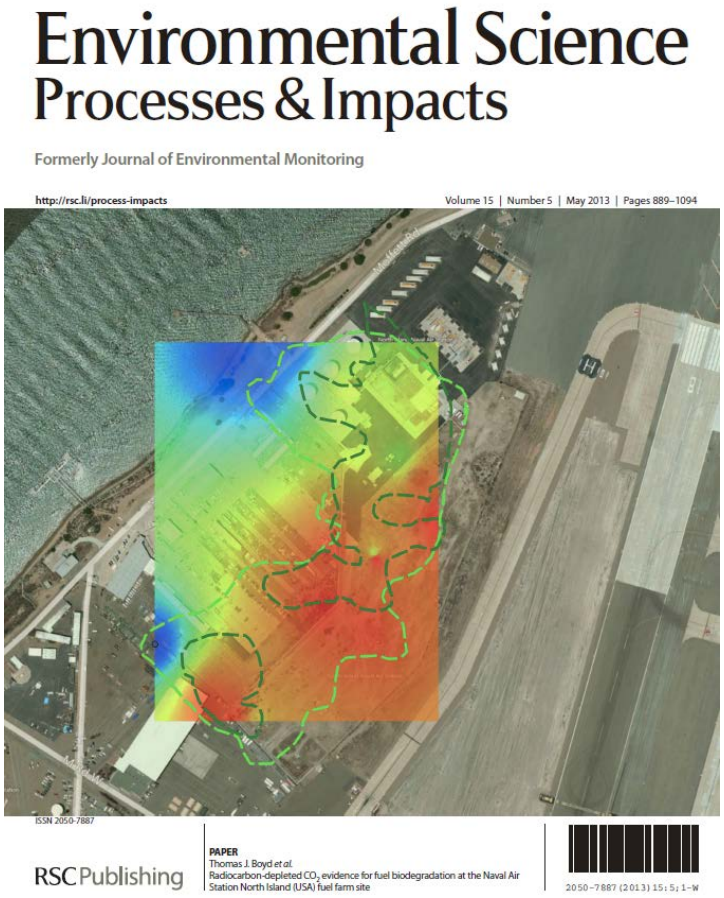

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Figure 2. CO2 radiocarbon results (as fraction CO2 from petroleum) at NASNI fuel farm (red = 95%).

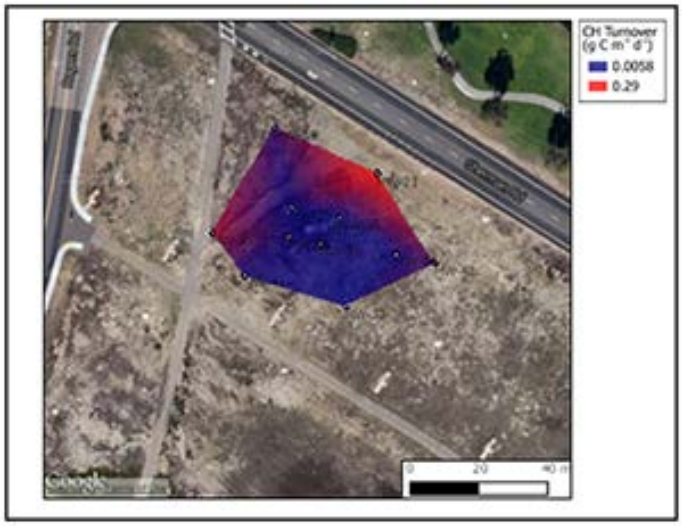

Figure 3. Chlorinated hydrocarbon removal rate for site IR 5 at NASNI.