

**Centre for Doctoral Training (CDT):
Geoscience and its Role in the Low Carbon Energy Transition
(2022 start)**

Project Title: Restoring Life and Function to Oil-Impacted and Remediated Soils
Host institution: University of Strathclyde
Supervisor 1: Christine Switzer
Supervisor 2: Charles Knapp, Andrea Hamilton
<p>Project description: The oil industry's legacy of contamination around the world requires long-term remediation and restoration. Low carbon processes such as smouldering remediation offer the opportunity to achieve significant progress with remediation; however, ecosystem restoration after remediation requires further study. Contamination and remediation can have devastating consequences on soil ecosystems, making them vulnerable to permanent changes including loss of biodiversity, invasive species, and other adverse effects. Human intervention is essential, but frequently results in an ecosystem overly reliant on external support and less resilient to further stress. The aims of this studentship project are to (i) establish the links between soil mineral transformations during smouldering and return of critical soil functions such as nitrogen cycling and (ii) examine the role of resistant organisms within a probiotic approach to restoration.</p> <p>Smouldering effectively destroys contamination by crude oil and other heavy hydrocarbons in soils. After ignition, smouldering generates all of its own energy (only external air supply is needed) making its carbon footprint significantly lower than other remediation processes. Temperatures of 500-1100°C over hours to days change soil-surface properties and how soil interacts with water, nutrients, and potentially toxic elements (PTEs). Nitrogen and total organic carbon (TOC) are lost at 500°C. Above 500°C, soil cation exchange capacity of clay is reduced and its capacity to retain water. Some phosphorus is lost around 500-1000°C; but the remainder is transformed or retained as more beneficial inorganic phosphorus. Nutrient amendments offer limited benefit and yield inconsistent results. However, transplant of soil microbes from healthy ecosystems accelerate progress toward self-sufficiency; however, these communities are vulnerable to harsh post-remediation conditions.</p> <p>This studentship will investigate the links between soil mineral transformation during remediation, particularly phosphorus and clay minerals, and restoration of nutrient cycling. We hypothesise that microbial communities from less than pristine environments have been primed for adverse conditions, and will therefore result in a better outcome than transplants from more pristine environments. These communities may have genetic adaptations to better handle environmental stresses: such as antimicrobial resistance mechanisms, including efflux-pumps and detoxification mechanisms (e.g., PAH and potentially toxic elements), and stress-response mechanisms. Genetic enhancements increase these communities' resistance to environmental toxicants and improve biochemical performance at sub-inhibitory levels of contaminants. This approach is analogous to probiotic health promotion in our diets: introducing versatile microorganisms that impart health benefits to their hosts. Establishing the links between mineral transformations, both beneficial and adverse, and microbial succession is essential to develop holistic approaches to ecosystem recovery after remediation. The results of this research will inform future restoration strategies that facilitate ecological cycling, succession, and resilience.</p>
Stated link to CDT theme: This project addresses a key challenge in the transition to Net Zero, which is the restoration of legacy oil-contaminated soils, and does so using a low carbon approach.
Any Additional Research Costs: Research costs e.g. field and lab costs conferences will be covered by the RTSG budget, and the supervisors will cover any shortfall.
Has access to data been secured? yes
Career routes: The student will be qualified to pursue a career in a wide range of oil and gas disciplines, including research; consultancy; environmental management and protection.