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Immobilization of As in soil using *in situ* electrochemical oxidation of iron

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Iron (Fe) oxides are among the primary mineral phases in soil that govern a wide range of geochemical processes, including contaminant transport and immobilization. As universal soil scavengers, iron oxides can adsorb both cations and anions due to their amphoteric nature, making them particularly effective for soil remediation. Studies indicate that Fe amendments can reduce the mobility of trace elements, particularly arsenic (As), in soil by up to 99%.

For effective trace element immobilization, ensuring proper mixing of Fe amendments with soil is crucial to facilitate contact between the amendments and contaminants, enabling immobilization reactions. In our research, we have explored the *in situ* introduction of additional Fe into As-contaminated soil using a low-voltage electric field. This approach utilizes Fe reinforcement rods as both electrodes and a source of metallic Fe amendments. The applied electrical field promotes the corrosion of Fe, facilitating the movement of Fe ions through the soil profile. As these ions disperse from the corroding electrodes, they undergo oxidation, forming poorly crystalline oxyhydroxides that react with dissolved As and immobilize it in the soil.

We have tested the method in both laboratory and field-scale settings, demonstrating a significant reduction in dissolved As concentrations. We also observed a notable increase in poorly crystalline Fe species in the soil surrounding the electrodes, where As was predominantly bound. Additionally, As bioavailability decreased. The applied electrical field influences not only the introduced Fe but also the indigenous Fe present in the soil. Therefore, ongoing studies aim to distinguish the role of additional Fe from that of naturally occurring Fe in As immobilization.

Since both Fe and As are redox-sensitive species, maintaining oxygenated conditions is essential for the long-term stability of Fe-bound As. Further investigations are underway to optimize redox control using an electric field to enhance method efficiency and ensure its long-term effectiveness.