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In-situ immobilization of an anthropogenic arsenic contamination at a military site in Northern Germany

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The groundwater at the investigated military site in Northern Germany is contaminated with arsenic (As)-containing chemical warfare agents. The maximum total As-concentration (As_{tot}) at the site was 9 mg/l. As_{tot} is predominantly organically bound As (As_{org}) and thus mainly occurs in the form of phenylized As compounds. Inorganic compounds (As_{inorg}: As^{3+} and As^{5+}, each $<10\%$) are also present. We developed and tested an in-situ technique for the immobilization of organic and inorganic arsenic compounds based on the subterranean deferrification and demanganesation and the addition of dissolved iron.

The selected site for the pilot plant had an initial arsenic concentration of about 1.9 mg/l. During a two-year operational period, we reduced As_{inorg} by 99% and As_{org} by 82%. The total As-concentration was reduced by 90%. The field study, as well as additional laboratory experiments using soil from the site, showed that the immobilization of As was stable under field conditions and that As was not remobilized in larger amounts.

Geochemical modelling combined with groundwater flow modelling was used to simulate and optimize the in situ immobilization. Organically-bound and inorganic arsenic species were generalized to one hypothetical species, and the hypothetical adsorption parameter was calibrated accordingly. Subsequently, a sensitivity analysis showed that the process can be optimized. Additionally, hypothetical scenarios showed that the technology can be transferred to other arsenic contaminations and that the success of the remediation technique can be evaluated.