Product Sheet

# GEOFORM® REAGENTS

GEOFORM® Reagents

**GEOFORM® Reagents** are engineered to deliver the building blocks needed to promote in situ biogeochemical reactions. GEOFORM® provides a source of sulfate, ferrous iron, electron donors, pH buffer, and nutrients to promote mechanisms for dehalogenation via enhanced anaerobic bioremediation, abiotic degradation, and the formation of reactive minerals. The component ratios have been optimized to maximize the formation of reactive iron sulfide minerals that provide an expanded surface area for abiotic degradation pathways. In addition, the amount of electron donor can be adjusted based on site specific geochemistry. GEOFORM® can be used for the treatment of groundwater and saturated soil impacted by persistent halogenated compounds and will also immobilize many heavy metals.

## KEY BENEFITS

- Multiple mechanisms for contaminant degradation
- Promotes higher reaction rates
- Treats mixed plumes with CVOCs and heavy metals
- Improved distribution properties / reactive surface area
- Minimal generation of daughter products
- Improved longevity
- pH balanced

## GEOFORM® FORMULATIONS AND APPLICATIONS

GEOFORM® is available in two formulations – a fully soluble formulation for ease of injection and a solid formulation for extended release.

## GEOFORM® SOLUBLE:

- Formulated to deliver as a fully soluble dry powder in two parts:
  GEOFORM® Soluble Mix – a proprietary blend of sulfate and ferrous iron
  ELS® Microemulsion or ELS® Concentrate - a 25% or concentrated organic carbon substrate
- Remains fully in solution during mixing and injection
- Ideal for plume and hot-spot treatment
- Longevity of 2-3 years
- Application via injection wells, infiltration networks or direct push

## GEOFORM® EXTENDED RELEASE:

- Formulated with a long-lasting source of hydrogen donor and zero valent iron (ZVI) for continued rejuvenation of iron sulfide minerals
- Ideal for Permeable Reactive Barrier (PRB) and source area treatment
- Longevity of 5-10 years
- Application via direct push, hydraulic or pneumatic fracturing or soil mixing

## GEOFORM® TREATMENT MECHANISMS

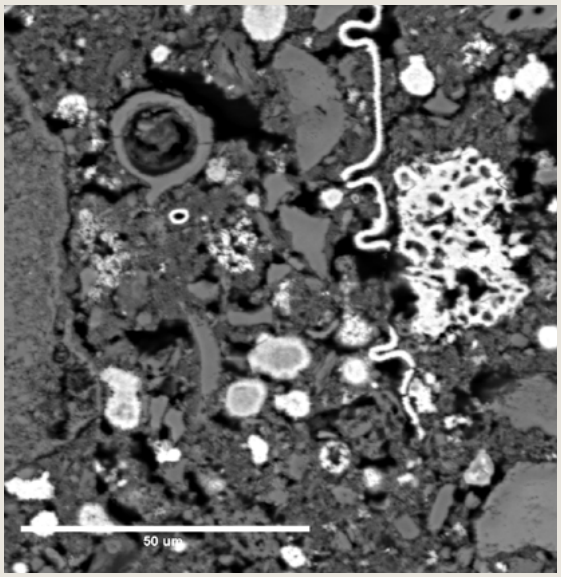
GEOFORM® rapidly creates reducing conditions by promoting both biotic and abiotic reduction mechanisms. The organic carbon serves as an electron donor for dechlorinating bacteria; stimulating biological reductive dechlorination. Under sulfate reducing conditions, the creation of reactive iron sulfide minerals will provide an expanded area for abiotic dehalogenation reactions. GEOFORM® Extended Release also promotes direct chemical reduction in contact with ZVI.

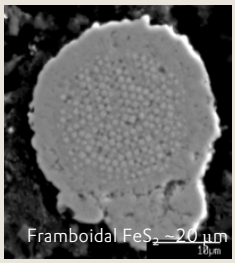
| | Composition | Treatment Mechanisms | | |
|---|---|---|---|---|
| | | Biotic Reduct | Abiotic Reduction | |
| | | | Reductive Minerals | ZVI |
| **GEOFORM® Soluble** | Soluble Sulfate and Ferrous Iron Mix added to an Emulsified Organic Carbon Substrate | • | • | |
| **GEOFORM® Extended Release** | Extended Release Organic Carbon, Sulfate, Ferrous Iron, Micro-Scale ZVI | • | • | • |

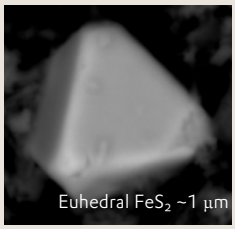
## AN EXPANDED ABIOTIC TREATMENT ZONE

A key attribute of GEOFORM® is the creation of an expanded treatment zone for abiotic dehalogenation. While abiotic degradation in contact with ZVI is going to be limited to the ZVI particle surface interface, the reductive mineral zone created by GEOFORM® may extend a significant distance downgradient from the placement zone. GEOFORM® releases dissolved iron and sulfate which will diffuse in to the surrounding soil matrix and transport with groundwater flow. Once reducing conditions have been established, sulfate reducing bacteria will reduce the sulfate to sulfide which will co-precipitate with ferrous iron and coat the soil with reactive iron sulfide minerals. This increases the surface area for abiotic degradation beyond the area of application and solves an important limitation of traditional ISCR reagents. Furthermore, the iron sulfide zone may be continuously replenished from low levels of organic carbon or hydrogen, thereby acting as an electron shuttle for continued abiotic reduction. The main reaction pathway is via beta-elimination, limiting the generation of daughter products.

For more information and detailed case studies, please visit our website.




| | Particle Size (µm) | Surface Area ($m^2$/kg) |
|---|---|---|
| Micro-Scale ZVI | 50-250 | ~5-30 |
| Framboidal Pyrite | 20 | ~10 |
| FeS Coatings | 3 | ~80 |
| Euhedral Pyrite | 1 | >200 |

Electron microprobe analyses performed on iron sulfide precipitation products estimated that 4.1 $ft^2$ of very reactive surface area was generated per liter of groundwater with 3,000 mg/L sulfate reduced to an estimated 3 µm thick FeS precipitate (Leigh et al).



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