Proven Source Zone Elimination in Fractured Bedrock

Chlorinated volatile organic compounds (CVOCs), such as PCE and TCE, often persist as dense nonaqueous phase liquids (DNAPLs) in fractured bedrock. CVOCs migrate through fractures and diffuse into the surrounding rock matrix, creating long-term contaminant reservoirs that sustain groundwater plumes through back diffusion.

Fractured bedrock presents unique remediation challenges:

- Fracture networks are discontinuous and highly variable
- Permeability is controlled by a limited number of conductive features
- CVOCs reside both in fractures and within the rock matrix
- Conventional remedies often fail to contact matrix-stored mass

As a result, many sites rely on long-term containment remedies rather than true source elimination.

How TCH Treats CVOC Source Zones

Uniform Heating of Fractures and Rock Matrix

Thermal Conduction Heating (TCH) addresses the limitations of conventional remedies by uniformly treating both fractures and the surrounding rock matrix using conductive heat transfer rather than fluid flow.

As the formation is heated to the boiling point of water, CVOCs volatilize or co-boil with groundwater in both fractures and bedrock matrix. This process overcomes diffusion-limited mass transfer from the matrix, which constrains conventional remedies and enables the removal of contaminant mass stored deep within the bedrock.

Because heating is uniform and sustained, TCH effectively addresses:

- DNAPL in fractures
- Sorbed and diffused CVOCs in the rock matrix

Field applications demonstrate significant CVOC mass reduction over relatively short timeframes, often months rather than decades, supporting faster site closure and reduced long-term liability.

Engineered Containment: Preventing Contaminant Migration During TCH

TCH integrates mass removal and containment, maintaining strong inward pressure gradients that prevent off-site migration. Vapor extraction wells co-installed with heaters intersect primary fractures at a typical spacing of approximately 15 ft, directing mobilized CVOCs toward extraction points.

Key containment elements include:

- Immediate capture of volatilized CVOCs
- Hydraulic and pneumatic control during heating
- Aboveground treatment of recovered vapors and liquids using proven technologies

These integrated controls ensure that contaminant mobilization occurs only within a fully controlled treatment zone.

Monitoring, Verification, and Predictable Performance

TCH systems operate with continuous, real-time monitoring of subsurface temperatures, vacuum and pressure conditions, and vapor and liquid extraction rates. These data confirm uniform heating and inward gradients throughout operations and allow system adjustments to address site-specific conditions.

Predictable Performance in Fractured Bedrock

TCH relies on conductive heat transfer rather than fluid flow, making performance independent of fracture connectivity, permeability variability, and groundwater velocity. This allows consistent treatment of contaminant mass stored both in fractures and deep within the rock matrix, where conventional remedies routinely fall short.

Contact Us

For fractured bedrock sites where conventional remedies have failed, Thermal Conduction Heating offers a proven path from long-term management to permanent risk reduction, with reduced uncertainty and accelerated site closure. Talk with TerraTherm to discuss applicability at your site.

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