



A Case Study of In Situ Bioremediation of Low Permeability Soils Using Specialized Waterjet Technology

Susumu Uesawa, Junichi Yamanobe, Katsuya Takayanagi, Kazutoshi Ishikawa, Tatsuya Shioya (Chemical Grouting Co., Ltd., Tokyo, Japan)

Meichin Yeh (EOS Asia Remediation Co., Ltd. Kaohsiung, Taiwan)

Robert Borden (EOS Remediation, LLC, Research Triangle Park, North Carolina, United States)



CHEMICAL GROUTING CO., LTD

Introduction

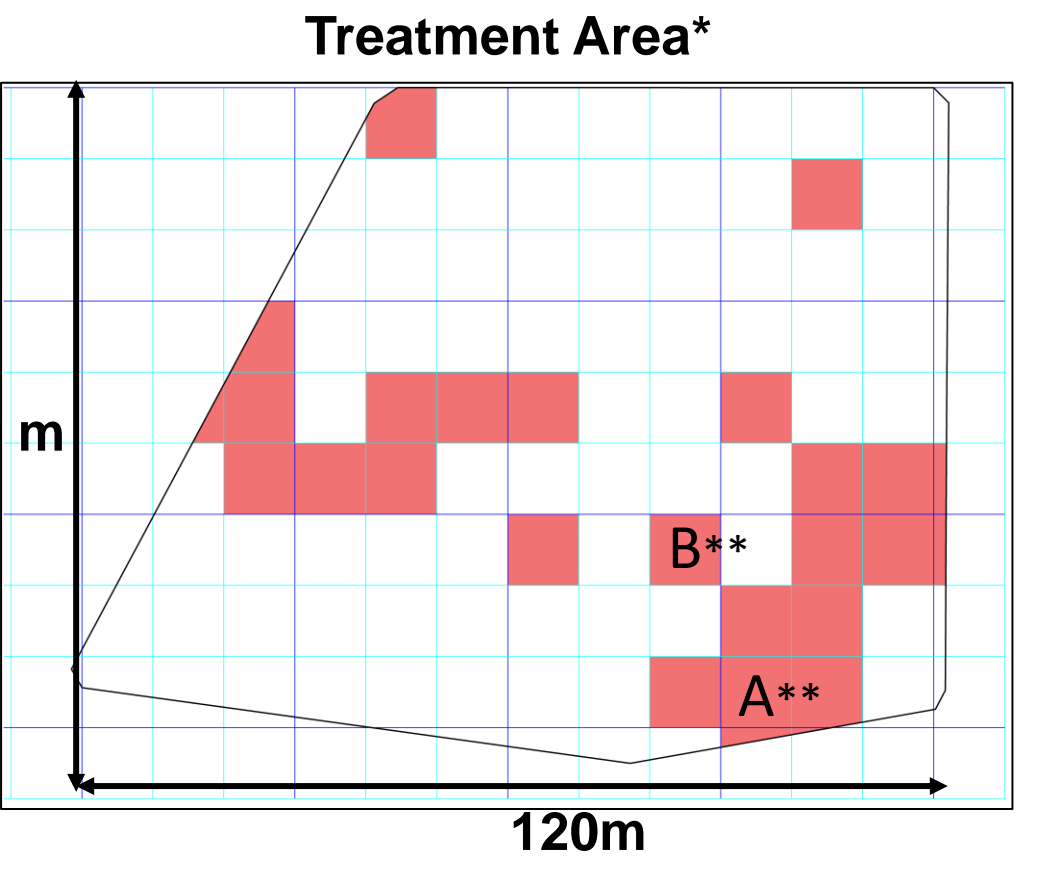
Bioremediation in low permeability soil is difficult with conventional methods. Mixing substrates with low permeability soil is effective but creates muddiness and impairs the ground strength.

Chemical Grouting Co., Ltd. and EOS Remediation, LLC developed BioJet™ to distribute hydrogen release substrates at even intervals throughout low permeable soils via thin slits sliced with water jet. This technology prevents muddiness of the ground; generates a sustained hydrogen source; promotes molecular diffusion; and stimulates microbial reactions in the underground.

BioJet™ was applied at a site in Tokyo in 2020 and the remediation target values were met in approximately 1.5 years.

Site Information

- Site Location: Tokyo, Japan
- Site use: Active factory.
- Site area: 9,300 m²
- Target area: 2,000 m²
- Depth (GL): -4 m ~ -13 m
- Treatment area volume: 10,000 m³
- Contaminant: cVOCs
- Soil Property
 - GL 0m to -4m : Sand; Permeability coefficient: 10E-1 to 10E-2 cm/s
 - GL -4m to -13m: Silt; Permeability coefficient: 10E-4 to 10E-6 cm/s



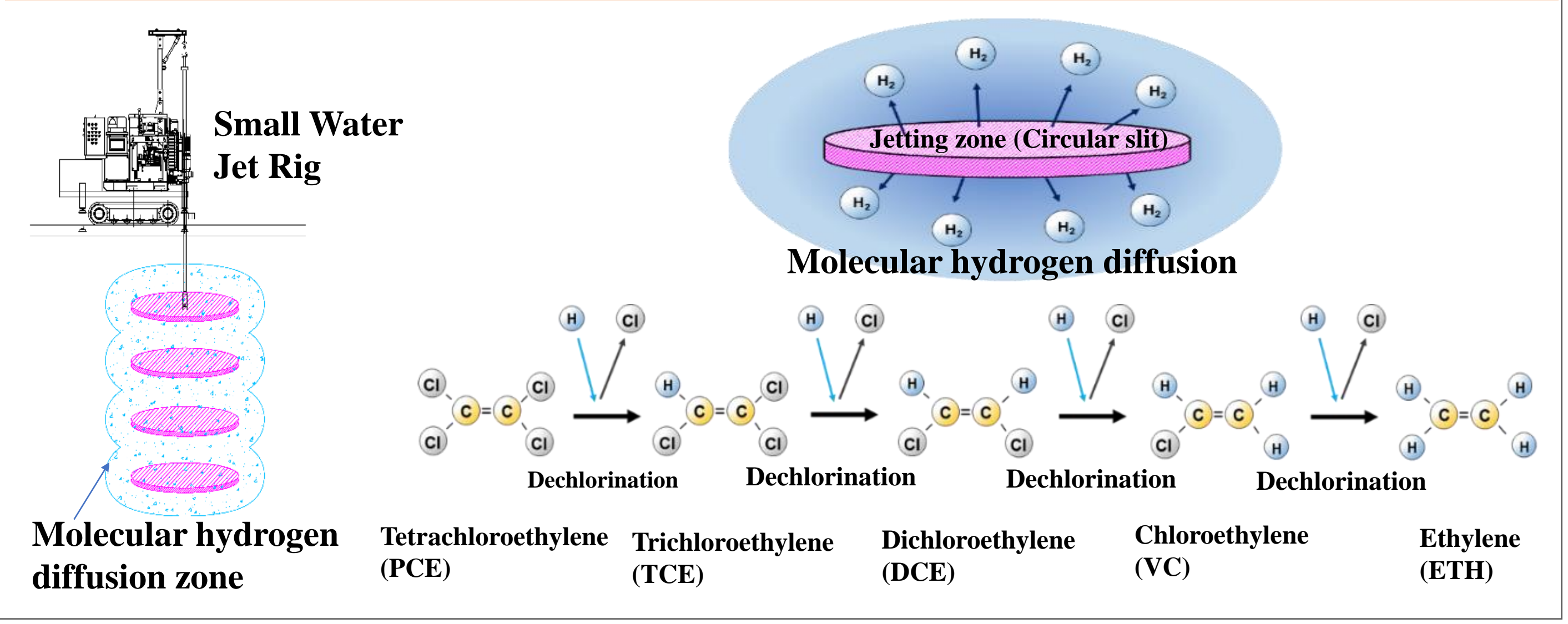
*Red areas illustrate 22 BioJet™ application points.
** Result for point "A" and "B" are shown in Remediation Results below.

Initial Investigation Results of Soil Contamination (Representative data)*

Depth (GL)	Soil Leachate Concentration (mg/L)			
	PCE	TCE	DCE	VC
-4.0 m	ND	ND	ND	ND
-5.0 m	ND	ND	ND	ND
-6.0 m	ND	0.025	0.16	0.11
-7.0 m	ND	0.013	0.090	0.12
-8.0 m	ND	0.13	0.20	0.11
-9.0 m	ND	0.033	0.12	0.050
-10.0 m	ND	0.11	0.021	0.004
-11.0 m	ND	0.021	0.006	ND
Standard value	0.01	0.03	0.04	0.002

*Red values indicate concentrations over the Japanese Soil Leachate Standards.

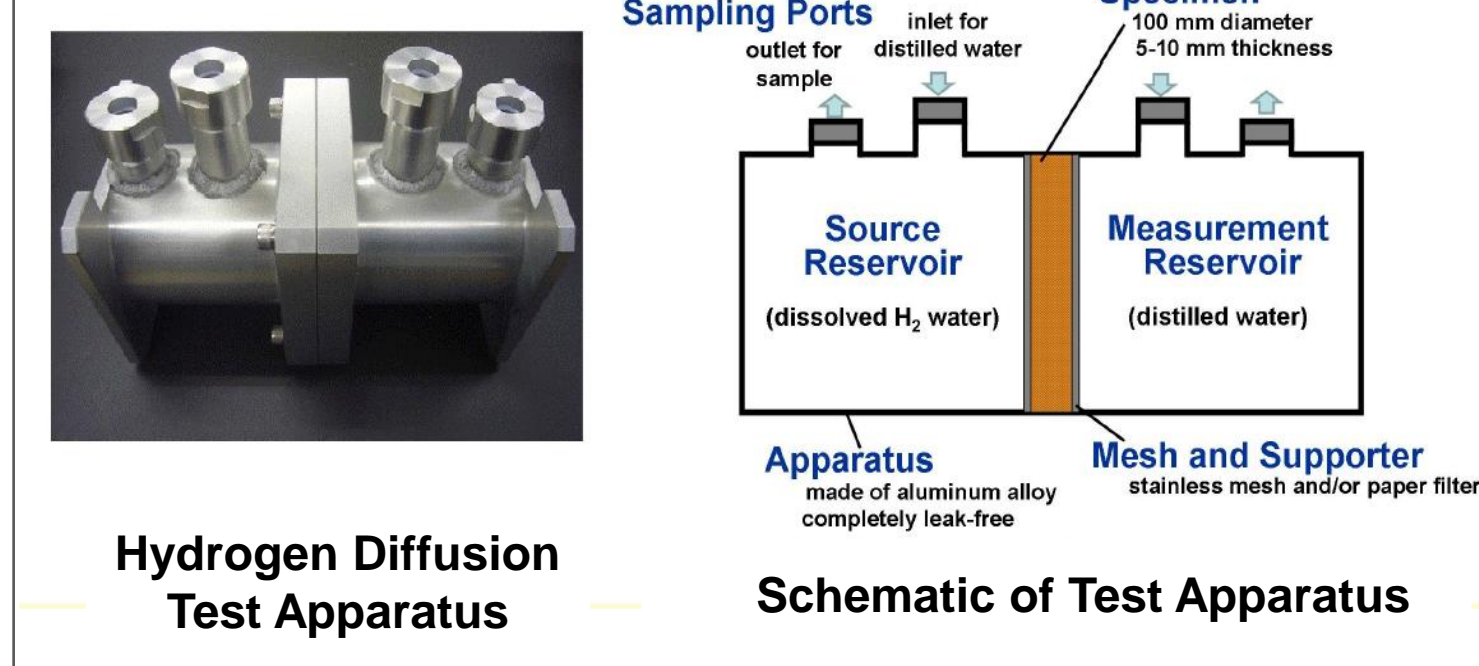
Concept of BioJet™



Hydrogen Diffusion Rate

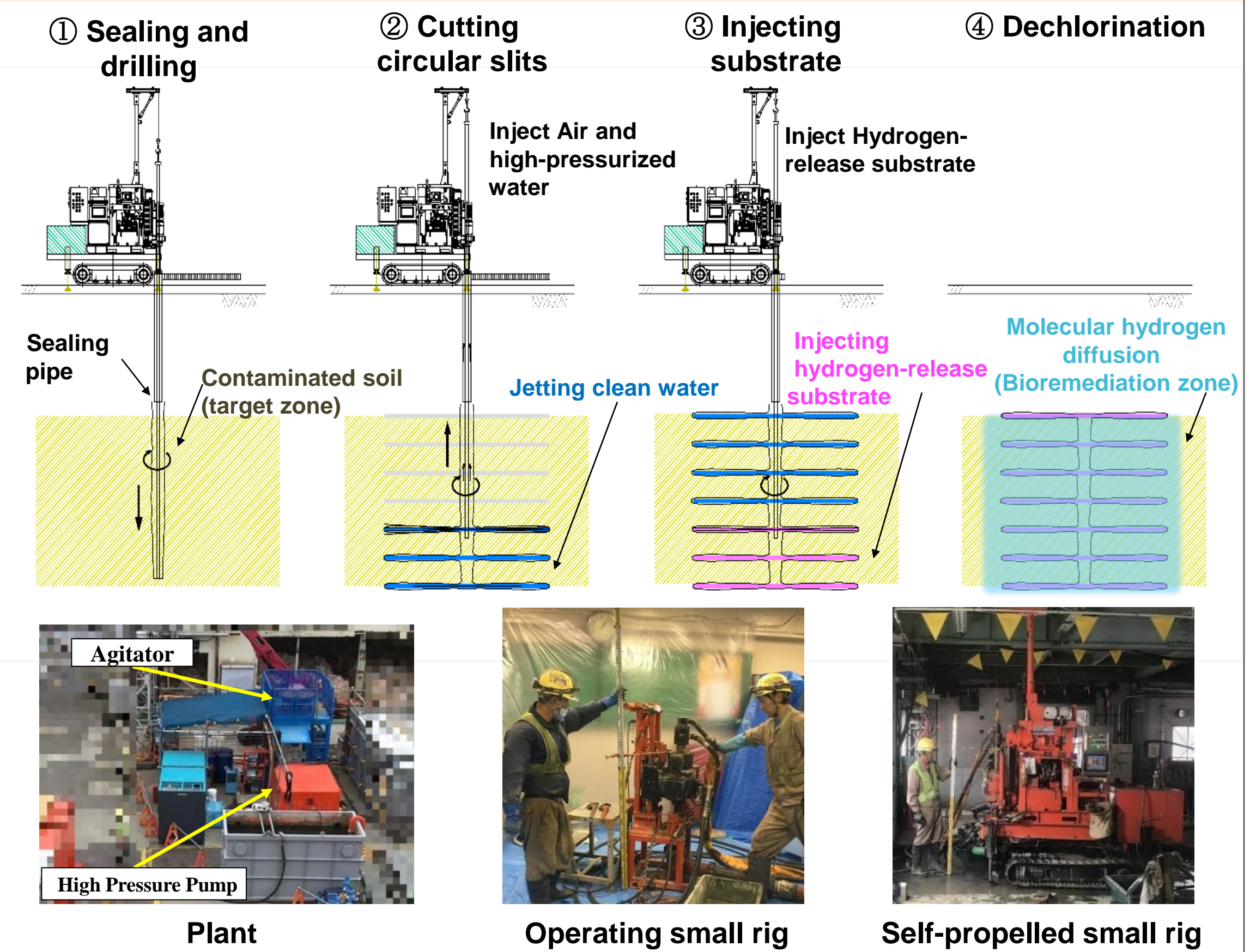
Past experiments showed various soil specimens with coefficients of permeability between the orders of 10E-2 and 10E-7 cm/s all had hydrogen diffusion coefficients on the order of 10E-10 m²/s.

This indicates minimal correlation between the hydrogen diffusion coefficient and permeability coefficient; and suggests hydrogen may be able to diffuse into an aquitard to fuel anaerobic bioremediation.

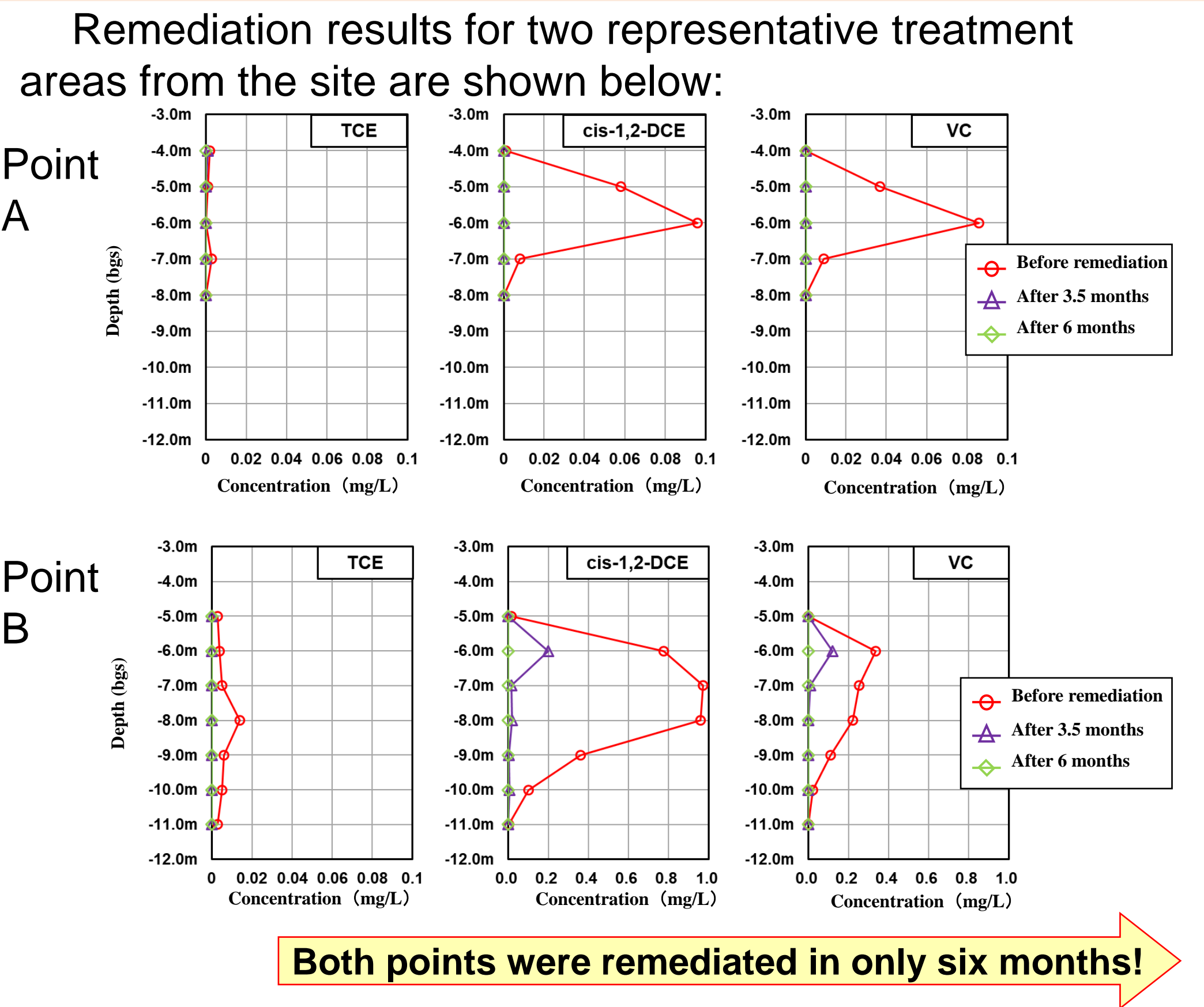


(M. Yoshikawa et al. (2010), Diffusion Study on Dissolved Hydrogen toward Effective Bioremediation of Chlorinated Ethenes in Aquitards, Abstract B43A-0453 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.)

BioJet™ Procedure



Remediation Results



Summary

BioJet™ technology effectively delivered EOS Remediation engineered electron donors into low permeability zones resulting in enhanced reductive dechlorination of targeted cVOCs without a loss of soil strength.

The initial soil leachate concentrations for this site were 0.13 mg/L for TCE, 0.20 mg/L for cis-1,2-DCE, and 0.12 mg/L for VC. The Ministry of Environment's cleanup goals for soil leachate concentrations and groundwater concentrations of 0.03 mg/L for TCE, 0.04 mg/L for DCE, and 0.002 mg/L for VCs were met approximately 1.5 years following BioJet™ application.

These results show:

- it is possible to remediate cVOCs contamination in low permeability soil by the concept of molecular hydrogen diffusion; and
- target concentrations can be achieved in 1.5 years depending on the initial contamination concentration and other conditions.

To learn more, view our BioJet™ technology introduction video:

