Grant Information: Institution, Principal Investigator(s), Contact Information, Grant Number	**Oregon State University** **Project:** Development of Passive and Sustainable Cometabolic Systems to Treat Complex Contaminant Mixtures by Encapsulating Microbial Cultures and Slow-Release Substrates in Hydrogels **Project Leaders**: Lewis Semprini, Michael R. Hyman, Willie Ernest Rochefort **Funding Period:** 2021-2025
Technology	Passive and sustainable systems are being developed for the aerobic cometabolic in-situ treatment of emerging contaminants, such as 1,4-dioxane, that are mixed with chlorinated aliphatic hydrocarbons (CAHs). These passive systems are being created by co-encapsulating axenic bacterial cultures with a slow-release compound (SRC) in hydrogel beads.
Innovation	**Materials: What novel materials are you developing?** The hydrogel beans are being fabricated using polyvinyl alcohol and sodium alginate that are crosslinked with boric acid and calcium ion. **Biological: What is the biological component?** The hydrogel beads co-encapsulated the bacteria *Rhodococcus rhodochrous* ATCC 21198 and an SRC that produces an alcohol as a growth substrate upon hydrolysis with water. **Why is this technology/approach different than what is already in the market?** The innovation is that long-term cometabolic transformations can be achieved by the co-encapsulated hydrogel beads.
Contaminant and Media	**Contaminants:** We are focusing on the emerging contaminant 1,4-dioxane and broad range of chlorinated ethanes, such as 1,1,1-trichloroethane, and chlorinated ethenes, such as 1,2-cis- dichloroethene and vinyl chloride. **Media:** Focusing on in-situ treatment of contaminated groundwater.
Expansion Potential	**Looking Forward:** The process using *Rhodococcus rhodochrous* strain ATCC 21198 has potential to treat a broad range of other contaminants, including MTBE, BTEX, polycyclic aromatic hydrocarbons (PAHs), 1,2,3-trichloropropane, and NDMA. **Combined Remedy:** The hydrogels might also be used to treat contaminated sediments and soils, and potentially drinking water.
Sites/Samples	We are working with groundwater samples and sediments for a U.S. Navy site on the West Coast.
Technology Readiness Level	TRL 4 — Technology validated in laboratory

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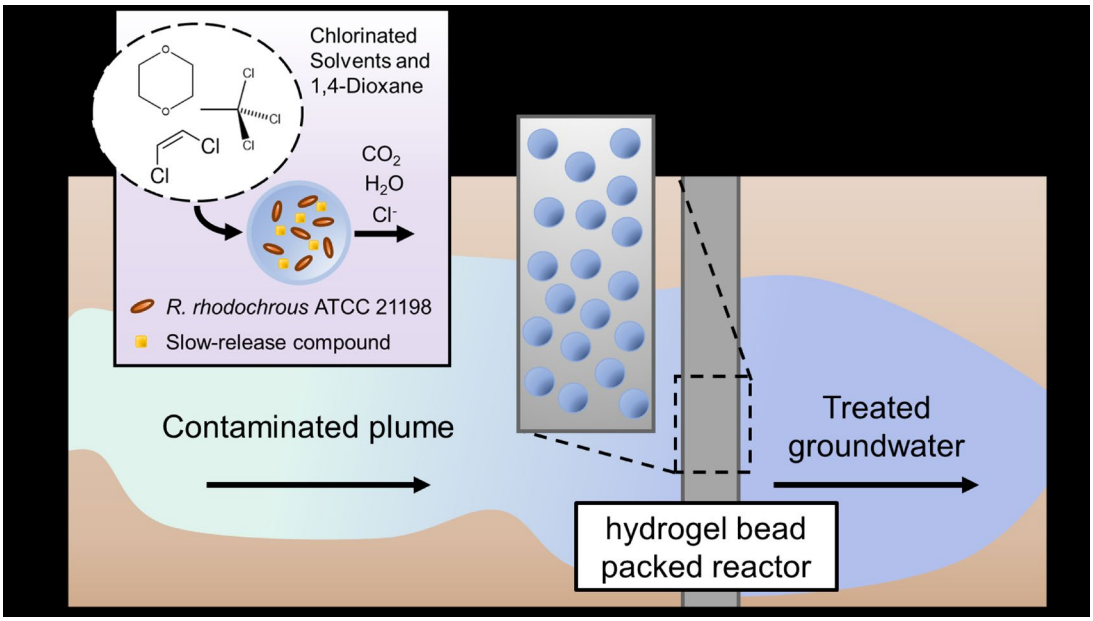
Update of Progress	Column Study of Aerobic Cometabolism of Chlorinated Solvents and 1,4-Dioxane With Co-Encapsulated Hydrogel Beads. Kaden Bennett, Kestrel Bailey, and Lewis Semprini (NIEHS SRP Annual Meeting, 2023) Chlorinated aliphatic hydrocarbons (CAHs) are a class of organic compounds that include several widely used industrial solvents. These chlorinated solvents have known toxic effects and are common groundwater contaminants across the United States. *Rhodococcus rhodochrous* 21198 (ATCC 21198) is a bacteria species that can dechlorinate CAHs. It is currently being studied in an engineered system for eventual application at contaminated groundwater sites. In this novel remediation approach, ATCC 21198 is encapsulated in hydrogel beads along with the slow-release substrate tetrabutyl-s-orthosilicate (T2BOS). T2BOS hydrolyzes to produce 2-butanol, a growth substrate for ATCC 21198. As ATCC 21198 metabolizes 2-butanol, a co-metabolic process occurs to dechlorinate certain CAHs. A packed column of hydrogel-encapsulated ATCC 21198 is being tested with a dilute groundwater media containing the CAHs 1,2-cis-dichloroethylene (cis-DCE) and 1,1,1-trichlorethane (1,1,1-TCA), as well as the common groundwater co-contaminant 1,4-dioxane (1,4-D). Hydrogen peroxide is being spiked into the column media to provide sufficient oxygen in the system. There are ongoing experiments to determine the system's oxygen requirements via in-situ dissolved oxygen measurements with a fluorescent probe. In the current system, over 99% remediation of 66 ppb cis-DCE, over 90% remediation of 200 ppb 1,1,1-TCA, and over 60% remediation of 1 ppm 1,4-D has been achieved with a hydraulic residence time of 25.8 hours.



Co-encapsulated hydrogel beads for the long-term in-situ aerobic cometabolic treatment of 1,4-dioxane and chlorinated aliphatic hydrocarbons.