MEETINGS

Remediation of Groundwater Contaminated by Nuclear Waste

A Workshop on Accelerating Development of Practical Field-Scale Bioremediation Models; An Online Meeting, 23 January to 20 February 2008

A Web-based workshop sponsored by the U.S. Department of Energy Environmental Remediation Sciences Program (DOE/ERSP) was organized in early 2008 to assess the state of the science and knowledge gaps associated with the use of computer models to facilitate remediation of groundwater contaminated by wastes from Cold War era nuclear weapons development and production. Microbially mediated biological reactions offer a potentially efficient means to treat these sites, but considerable uncertainty exists in the coupled biological, chemical, and physical processes and their mathematical representation.

Individuals from academia and DOE laboratories with expertise in modeling or microbiology and experience involving groundwater bioremediation participated in the workshop, which involved 10 hours of online meetings over a 5-week period in early 2008 via linked audio and video communication. The objective of the workshop was to narrow the communication gap between modelers and microbiologists, engineers, and scientists who tend to look at problems from different and sometimes divergent perspectives.

Groundwater contamination problems occur in very heterogeneous subsurface conditions at scales of kilometers. Because measurements are generally obtained at much smaller lengths, scaling issues have broad implications for prediction uncertainty and model formulation. Methods for incorporating scale effects in models were discussed. Some participants regarded explicit treatment to be required for accurate modeling, while others favored implicit upscaling methods for practical applications.

More generally, the issue of "optimal" model complexity was discussed. Theoretically, precision should improve with greater resolution and conceptual detail. In practice, however, optimal complexity involves trade-offs between the benefit of reduced prediction uncertainty and the cost of obtaining data needed to calibrate more complex models. A better understanding of these trade-offs is needed not only to use models to best advantage, but also to direct research priorities so as to best utilize limited research funds. While striving to improve simulation models, practical limits on model complexity imposed by trade-offs between prediction uncertainty and data availability must be considered.

An overarching research priority noted by workshop participants was the identification of rate-limiting processes for microbial growth and microbially mediated chemical transformations along with the formulation of relevant rate equations. More controlled experiments are needed to test and refine reaction models and to define functional microbial groups employed in computer models, with actual microbial populations measured using modern molecular biological techniques.

The workshop stressed the need for collaborative research involving diverse experts working with end users to undertake iterative refinements driven by model-derived priorities to advance both basic scientific understanding and practical applications of groundwater bioremediation at DOE and other sites. Programmatic efforts to improve integration between modeling and experimental studies are felt likely to pay significant dividends. Efforts to resolve basic science questions may also identify gaps in understanding that ultimately lead to improvements in future generations of models.

A detailed report including a full list of participants and specific recommendations is available at http://isse.utk.edu/pdf/BioremediationModelingWorkshop.pdf.

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