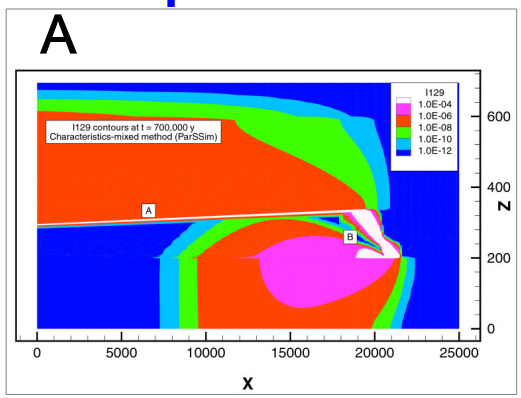
GC-4 Highlight

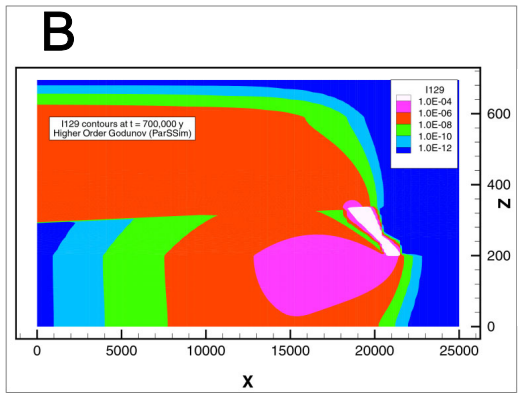
University of Texas-Austin

Accurate transport schemes for prediction of long-term repository performance

S. Bryant



Simulation of 0.7 million years of leakage from a radioactive waste repository. The Characteristics-Mixed Method (CMM) captures important fine-scale features in a plume of Iodine-129 such as (A) the streak of high concentrations at the upper boundary of the clay layer and (B) the large gradients in concentration to the left of the repository.



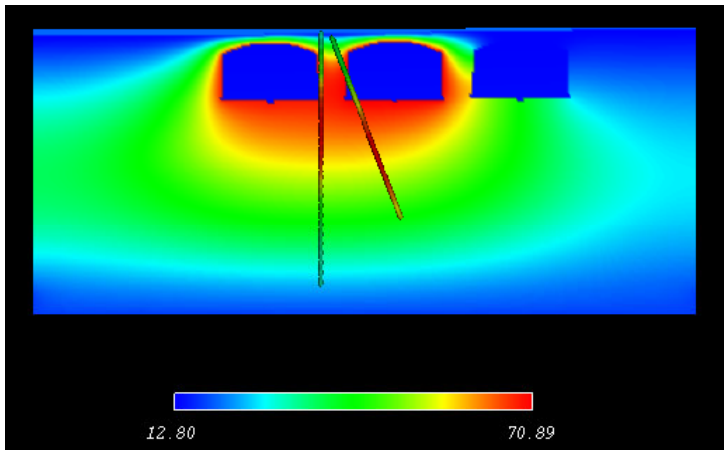
Same problem as in A but simulated using a higher-order Godunov scheme. Numerical dispersion has obscured the features noted in A. Moreover the simulation predicts significantly faster advance of the contaminant plume in the limestone layer below the repository.

We illustrate the importance of reducing numerical dispersion with simulations of the far-field behavior of a leaking radioactive waste repository, devised from the Couplex1 test problem (http://www.andra.fr/fr/actu/archi-0030.htm). This problem is one of several designed to evaluate the capabilities of reactive transport simulators worldwide, and the Center for Subsurface Modeling at the University of Texas at Austin is participating in the second round of testing and evaluation. The problem sets a leak rate for radioactive iodine, I^{129}, and steady flow rates through limestone layers above and below a thick clay layer in which the repository is situated. The extremely low permeability of the clay results in flow velocities four to six orders of magnitude smaller in the clay than in the limestone. Dispersion is consequently much higher in the limestone as well, while molecular diffusion is a significant transport mechanism in the clay. Initial concentrations in the vicinity of the repository are of order unity, and we must track concentrations down to parts per trillion over a period of 10 million years. The figures show I^{129} plumes after 0.7 million years. Note that the CMM simulator has a much sharper appearance, as the Godunov method experiences a much greater level of numerical dispersion, obscuring the result. Moreover, the long time advance of the plume is improperly enhanced by the numerical dispersion in the latter case.

EMSL UP # 1834

Historical heat loading effects from Hanford HLW tanks on vadose zone fluid flow

M. White



Predicted temperature distribution and observed borehole temperatures in the year 2000 based on operational histories of tanks in the Hanford SX Tank Farm.

This study used numerical simulation to investigate the coupled processes of multifluid flow, heat transfer, and solute transport in a heterogeneous geologic environment surrounding the subject row of single-shell tanks. These STOMP90 simulations were executed using the biconjugate gradient stabilized solver and incomplete LU factorization preconditioner with three levels of fill offered by SPLIB and PETSc, respectively. Although phase transitions and primary variable switching delays convergence and without constraints can yield unstable phase flopping conditions, Newton-Raphson linearization with numerical derivatives and primary variable switching has proven to be robust and convergent for direct linear system solvers. This scheme functioned equally well for iterative linear system solvers with adequate preconditioning (e.g., incomplete LU with three levels of fill), but failed for the simpler preconditioning schemes (e.g., diagonal preconditioning, incomplete LU with no fill).