Development of Numerical Grids for Unsaturated Zone Flow and Transport Modeling

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RESEARCH OBJECTIVES

Numerical grid generation is an integral part of the development of numerical models used for simulating unsaturated zone (UZ) flow and transport at Yucca Mountain. Previous studies at Yucca Mountain have generated detailed information on the geologic and hydrological properties of the UZ. Information on the stratigraphy, orientation, and location of faults, presence of vitric and zeolitic subunits, hydrological properties of the different hydrogeologic units, the location of the water table, and the design and location of proposed repository drifts can be used to develop complex 3-D numerical grids. The objective of this work is to construct numerical grids that provide the necessary resolution for subsequent UZ hydrological-property and flow calibration and mountain-scale flow and transport simulations for the Yucca Mountain system.

APPROACH

Numerical grid generation is an iterative process that must achieve a proper balance between desired numerical accuracy (requiring more gridblocks) and short computational time (requiring fewer gridblocks). Fault and stratigraphic contact data obtained from the Yucca Mountain Geologic Framework Model were used in conjunction with hydrogeologic unit definitions to form the basis for the development of numerical grids. Other key input data included the location of calibration boreholes, the proposed repository layout, the water table surface (which forms the lower boundary of the UZ), and the location of zeolitic and vitric tuffs within the Calico Hills nonwelded units. These data were used as input for the WinGridder software package to develop 1-D, 2-D, and 3-D numerical grids (Figure 1). The resulting grids were checked using visual inspection and test simulations to verify the accuracy of the mesh and gridblock connections. Fracture data were used along with the program 2kgrid8.for to transform the effective-continuum model 3-D grid into the dual-permeability 3-D numerical grid required for conducting flow and transport models in heterogeneous, fractured rocks.

ACCOMPLISHMENTS

A revised set of 1-D, 2-D, and 3-D numerical grids was generated for use in numerical modeling of UZ flow and transport at Yucca Mountain. These grids incorporated changes made to the Yucca Mountain Geologic Framework Model, the UZ Model area boundaries, the position of the water table, the proposed repository design, and the location of vitric and zeolitic subunits in the Calico Hills nonwelded tuffs. The new grids also contained enhanced vertical resolution in selected units to better resolve processes such as lateral flow.

SIGNIFICANCE OF FINDINGS

The resulting numerical grids have been used for calibration of hydrogeologic unit properties and flow fields, testing of conceptual models of UZ flow and transport, and simulation of mountain-scale flow and transport behavior for the Yucca Mountain system under a variety of climatic and thermal-loading conditions.

RELATED PUBLICATION

Dobson, P.F., L. Pan, and R. Hedegaard, Development of numerical grids for UZ flow and transport modeling. ANL-NBS-HS-0000015 REV01, BSC, Las Vegas, Nevada, 2003.

ACKNOWLEDGMENTS

This work was supported by the Director, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, through Memorandum Purchase Order EA9013MC5X between Bechtel SAIC Company, LLC, and the Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab). The support is provided to Berkeley Lab through the U.S. Department of Energy Contract No. DE-AC03-76SF00098.

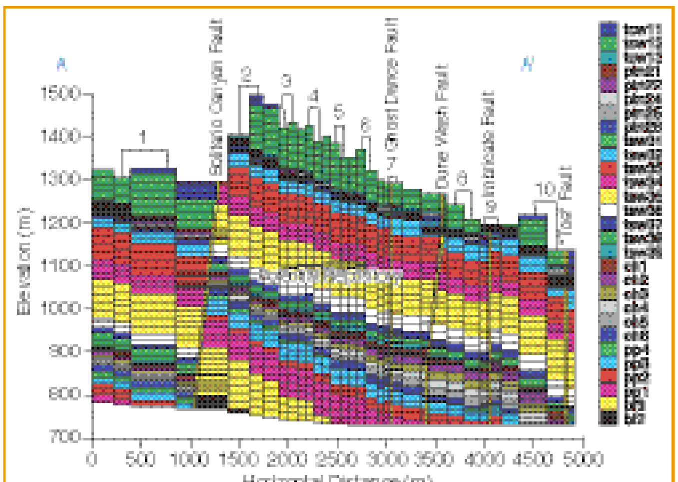

Figure 1. East-west cross section from the UZ Model Grid. Model layers represent hydrogeologic units derived from the Yucca Mountain Geologic Framework Model. Numbered column pairs were used to compare contact elevations obtained from the UZ Model and the Geologic Framework Model.