Modeling Tip: Modeling Outcropping or Pinching Layers in Visual MODFLOW

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MODFLOW is a three-dimensional groundwater flow model originally developed by the U.S. Geological Survey. The model is based on a finite difference formulation of the groundwater flow equation requiring all model layers to be continuous across the entire model domain. Each layer is required to have a finite layer thickness in order to assure conservation of mass and, hence, the stability and accuracy of the solution. As such, geologic layer pinchouts or outcropping of geologic units at the surface cannot be explicitly represented using a finite difference grid. However, two different approaches can be used to get around this problem:

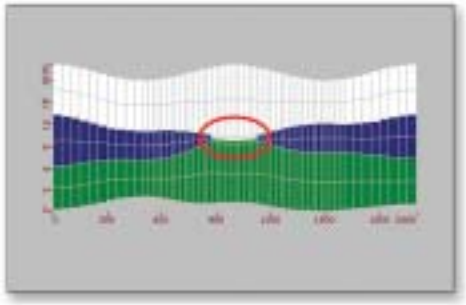

Figure 1: Deformed Grid Approach

(1) Deformed Grid Approach: Geologic layer surface elevations are imported to the model layer surfaces in order for the shape of the model grid to represent the shape of the geologic units. In places where the geologic units pinch out, the model layers are pinched down to a very small thickness. Visual MODFLOW allows the user to specify a minimum layer thickness when importing surface elevations for each model layer. Once the model layer surfaces are imported, the user can simulate the pinchout by assigning appropriate property values to the cells in the pinchout section (see Figure 1).

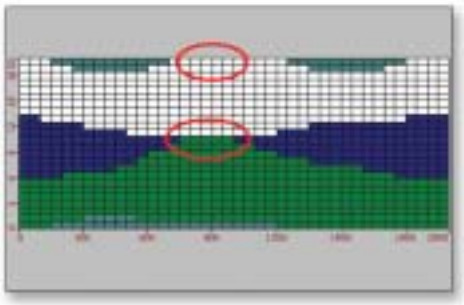

Figure 2: Fixed Grid Approach

(2) Fixed Grid Approach: The finite difference grid consists of uniformly flat horizontal layers. The grid cell property values are assigned as needed in order to represent the shape of the geologic units. This approach fully respects the finite difference assumptions and will result in a more stable solution than the previous approach,.however, it is much more difficult to design and modify and is not as attractive for presentation purposes (see Figure 2).

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USGS Releases New Software for Estimating Flood Flows

In February, the U.S. Geological Survey (USGS) announced the release of new software that allows users to estimate flood flows for streams throughout the United States. The new software, Version 3 of the National Flood Frequency (NFF) Program, provides estimates of flood flows having recurrence intervals of two years to 500 years for user-selected sites on rural and urban streams.

The NFF software compiles more than 2,000 flood-flow equations developed by the USGS for 289 regions of the nation into a single, user-friendly package. The equations relate the flood flows to physical and climatic characteristics, such as the land area that drains to the site of interest and the mean annual precipitation for the area. Users can enter the characteristics into NFF to obtain flood-flow estimates for their

sites of interest. Different regions require different characteristics as input for solving the equations. The estimates are provided onscreen as tables or as plots, and users can save the output to files on their computers.

"This new software has been anxiously awaited by federal, state, and local government agencies, and by the engineering and consulting communities," said Kernell Ries, a USGS hydrologist who compiled the report that documents the software. "The estimates provided by NFF are often used as a basis for determining flood-plain areas on the Federal Emergency Management Agency's flood insurance rate maps, and by other agencies for making planning and management decisions. In addition, the estimates are used to design bridges, culverts, and flood-control structures."

A previous version of the software was released in 1994, and since then, new equations have been developed for more than 30 states. The report, titled "The National Flood Frequency Program, Version 3: A Computer Program for Estimating Magnitude and Frequency of Floods for Ungaged Sites," compiled by K.G. Ries III, and M.Y. Crouse, has been released as U.S. Geological Survey Water Resources Investigations Report 02-4168. Digital copies of the report and the software can be downloaded from the NFF Web page, http://water.usgs.gov/software/nff.html. The Web site also contains links to documentation to assist users in solving the equations for each state. Paper copies of the report, which include a CD-ROM of the software, can be purchased at U.S. Geological Survey, Information Services, Box 25286, Denver, CO 80225-0286, telephone: (303) 202-4700. The NFF software runs only on computers with Windows operating systems.

Satellites Reveal Ground Subsidence from Water-Level Declines in Parts of Mojave Desert

The earth has subsided as much as four inches in parts of the Mojave Desert in Southern California, according to U.S. Geological Survey (USGS) scientists. Using the satellite-mapping process known as "interferometric synthetic aperture radar" (InSAR) (see related article on page 8), scientists have detected large earth-surface depressions near the agricultural areas of Lucerne Valley, El Mirage, Lockhart, and Newberry Springs in the southwestern portion of the Mojave Desert. The subsidence occurred between 1992 and 1999 and is linked to declining water levels.

"The magnitude of subsidence in some of the areas is significant," said Michelle Sneed, USGS scientist and lead author of the study, "The compaction of the aquifer systems in these areas may be permanent."

The USGS study, in cooperation with the Mojave Water Agency, found that land subsidence was linked to water-level declines of more than 100 feet between the 1950s and the 1990s. Land subsidence can disrupt surface drainage; reduce aquifer storage; cause earth fissures; and damage wells, buildings, roads, and utility infrastructure. "Earth fissures several feet wide and deep have been observed in Lucerne Valley," Sneed said. The USGS reports that continued monitoring of some areas of the Mojave Desert is warranted because groundwater levels continue to decline, and pumping-induced land subsidence, documented by this study, likely will increase.

The U.S. Geological Survey report, "Detection and Measurement of Land Subsidence Using Interferometric Synthetic Aperture Radar and Global Positioning System, San Bernardino County, Mojave Desert, California" by Michelle Sneed, Marti E. Ikehara, S.V. Stork, Falk Amelung, and D.L. Galloway, can be found at: water.usgs.gov/pubs/wri/wri034015/.

Solar Energy Leader Initiative to Further Solar Use in Water Management

International Center for Water Technology, California State University, Fresno

On March 27, The International Center for Water Technology (ICWT), based at California State University, Fresno, announced it signed a memorandum of understanding with solar energy industry leader World Water Corporation. This step was taken to further ICWT's partnership with industry and to encourage widespread adoption of water and energy technology that is economically and environmentally beneficial.

The New Jersey-based World Water Corporation is a solar energy company that develops and installs water and irrigation pumping equipment utilizing new technology. The company recently dedicated a proprietary state-of-the-art, 50-horsepower, solar-irrigation pump system – the only one of its size in the world – at the Mendota, Calif.-based D.T. Locke Ranch.

The ICWT will launch a major Solar Initiative during Summer 2003 to encourage farmers, water districts and other agricultural water users to utilize solar energy to pump a significant amount of their annual irrigation water during peak electrical usage periods. The new technology provided by World Water and high efficiency arrays by other firms will enable an evolutionary shift in renewable energy sources for agricultural water pumping.

With the new Solar Initiative, ICWT hopes to accomplish the following goals:

1. Reduce and/or shift peak water pumping energy demands.
2. Promote small-scale distributed generation in agricultural areas of utility grids that are transmission-constrained.
3. Promote renewable energy as an alternative to energy sources that have a significant negative impact on the environment.
4. Educate farmers and water purveyors about programs and incentive rebates that produce a favorable economic climate for the adoption of solar-power, water-pumping systems.
5. Encourage and investigate the use of water and irrigation technology that is energy-efficient.
6. Provide for a more informed decision-making process for farmers and water purveyors to reduce overall water and energy consumption, wherever possible.

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