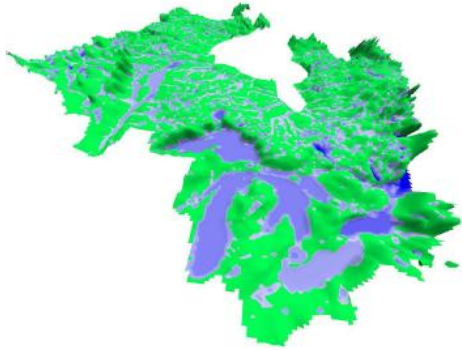


# HydroGeoSphere

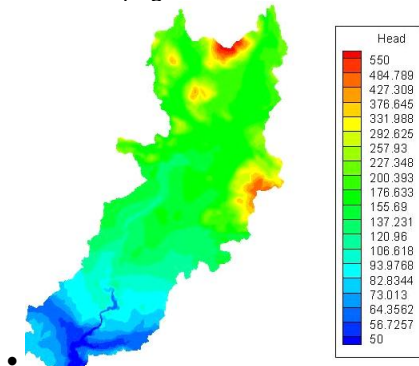
## A Three-dimensional Numerical Model for Fully-integrated Subsurface and Surface Flow and Solute Transport



**HydroGeoSphere** is a powerful numerical simulator for supporting water resource and engineering projects pertaining to hydrologic systems with surface and subsurface flow and mass transport components. It is an upgraded version of the **FRAC3DVS** discrete fracture model where surface water simulation capabilities have been added and where all features of **FRAC3DVS** are retained. **HydroGeoSphere** has the following attributes:

### Fluid Flow

- Complete hydrologic cycle modeling using detailed physics of surface and subsurface flow in one integrated code.
  - Surface domain represented as 2-D areal flow for the entire surface or as 2-D runoff into 1-D channels.
  - Subsurface domain consists of 3-D unsaturated and/or saturated flow.
  - Both domains naturally interact through physically-based fluid exchange terms.
- Physically-based accounting of all components of the hydrologic cycle water budget.
  - Temporally and spatially varying evapotranspiration based on land use/land class and seasons.
  - Impact of snowmelt on hydrologic regime.
- Accurate delineation and tracking of the water table position.
- Handling of non-ponding or prescribed ponding recharge conditions and seepage faces.



- Accommodation of storage, solute mixing and variable flow distribution along wellbores.
- Representation of fractured geologic materials with arbitrary combinations of porous, discretely-fractured, dual-porosity and dual-permeability media for the subsurface.
- Density-dependent flow and transport.

### Mass and Heat Transport

- Simulation of non-reactive and reactive chemical species transport, and heat transport in the associated surface and subsurface flow fields.
- Accurate handling of fluid and mass exchanges between fractures and matrix including matrix diffusion effects and solute advection in the matrix.
- Chain-reactions of radionuclide components.
- Calculation of water age and solute transit time probabilities.

### Numerical Methods

- Fully-implicit coupling approach for all domains provides for a robust mass conserved solution scheme.
- Advanced computational algorithms that allow the code to perform unprecedented, fully-integrated, 3-D simulation/animation on a personal computer.
  - Adaptive time-stepping schemes with automatic generation and control of time steps.
  - Efficient ILU-preconditioned iterative sparse-matrix solver.
  - Efficient Newton-Raphson linearization option.
- Fluid and solute mass balance tracking.
- Unstructured finite-element grids.
  - Advanced meshing of irregular discrete fractures.
  - Axi-symmetric grid option.
  - 8-node block or 6-node prism elements, 3- and 4-node plate elements for fractures and surface water, and 2-node line elements for wells and tile drains.
- Finite difference option (7-point template).

### Pre- and Post-processing

- User-friendly pre-processor with **GridBuilder** and **GMS** compatibility for mesh generation and problem setup.
- Import options for **GIS** formatted data.
- Export options for **Tecplot** visualizations.

### Applications and Research Investigations

**HydroGeoSphere** can perform event-based and continuous simulations on widely varying spatial and temporal scales. Examples of field applications include:

- Integrated water resource assessment and watershed hydrologic analysis.
- Land-use or climate-change impacts on both surface and subsurface water.
- Contaminant fate in surface and subsurface water.
- Fractured rock hydrogeology.

### Developers and Contact Information

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