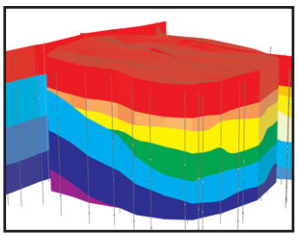
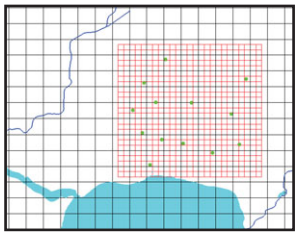
Technology Sheet

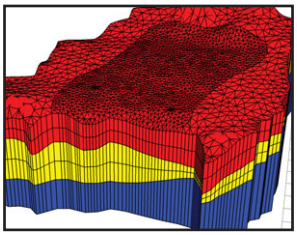
Schlumberger WATER SERVICES



Define the geologic model from borehole and cross-section data



Develop child grids for Local Grid Refinement (LGR)



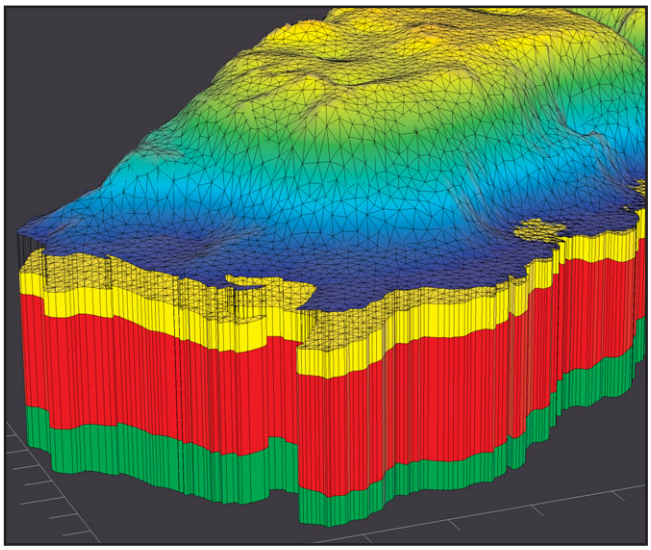
Refine the finite element mesh around wells

Hydro GeoBuilder Users Include:

- Groundwater modelers
- Hydrogeologists
- Geologists
- Government agencies
- Environmental consultants
- Remediation engineers
- Mining experts

Hydro GeoBuilder

A flexible conceptual modeling environment for Visual MODFLOW and FEFLOW



Highlights:

- Design the conceptual model and convert to input for FEFLOW or MODFLOW
- Automatically generate the mesh or grid from multi-layered pinchouts and discontinuous layers
- Define flow properties and boundaries using GIS data
- Conveniently assign tens or hundreds of multi-layered wells to the finite element mesh or finite difference grid

Hydro GeoBuilder* provides a conceptual modeling environment for MODFLOW or FEFLOW™ and streamlines the process of defining flow properties, boundaries, pumping wells, and three-dimensional finite element meshes and finite difference grids. With traditional MODFLOW and FEFLOW modeling, the input is assigned to the grid or mesh, posing challenges when the grid or mesh is inadequate or modeling objectives change. Using Hydro GeoBuilder, the model input is defined conceptually, independent of the simulator, which provides the following benefits:

- **Improve Efficiency** - Maximize the use of existing GIS data and incorporate physical geology and geographic conditions into the conceptual model before designing the grid or mesh. Automatically generate complex model layers from the conceptual model structure. Modify the grid or mesh, or easily change simulators to meet demanding project objectives.
- **Improve Quality** - Generate multiple numerical models from the same conceptual model – ideal for comparing a variety of grid or mesh discretizations for uncertainty analysis. Use the visual tools to compare raw field/borehole data to the resulting grid/mesh layers, increasing the confidence in the quality of the numerical model input. Load simulation results (heads, drawdown, and pathlines) and correlate to the conceptual model and grid/mesh.
- **Physical Definition** - Define pinchouts and lenses using shapes and surfaces and automatically convert to the appropriate grid cells or finite elements. Design local grids around the area of interest for simulation using MODFLOW-LGR (Local Grid Refinement). Define one or more finite element models on local or regional scales.

From raw data, to the conceptual model, to the numerical model, Hydro GeoBuilder will dramatically reduce the time it takes to build the defensible groundwater model. Working with grid and mesh-independent data, you will quickly capture the essence of the groundwater flow system without being constrained by a particular grid/mesh size or type. Hydro GeoBuilder provides a full range of graphic tools and features for populating the three-dimensional grid and finite element mesh in an automatic process, allowing the user to focus on improving the interpretation of the subsurface environment.

Hydro GeoBuilder: Features & Benefits

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Hydro GeoBuilder. The ideal companion product for MODFLOW and FEFLOW

Data Import

- Seamless data validation and error checking during data import
- Convert raw data to project units during import
- Automated coordinate system conversion during import
- Import XYZ points with attributes: MS Excel™ (XLS), MS Access™ (MDB), Text (.TXT, .CSV), AutoCAD (.DXF), FEFLOW Triplet (.TRP)
- Polygons/Polylines: 2D/3D Shapefiles (.SHP), or CAD (.DXF)
- Cross-sections: Hydro GeoAnalyst 3D-Explorer file (.3XS)
- Surfaces: Surfer (.GRD), USGS (.DEM), or ESRI ASCII (.GRD, .ASC)
- 3D Gridded Data: TecPlot (.DAT) or MODFLOW Heads (.HDS)
- Wells (Vertical, Horizontal, or Deviated): Import well location, wellpath, screens, pumping rates, or geology from (.XLS), (.MDB), (.TXT), (.CSV)
- Raster Images: .JPG, .GIF, .TIF, .BMP, with georeferencing
- Time Schedules: MS Excel (.XLS)
- Create new point, polygon, or polyline objects and define in 2D

Coordinates and Units

- Flexible metric and imperial units for length, conductivity, flow rates, pumping rates, simulation time, and recharge
- Convenient unit conversion to MODFLOW/FEFLOW files formats
- Support for UTM and State Plane Projections (NAD 27/NAD 83), Gauss Krueger, Geographic, and Local (non-cartesian) coordinate systems

Data Display and Visual Settings

- Multiple 2D, 3D, and spreadsheet interactive windows
- Modify size, color, and style of points, polygons, and polylines
- Display attribute labels in 2D or 3D (e.g. well ID, feature names)
- Render points, polygons, and polylines by attribute in 2D or 3D
- Group objects in the explorer to help simplify data management
- Display 3D Gridded data with wireframe, as solids, or isosurfaces
- Modify transparency of surfaces and 3D volumes
- Display well screens and geologic contact points for borehole data
- Modify contour line interval, color ramps, and labels for surfaces

Data Operations

- Drape points, polygons, or polylines over a surface for 3D display
- Calculate well elevation from surface (e.g. .DEM)
- Convert cross-section interpretations to points for building surfaces
- Display raster images (site photos) draped over surface in 3D

Surfaces

- Interpolation using Natural Neighbor, Inverse Distance, or Kriging
- Define variograms for Kriging interpolation
- Modify resolution of the interpolation grid
- Calculate spatial interpolation extents from a polygon
- Combine multiple point data objects during interpolation

2D / 3D Displays

- Adjust layer order of objects in 2D
- Display X,Y,Z axis, adjust background color
- Pan and dynamic zoom, zoom with box, zoom full extents
- Zoom, pan, and rotate in 3D displays
- Render colorful, high-impact 3D views
- Efficiently generate dynamic three-dimensional cut-aways

Conceptual Model

Structure

- Horizons approach allows to define the layer hiearchy, for efficient generation of pinchouts and discontinuities
- Automatic generation of three-dimensional geologic zones
- Volume estimation for geologic formations

Properties

- Define property values for an entire geologic formation or utilize polygons (.SHP or .DXF) for the geometry
- Define geologic lenses using simple shapes and surfaces
- Display property zones in 3D with cut-aways and calculate volume
- Define conductivity, initial heads, and storativity using several options
  - -Constant value for the entire formation
  - -Surface: 2D property distribution
  - -3D Gridded data set from a block model or previous model
  - -Shapefile attribute: for accurate GIS representation

Boundary Conditions

- Use polygons/polylines (.SHP or .DXF) to define the geometry
- Generate boundaries for MODFLOW: River, Lake, General Head, Specified Head, Drain, Recharge, Evapotranspiration, Wells
- Graphical tools allow for simple assignment of boundaries to sides of model (e.g. specified flux or head)
- Assign parameters at points along lines for linear interpolation
- Define parameter values using several options
  - -Constant for entire geometry
  - -Transient values from time schedule file
  - -Surface: 2D distribution of recharge; river stage calculated from DEM
  - -3D Gridded data: Use heads from regional model for a localized model
  - -Shapefile attribute: for accurate GIS representation

Grid & Mesh Generation

- Generate multiple finite difference grids or finite element meshes
- Convenient 2D and 3D previews assist in grid refinement, positioning, and provide instant display of the grid/mesh
- Efficiently create multiple child grids for regional and localized simulations using MODFLOW-LGR (Local Grid Refinement)
- Enforcement of minimum layer thickness ensures compatibility with MODFLOW and FEFLOW
- Generate finite element meshes using Triangle
- Include wells, lines, and polygons as add-ins for the superelement mesh
- Refine mesh around point, well, and line add-ins
- Advanced vertical refinement options for entire layers
- Generate model layers that follow the geology or uniform layering independent of the geology

Translation to MODFLOW and FEFLOW

- Intuitive wizards simplify the creation of the input for MODFLOW-2000, 2005, LGR, and FEFLOW (ASCII .FEM v.5.4 or later)
- Seamless data validation and error checking during conversion with logging of errors or warnings
- Easily adjust simulation type (steady-state or transient), date/time
- Automatically define inactive cells for MODFLOW
- Property values in pinchout regions are automatically defined based on layer location and following the horizons hierarchy
- Advanced property upscaling accounts for Darcy's Law for accurate representation of vertical conductivity

Export

- Export geometry to Shapefiles (.SHP) and tabular data to .CSV
- Export high quality 2D/3D display to raster formats

October 2009 SWS-09-10-29-3