GEOScene3D

GEOSCENE3D and GEOCLOUD

- designed and built by geologists

Our products...

- The GeoScene3D software package
- Layerbuilder
- Voxelbuilder
- AEM—Smart Interpretation (SI)
- Hydro
- Multiple Point Statistics (MPS)
- GeoCloud
- Training

More information on...

- www.geoscene3d.com
- www.vimeo.com/geoscene3d
- www.linkedin.com/showcase/77923668

GEOScene3D

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About GeoScene3D

GeoScene3D is a 3D geological modelling package for visualizing geoscience data and building geological models for distribution to specialists and stakeholders.

The software is designed for geoscientists in both public and private organizations, working on engineering geology, groundwater, soil contamination or other tasks that involve compilation, interpretation or visualization of spatial data.

GeoScene3D simplifies integration of a wide range of geoscience data. Common applications often include water well descriptions, geophysical profile data, chemistry results, terrain surface models, imagery, and buried geological-surface grids. Tools are available for manual or semi-automated interpretation and correlation of point data, for the generation of geological-surface grids through advance interpolation techniques, and for export of surface grids for further processing in other software (e.g., FEFLOW, MODFLOW). GeoScene3D also allows geological models to be easily built using both community- and user-defined workflows.

GeoScene3D is the standard platform for geoscience data visualization and modeling in Denmark, and is being continuously developed in collaboration with the Geological Survey of Denmark (GEUS), the Danish Nature Agency, all major Danish geo-engineering companies and a number of international clients.

The versatile design and robust functionality of Geo-Scene3D has been guided by the range of problems our clients face and the commitment at I•GIS to provide tools for finding practical solutions.

Data types and formats

GeoScene3D support a variety of data types and provides sophisticated import wizards, making it easy to visualize your data.

Common data types in GeoScene3D:
- Digital terrain models
- Imagery and raster layers (e.g. tiff, jpeg, grd)
- Vector map layers (e.g. shp)
- Driller's logs
- TEM, Airborne TEM
- DC, ERT
- Geophysical wireline logs
- MRS
- Seismic data, SEGY
- Tabular data (e.g. database, CSV ...)
- Chemical data
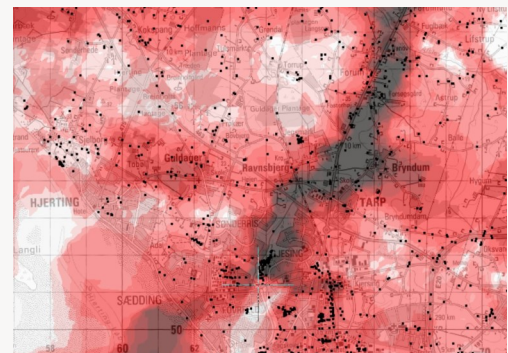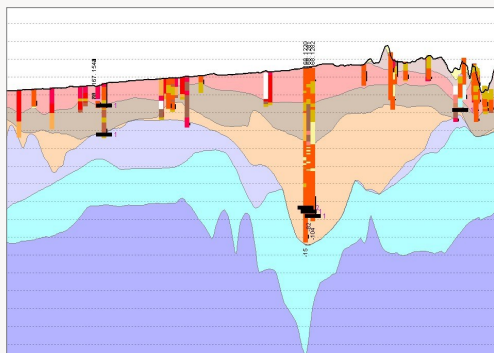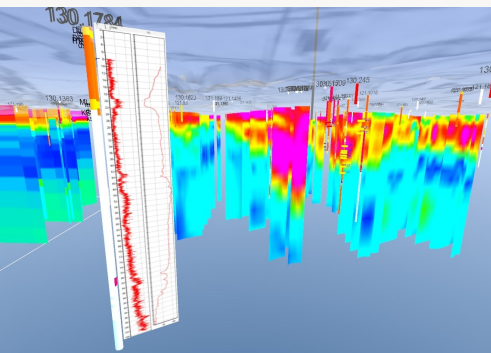
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User interface and Modeling Tools

The GeoScene3D interface is based on 3 fundamental views of model and data, all integrated and interlinked:

• Cross Sections

Cross sections are defined in maps and 3D, and can be handled dynamically. User-defined buffer zones can be added to data in cross sections.

• GIS Maps

Any number of GIS maps can be added to a GeoScene3D project. GeoScene3D accepts standard GIS data formats (shape, TAB...), WFS and WMS services.

• 3D Scenes

Any number of individual 3D camera views can be generated for any model.

• Editing

Tools are available for direct editing of surfaces, points, voxels, layer attributes, etc. in all views. Easy-to-use Wizards guide the user throughout the modelling process.

Export utilities are available for model elements and support several standard formats, including MODFLOW, FEFLOW, Surfer, CSV points, and more.

GeoScene3D Modules and Extensions

GeoScene3D is licensed as a series of modules and extensions. This enables the end user to tailor the software to their organizational requirements.

The various modules enable building of geologic models, while the extensions provide tools for specific application areas (e.g. tools for work with AEM data, or hydrogeologic calculations).

Description of modules and extensions

• Basic Module

Create new projects, visualize data and work with cross sections, maps and 3D.

• Layer Builder Module

Tools for constructing layer based models including interpolation tools.

• Voxel Builder Module

Tools for constructing voxel models.

• AEM Extension

Special tools for working with Airborne EM data, incl. Geo-Soft XYZ support and Smart Interpretation, enabling fast model building from AEM data.

• Hydro Extension

Tools for creating potentiometric maps (also aquifer specific), simple hydrological calculations as draw down based on Theis equation.
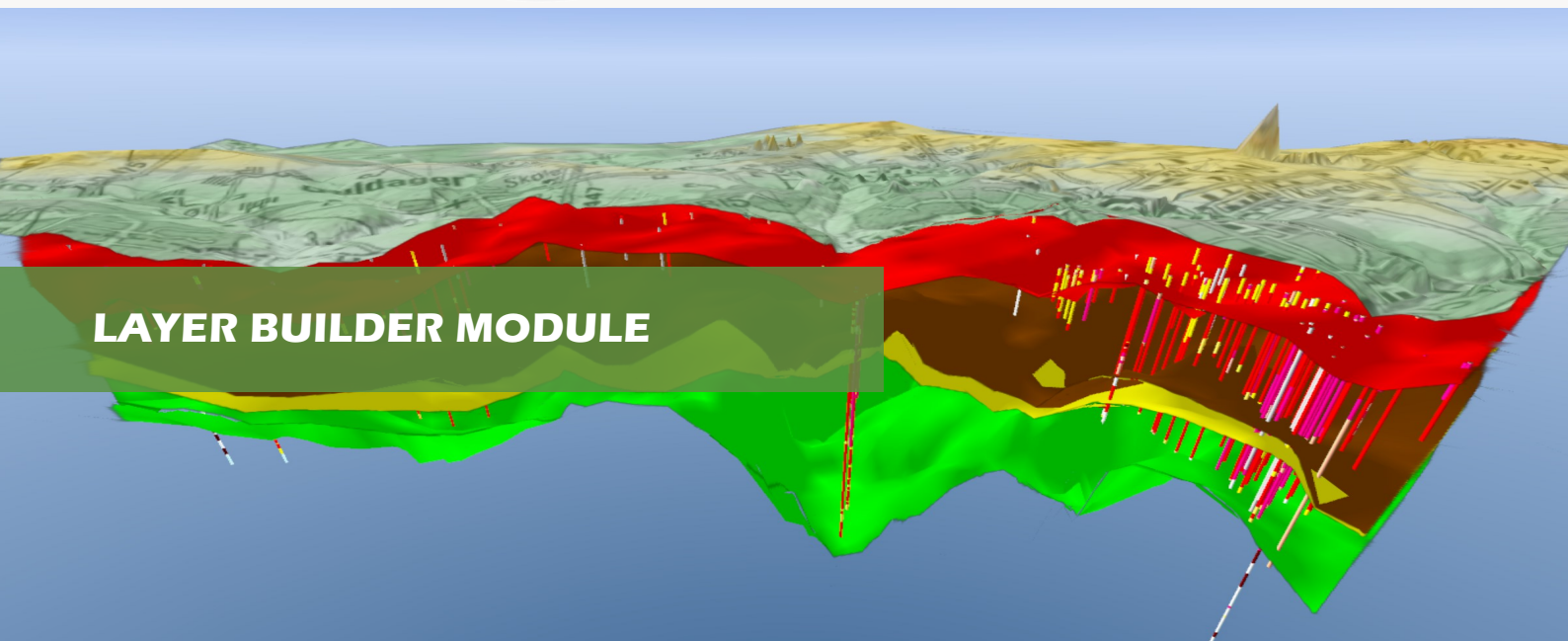
• Simulation Extension

Tools for simulation of voxel properties, including Multiple Point Statistics (MPS), creation of hard and soft data and handling of simulations.

vimeo

WANT TO KNOW MORE?

We are here to help you! Find our useful online tutorials and information about GeoScene3D on our homepage or on Vimeo: www.vimeo.com/geoscene3d
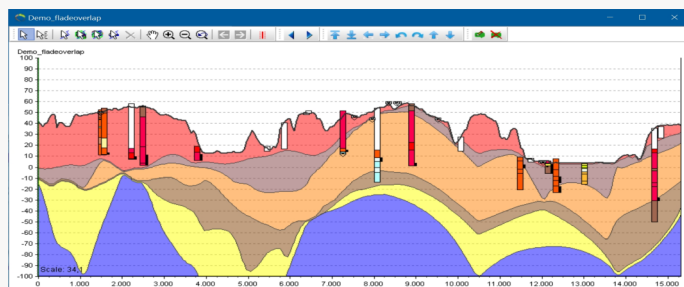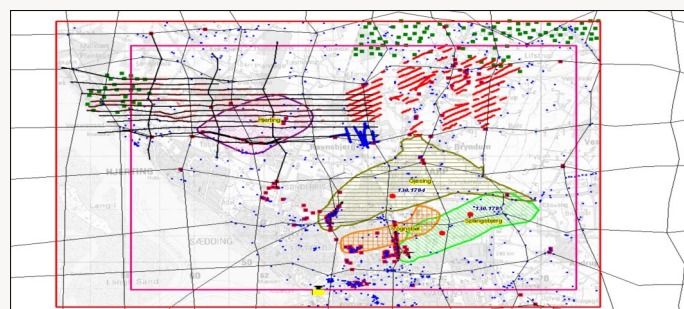
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LAYER BUILDER MODULE

Layer Builder— a GeoScene3D Module

Layer Builder is a specialized add-on module for building geologic layer-based models in GeoScene3D. The module is well suited for geoscientists working on regional scale geologic models, e.g. hydrogeological models, as well as local models, e.g. contaminated sites or detailed models in

Modeling Workflow

Layered models can be built in GeoScene3D using various workflows. One well-tested methodology entails importing all available data for the area into GeoScene3D. Based on a geological evaluation of the data and geological knowledge for the area, a series of Interpretation Points are defined — typically on cross sections. An interpolation algorithm is then selected and configured to create 2D surface grids from the Interpretation Points.


One Environment

GeoScene3D Layer Builder offers access to a Map View for multiple GIS layers, a Cross Section View, and a fully-interactive 3D view, all in one integrated and seamless environment.

Interpretation Points can be added directly in all three views, Cross Sections, GIS Maps, 3D View and the results can be inspected directly in all three views.

The Tool Box contains tools for adjusting interpolated surfaces, grid manipulations, and export utilities.

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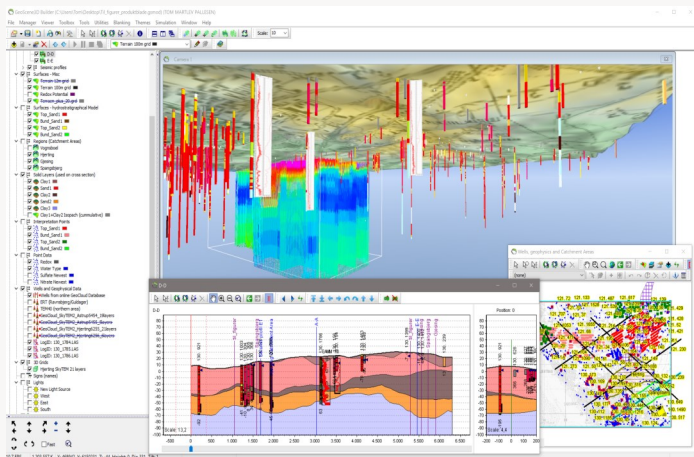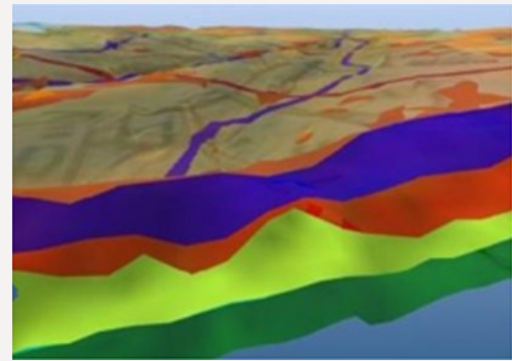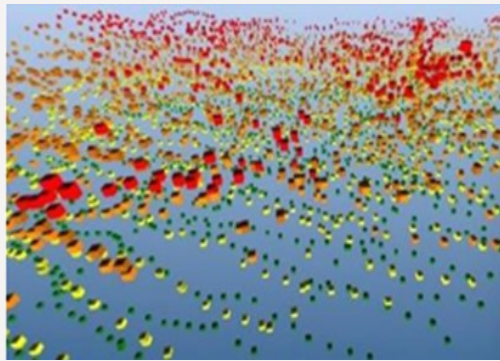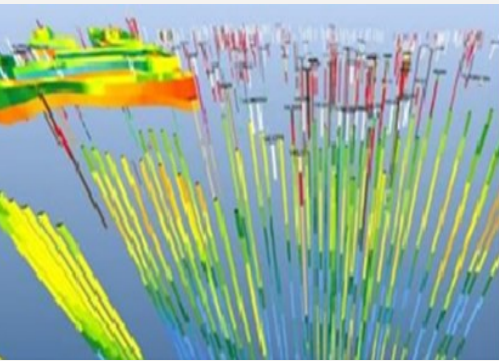
Modeling Tools and Data

A large number of data types can be visualized and used to build your layer model, e.g.

- **Borehole information** – Lithology, water table, screens, Gamma, CPT, etc.
- **Geophysical data** – 1D and 2D AEM, TEM, ERT, Geo Radar, Seismic
- **3D Grids** – based on geophysical data, chemistry and other data types
- **Vector based data** – pipelines, roads, buildings etc.
- **Exciting models** – surfaces as grids from older or nearby models
- **Point data** – groundwater chemistry and other point observations
- **Geological maps**

User-friendly tools are available for editing 2D points and 2D grids directly in all views, GIS Map, Cross Section and 3D. Data can be interpolated in 2D and 3D grids, volume calculations can be done based on 2D and 3D grids, surfaces can be adjusted and manipulated in the Tool Box as well.

Exporting Modeling Results

Interpretation points are stored in standard MS Access database format while the generated 2D grid surfaces are stored in Surfer binary, both easily accessible for use in other software, e.g. QGIS, MODFLOW and FEFLOW. Data export is facilitated by the Export Data Wizard, where a number of export formats can be selected.

Interpolation and Geostatistics

Interpolation is implemented in the Layer Builder using a series of wizards. Kriging is available using the GSLIB geostatistical code, while Inverse Distance Weighting and Nearest Neighbor are implemented using standard algorithms. Tools for modeling semi variograms and generation of uncertainty estimates for kriged surface models are also available through the wizard. Interpolation has been implemented in GeoScene3D so it can be done on the fly within any workflow.
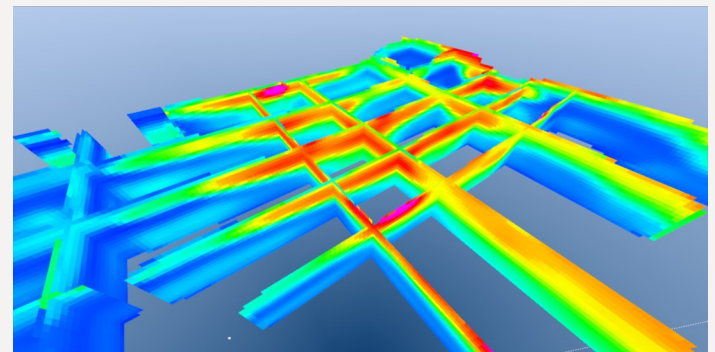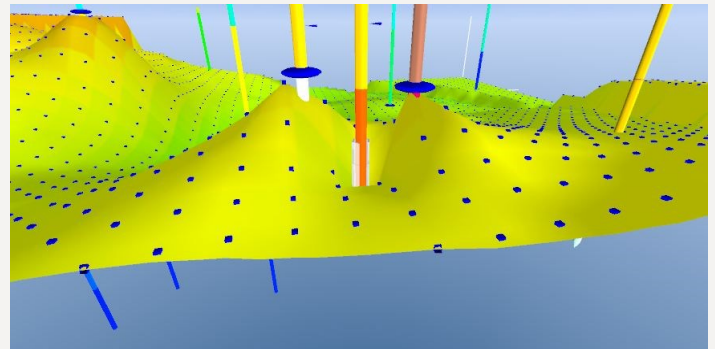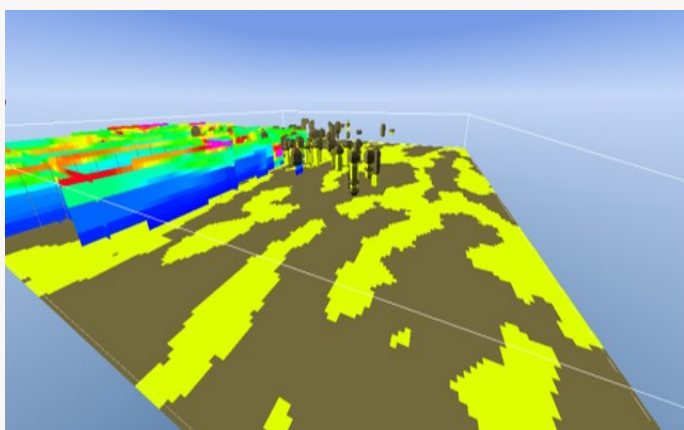
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SIMULATION EXTENSION

Voxel-based Multiple Point Statistics (MPS)

## A New Implementation of MPS

In this Simulation Extension, GeoScene3D utilizes and extends a new implementation of MPS algorithms developed in cooperation I•GIS and researchers at the Niels-Bohr Institute, University of Copenhagen and the Danish Geological Survey (GEUS), as part of the Danish geological modeling research project, ERGO.

The Simulation Extension adds extra functionality to the Voxel Builder Module in GeoScene3D, giving access to Multiple Point Statistics for property simulation i voxel models. These tools provide you with the functionality for working with the latest advancements in geological modeling, all wrapped up in a sequence of user friendly software Wizards, guiding you through the modeling workflow.

Multiple Point Statistics

MPS provides a statistical approach to modeling the geological heterogeneity observed within rock type variations. It is an alternative to Gaussian-based geostatistics with semi-variograms, and instead relies on geological knowledge captured in user-defined Training Images (TIs). TIs help quantify expert knowledge about the shape, proportion and transitions between various geological features. The TI is used together with geophysical and borehole information to model a suite of geologically-realistic rock-type models. The GeoScene3D Simulation Extension implementation of MPS both allows modeling of rock-type heterogeneities and characterization of geological uncertainty within these distributions.
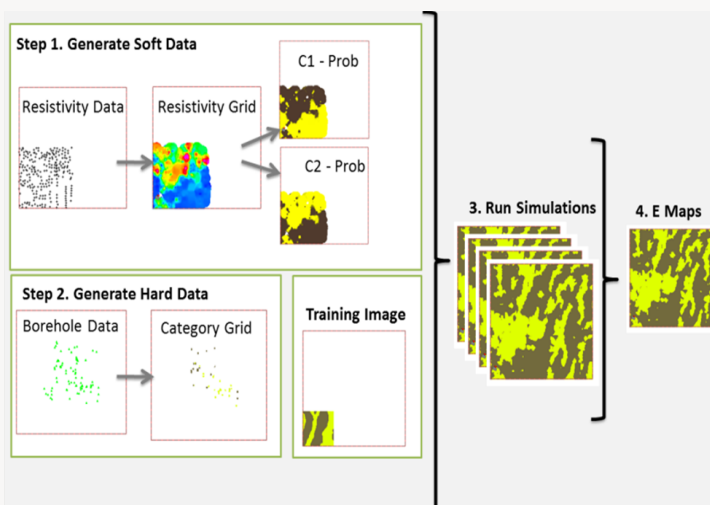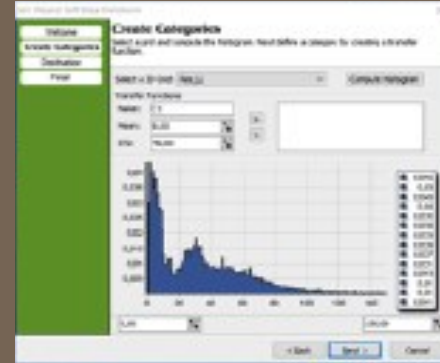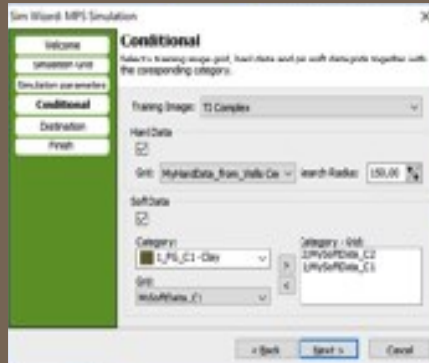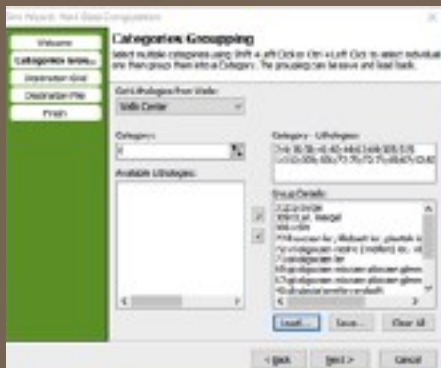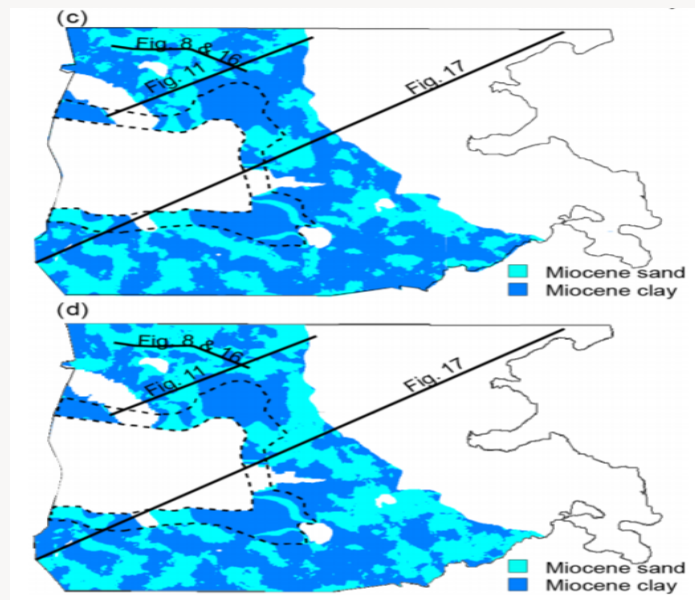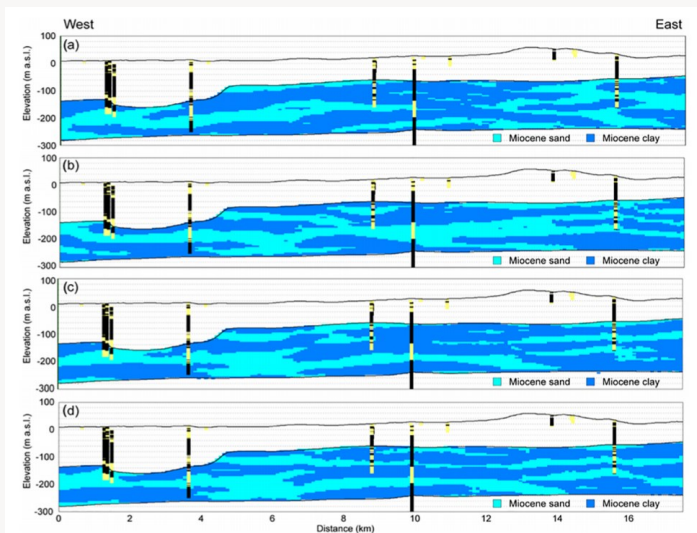
One seamless workflow

The Simulation Extension provides tools for transforming observed data, e.g., geophysical resistivity data or well data, into soft and hard data (which reflect variable data quality) and integrate these into the MPS algorithm.

GeoScene3D fully enables these voxel-based MPS results into the software's integrated environment, allowing visualization in interactive 3D, Cross Sections and GIS Map Views, and provides additional analytical tools that can be applied to the simulation results (e.g., E-Type Maps).
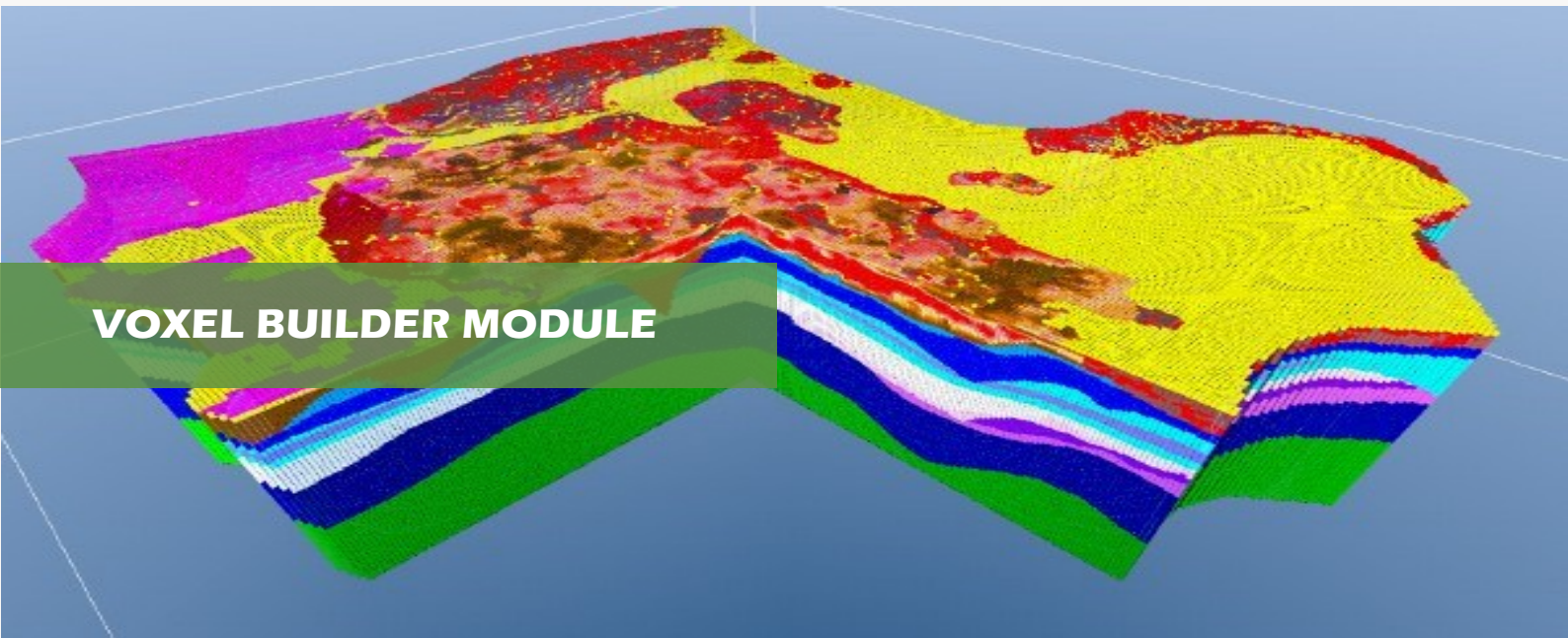

A wizard based workflow

As part of the seamless integration of the MPS tools into GeoScene3D Software, a set of easy-to-use wizards are available to guide the user through the MPS workflow.

Wizards support the user within the MPS modeling workflow, ensuring faster and more reliable results.

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VOXEL BUILDER MODULE

Voxel Builder — a GeoScene3D Module

The Voxel Builder is a specialized add-on module for building voxel models in GeoScene3D. The module is well suited for tasks involving compilation and interpretation or visualization of a variety of data types, and when there is a need for high resolution geological models.

Task examples for the Voxel Builder Module

Geologic models supporting applications in:

- Smart-city development
- Engineering geology
- Groundwater
- Soil contamination
- Surface near water flow in the field of WSUD
- Future climatic assessments

Voxel Builder contains several tools developed to assist the geologist in the modeling process.

Tools have been added to simplify inclusion of infrastructure features into geologic models (e.g., pipelines, roads, buildings). These tools allow easy integration of Geo-Scene3D voxel models into detailed smart-city applications.

3D voxel grids and sizes

Voxel models in GeoScene3D are based on regular 3D grids where each grid cell defines a voxel. Voxels can be assigned to represent different parameters (e.g., lithology, age, transmissivity, porosity), and can be used with models of any resolution. GeoScene3D allows the user to group voxels by value or spatial location, and to customize the model volume and cell size to their application needs.
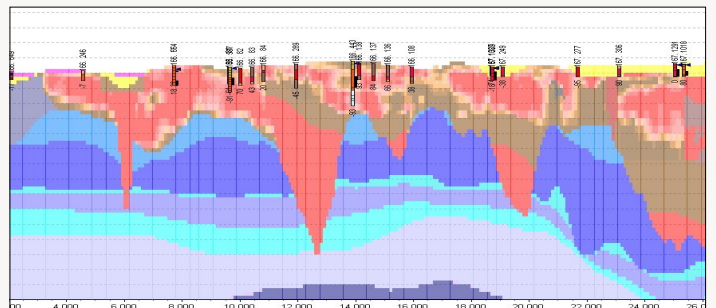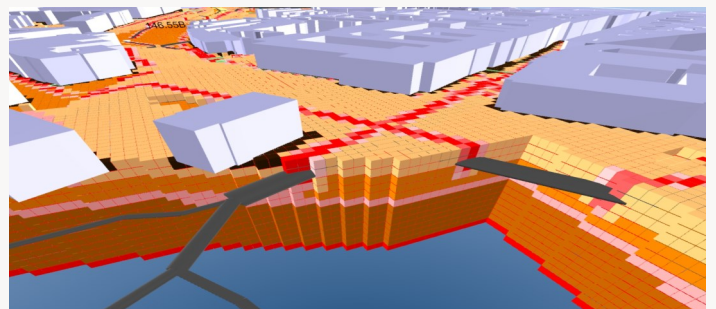
Modeling tools and data

A large number of data types can be visualized and used to select and fill out voxels, including:

- Borehole information
- Geophysical data
- Layer boundaries
- XYZ point information
- 3D grids
- Vector based data (e.g., water pipes, roadbeds and basements)
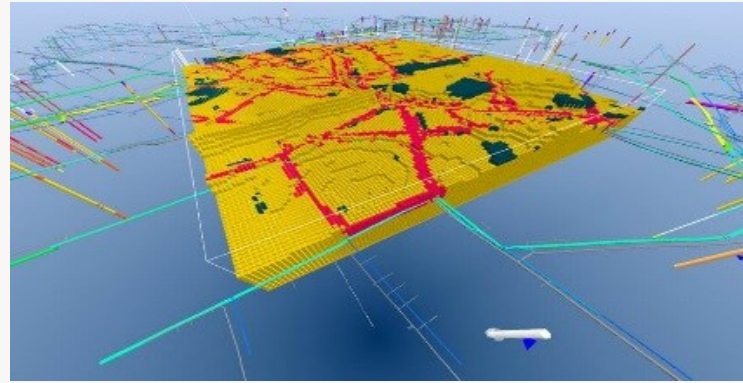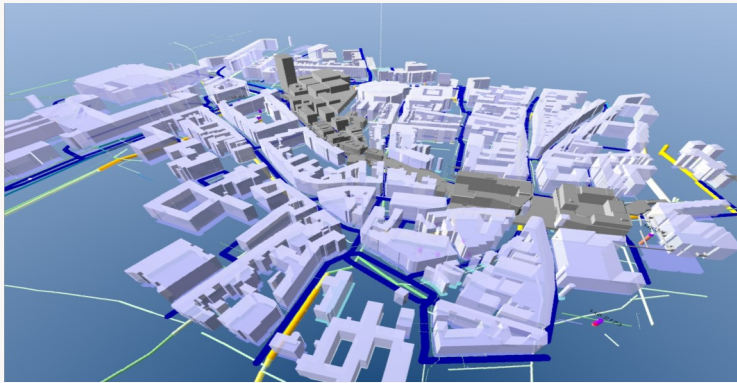
Modeling Tools and Data

GeoScene3D simplifies model setup and data import/export are by providing wizards to help the user. The Voxel Builder interface is simple, intuitive and fully integrated with the basic GeoScene3D user interface design.

Profile Polygon Tool

The Polygon Profile Tool can be used to manually select and relabel voxels using the Cross Section View. This tool is particularly useful when interpreting borehole data (e.g., geophysical wireline logs).
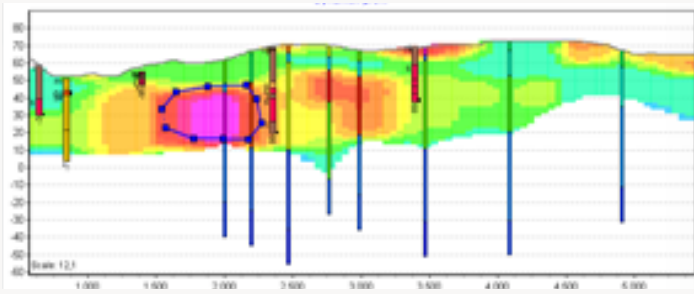
In this example the polygon (dark-blue line with dots) is used to select voxels based on geophysical resistivity (AEM).
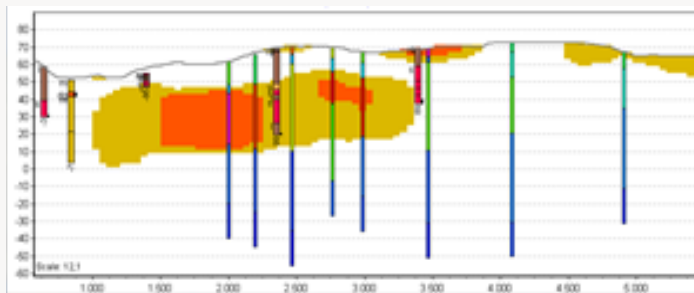

Voxel selected in the figure above assigned lithology.

Map Polygon Tool

The Map Polygon Tool is used to manually draw a polygon within a GIS Map View window. In GeoScene3D, these types of polygons can be used for various reasons, including voxel relabeling and voxel grouping.

Layer models to voxel models

GeoScene3D layer models, created with the Layer Builder Module, can be converted to voxel models within the Voxel Builder Module. Layers and polygons (from either Cross Section or GIS Map Views) can be used as limits during assignment of voxel values. The two cross sections, below, show steps in converting a layer model to a voxel model.
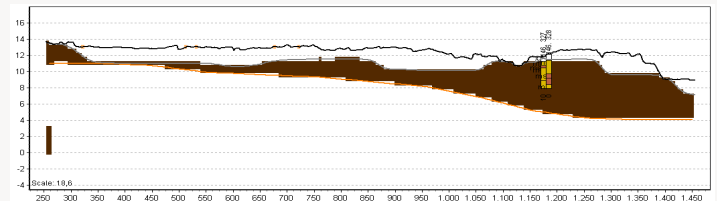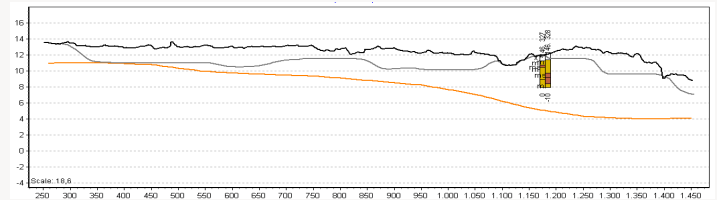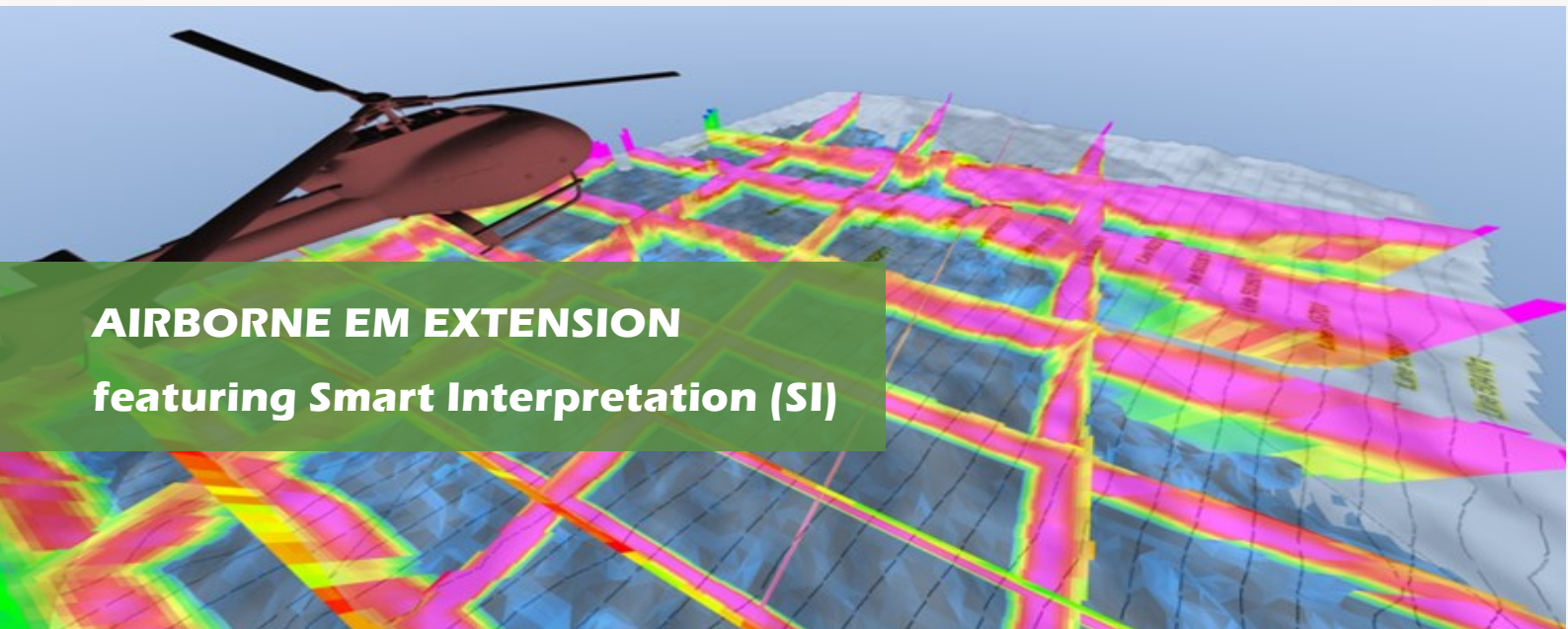

Vector Theme Tool

Shape files can be imported and used as the basis for selecting and assigning voxel values within a voxel model. Feature attributes like pipeline diameter or construction year can be used for either voxel assignment or enhanced visualization.

AIRBORNE EM EXTENSION

featuring *Smart Interpretation (SI)*

Airborne Electromagnetics (AEM)

The Airborne Electromagnetics (AEM) Extension works directly with the Layer Builder Module in GeoScene3D. This extension provides access to additional import capabilities for data formats commonly used in AEM surveys. The AEM Extension also introduces the new, *Smart Interpretation* tool, a user-assisted process for rapid interpretation of large AEM datasets. The Smart Interpretation tool will save you many hours of interpretation when modeling areas with large AEM surveys.

AEM data and GeoScene3D

GeoScene3D and AEM data go hand in hand. The software was developed at a when regional AEM surveys were being conducted across Denmark as part of a nation-wide groundwater mapping initiative.   This connection means that AEM data are naturally integrated with the GeoScene3D geological modelling workflow. Tools and capabilities are in place to combine information from AEM data with other data and knowledge into your final geological model.
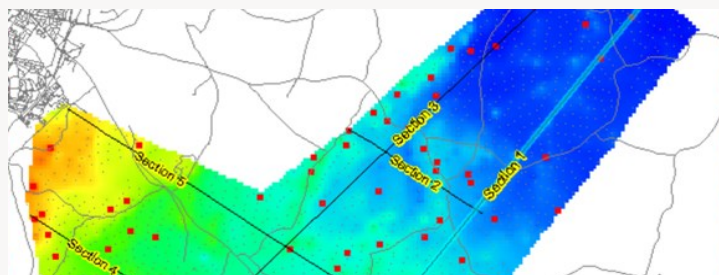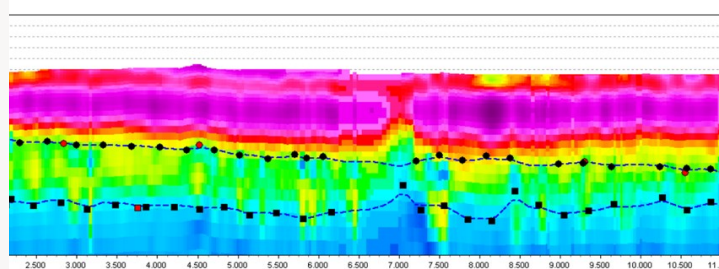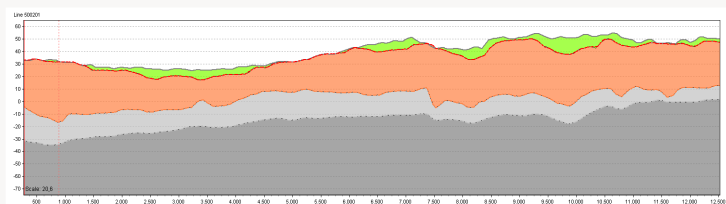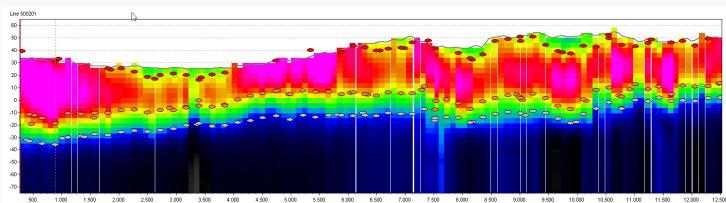

## What is Smart Interpretation—and why use it?

Smart Interpretation is a user-directed tool for rapid interpretation of AEM data, that is fast, easy to use, and enables you to utilize all your available data, saving valuable time when building geological models.

With inspiration from the Oil & Gas industry's use of Seismic Auto-pickers as a well proven methodology to overcome these obstacles, we have developed *Smart Interpretation* to offer our customers a **practical and usable** tool for assisting the geologist in the normal modelling workflow. Smart Interpretation is a methodology developed together with the Niels Bohr institute at the University of Copenhagen.
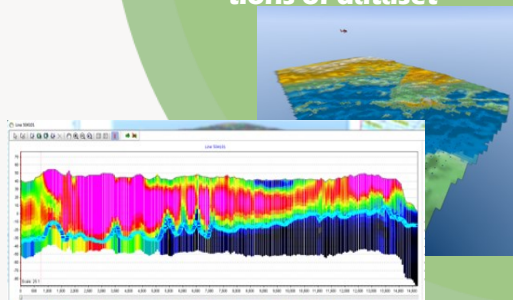
SMART INTERPRETATION — the work flow
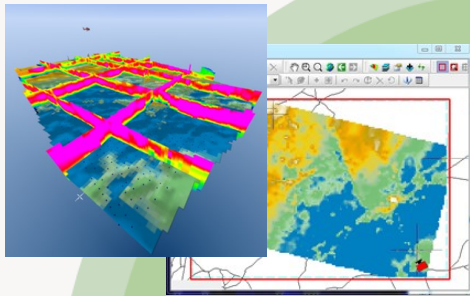
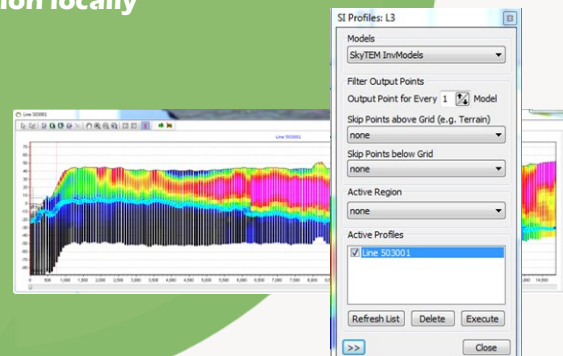**4: Inspect, evaluate and adjust results as needed**
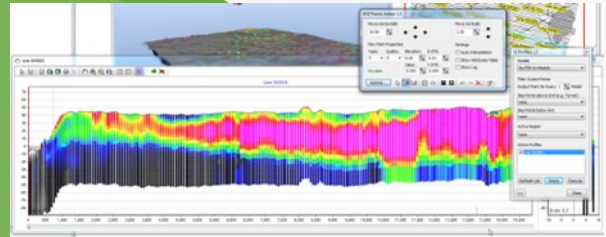
1: Add a few manual interpretation points

3: Apply local interpretations to untested portions of dataset

2: Run Smart Interpretation locally

## Smart Interpretation—the workflow

Smart Interpretation has been designed to integrate seamlessly with the standard GeoScene3D workflows. By training the system on portions of AEM datasets, the tool learns how the geologist combines and interprets all of their data. As the figure shows, the geologist uses Smart Interpretation to iterate through their data, assigning some interpretations to individual soundings, applying learned patterns to larger, untested areas, evaluating these new areas for accuracy, manually correcting errors, and adding in new areas.

This tool takes advantage of both the consistency of AEM interpretations and larger-scale changes in geologic patterns, to rapidly move through large AEM datasets while integrating geologic knowledge as known patterns change. Wizards are provided to guide the user through the Smart Interpretation process, making this workflow easy and intuitive. Interpolation and grid adjustments are also available through the integrated GeoScene3D environment to ensure a smooth and efficient modelling experience.
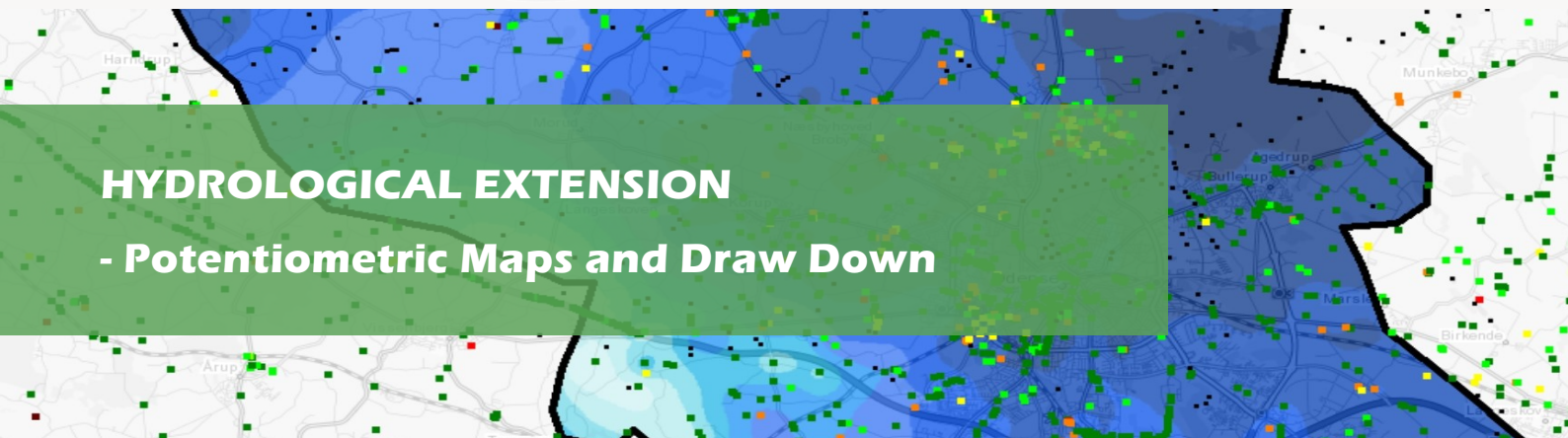
HYDROLOGICAL EXTENSION

- Potentiometric Maps and Draw Down

Hydrological Extension

The Hydrological Extension provides a set of tools for conducting common analyses related to understanding water levels in aquifers and wells. The extension provides capabilities for conducting efficient hydrologic analyses like creation of potentiometric surface maps and conducting drawdown analyses. In addition, tools from the toolbox can be integrated with this extension to increase utility.

Potentiometric Maps

Potentiometric maps can be created with the Hydrologic Extension. The tools ensure a smooth workflow through the entire process, from extracting water levels from your database to interpolation and saving as a grid file.

The maps can be made from layered geologic models, creating aquifer-specific potentiometric maps, or based on specific depths (e.g., screen depths from boreholes), and can be visualized in any of the 3D, GIS Map and Cross Section View windows.

Extraction of water levels

Wizards guides the user through the process of data selection. Selections can be based on
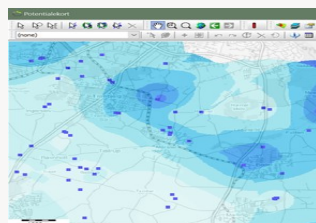
- Boreholes with screens.
- Boreholes without screens.
- Physical limits defined as regions or layers.
- Time and/or seasonal variations.
- Output can be calculated has mean, maximum, minimum, latest, oldest measurements in the chosen period.
- Standard deviations ("uncertainty") can be calculated.
- Chosen setup is stored in xml file for future updates.
- Water levels are stored in an MS Access Database.

Interpolation

Data can be interpolated in GeoScene3D and creates a grid file for further use. User-defined and calculated standard deviations can be used in the interpolation (when using Kriging) and shows up on cross sections.
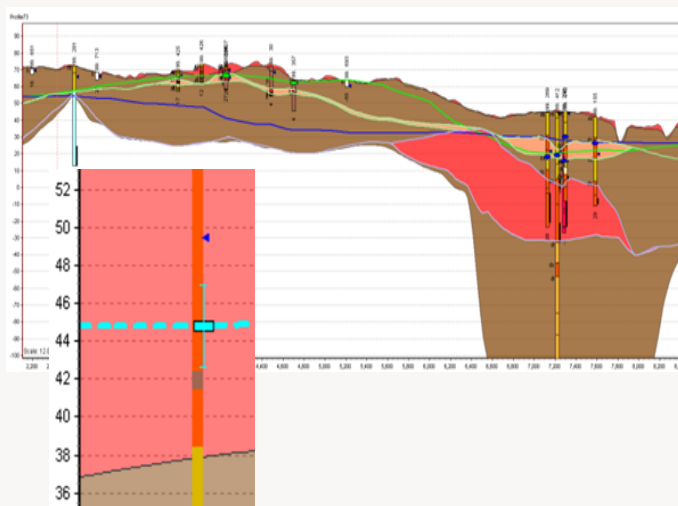
## Water levels based on other observations

Points based on observations other than water level measurements from boreholes can be added to the database manually. Using a combination of terrain information and map layers that identify surface water body locations, points can be digitized and attributed directly into the database to represent the elevations of these features.

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Drawdown Analysis

Using the Hydrologic Extension, drawdown analyses can be easily conducted from well data based on the Theis Equation. This provides an estimate of drawdown over time and under specific conditions.
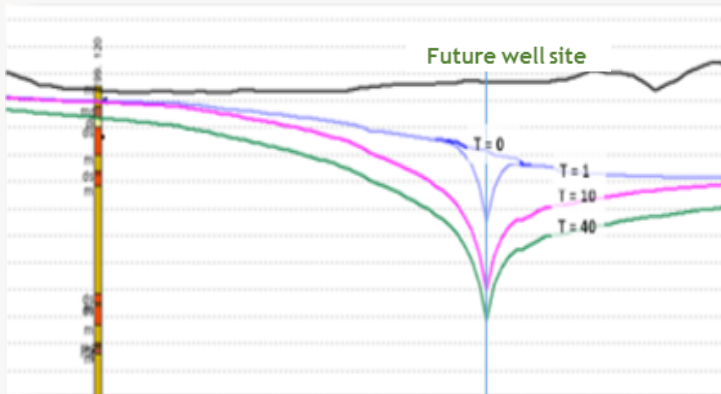
Drawdown calculations at different times after pumping start

Visualization and output

Calculated water levels are automatically added as grid files into GeoScene3D's Map Window and 3D environment.

Drawdown maps (difference between before and after situation) are added to the Map Window and show the actual calculated drawdown.

Color scales can be defined individually.

Settings (used hydrological parameters) and file names are written as remarks to the individual grid-files.
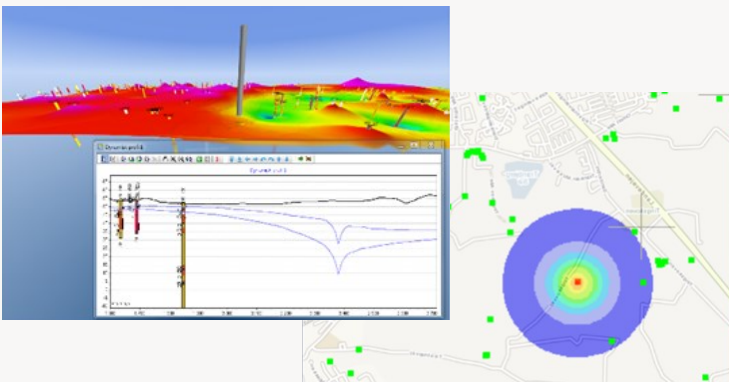

Drawdown Calculation Parameter Options

- Homogenous, isotopic, nonleaky confined aquifer
- Uniform thickness and infinite areal extent of aquifer
- Flow to pumping well is horizontal when pumping well is fully penetrating
- Water table is horizontal
- Control well is fully or partially penetrating
- Water is released instantaneously from storage with decline of hydraulic head

User Interface and Workflow

The user interface and workflow in GeoScene3D is simple (see figure below):

1. Add a water table

2. Define pump/well position (simplified by just on the desired position in a Map Window

3. Insert desired hydraulic– and pump parameters
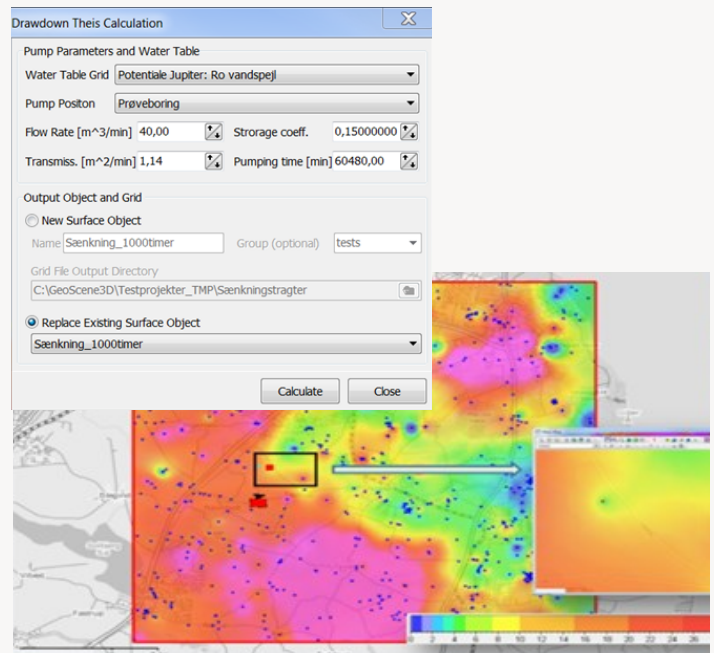
Data export

The calculated grids can be exported in several file formats (*.asc, *.grd, *.csv, *.txt etc.), for import in other programs. An Export Wizard assists the user in the process.

GEO Cloud

Get the most out of your Geological Data

GeoCloud - A WEB based data management system with a web viewer and integration into Geo-Scene3D and GIS programs

Quick overview and fast access to your geoscience data and geological models provides the basis for good data management. GeoCloud provides this - With GeoCloud the geo-data management task has become much easier. GeoCloud store your geological models and their related data. These can be made available to your colleagues, stakeholders, decision makers, external business partners, or the public. The data and models stored on GeoCloud can be accessed through several online services:

- Directly in the web-browser
- Through Web Map Service (WMS)
- Directly in GeoScene3D

Data access

The administrator(s) can give access to their portal to anyone relevant. This ensuring easy access and sharing of your models, data, and results to the relevant partners and stakeholders.

Data on the GeoCloud can be marked as published, unpublished and hidden below a administrator defined depth as well. This allows for data access at different user levels.

Depending on access level, data can be uploaded, downloaded or restricted to visualization only.

Data visualization

The GeoCloud website allows for visualization of data in multiple ways:

- GIS Map
- 2D Profiles
- 3D viewer

All data and models uploaded to the GeoCloud can be visualized as WMS in the GIS map. You can upload your own profiles (cross sections) or digitizes directly on the map.

The 3D-window is opened in the browser, and provides visualization, navigation, and measurement tools – in a 3D environment.
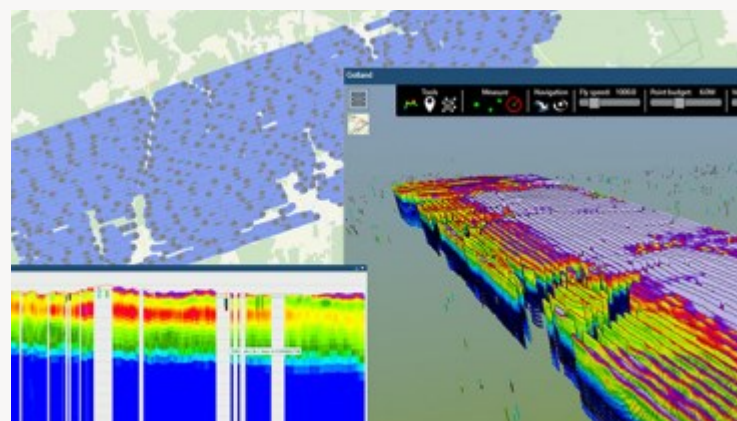
Get the most out of your Geological Data

GeoCloud - Data access through WMS

In addition to accessing data directly in the web browser, data can also be accessed through a web map service (WMS). Just copy the link to the dataset's URL and access the data in any other software solutions or services supporting WMS.

Access through GeoScene3D

GeoCloud is also closely connected to GeoScene3D - All data stored in GeoCloud can be seamlessly accessed in GeoScene3D. Through a self-explained wizard, you log in to the GeoCloud portal and download any data type or model available.

When combining GeoCloud and GeoScene3D. You find yourself equipped with the tools and services needed to become a GeoSmart organization.

A Geosmart setup will enable your organization to

- Manage, store, and use your data
- Avoid data to be forgotten
- Easily integrate new data
- No need to convert data formats
- Collaborate on models and data from different locations
- Share data, models, and results • Free-up time for other tasks

**3D view with a surface, wells and TEM soundings**
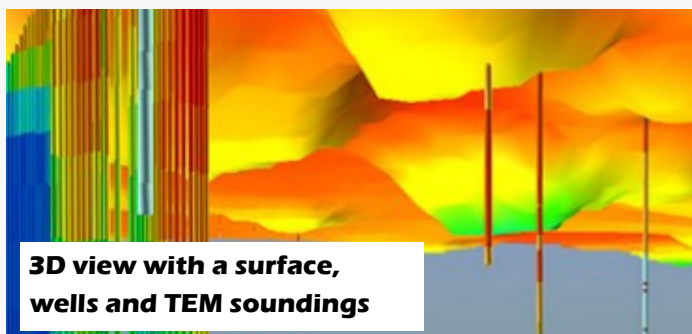
Future developments

The GeoCloud is continuously being developed and adjusted to customer specific needs.

If your organization has special requirements or need for extra functionality, our team of GeoCloud developers are ready to look at that.

For more information on GeoCloud and the possibilities it provides for your organization, please contact our consultants at support@geoscene3d.com.

Please visit geoscene3D.com/GeoCloud or contact our consultants at support@geoscene3d.com for a demonstration of the GeoCloud and a free access to our demo portal.
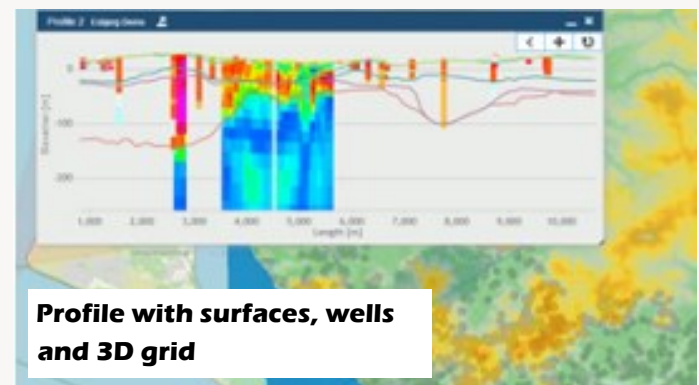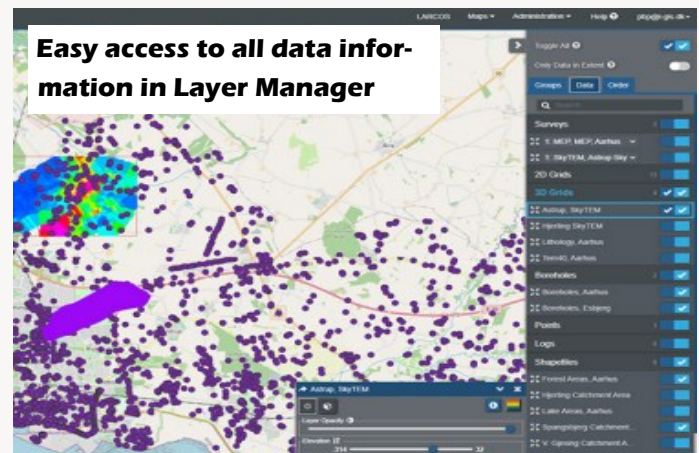
Easy access to all data information in Layer Manager

**Profile with surfaces, wells and 3D grid**

WANT TO KNOW MORE?

We are here to help you! Find our useful online tutorials and information about GeoScene3D on our homepage or on Vimeo: www.vimeo.com/geoscene3d

info@geoscene3d.com • (+45) 87 31 00 80 • www.geoscene3D.com

GEOScene3D a product from I•GIS

GEOSCENE3D MODULES AND EXTENSIONS

To meet the varying needs of our users, GeoScene3D is offered as a series of modules and extensions. This enables the end user to tailor the software to meet their organizational requirements. All modules and extensions are updated frequently.
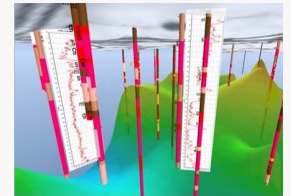
Packages

GeoScene3D Free Viewer
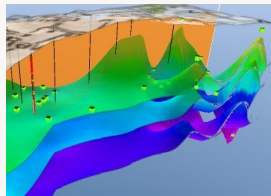
- Free inspector of GeoScene3D projects in full 3D
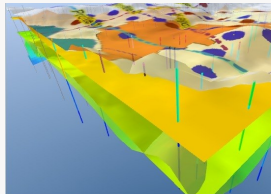- Open cross sections
- Navigation in 3D

GeoScene3D Basic

- Entry level of GeoScene3D
- Create new 3D visualization projects
- Import and visualize geological data
- Create and work with animations and visualizations of data in maps, profiles and 3D
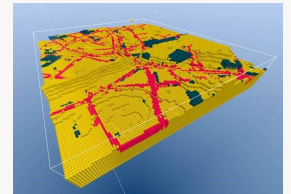
Add on modules

Layer Builder

- Build layer based geological models
- Interpolate layers in 2D and 3D from geological data
- Volume calculations
- A number of helpful guiding wizards

Voxel Builder

- Build voxel models with 2D and 3D interpolation
- Layer to voxel conversion
- 3D grid to voxel grid
- Urban infrastructure tools

Special package — extension

Airborne EM Extension

- Import of GeoSoft date (AEM, Wells, Logs, Points)
- Auto generation of cross sections along flight lines
- Smart interpretation, semi-auto picking of AEM inverted data

Hydrological Extension

- Calculate drawdown based on Theis equation
- Add fictitious calculation points
- Create water level grids based on calculations

Simulation Extension

- Voxel value simulation based on sequential Gaussian statistics
- Voxel value simulation based on Multiple Point statistics
- Tools for creating soft conditional data from AEM 3D voxels

Our GeoScene3D Team consists of software developers, geologists and geophysicists. All licensed GeoScene3D versions

GEOSCENE3D TRAINING

We offer a wide range of onsite and online training based on your needs

Online Training

Our online training is a series of 2-4 live training sessions, together with an at-home assignment, and are designed around your specific needs.

Our standard online course is scheduled as:
- Session 1: Basic GeoScene3D
- Session 2: Modeling in GeoScene3D

Home assignment working on geological modeling in Geo-Scene3D:

- Session 3: Review of homework, learning points
- Session 4: Optional! Free for your special interests

Customized Courses

Training can be customized to fit your exact needs, ranging from one-to-one to group lessons, and we can either use our training data or we can integrate your data into all our exercises.

Customized courses are targeted to your specific work content. We deliver customized courses and consultancy services worldwide, within the topical areas of GeoScene3D, geological modeling, and geological data management.
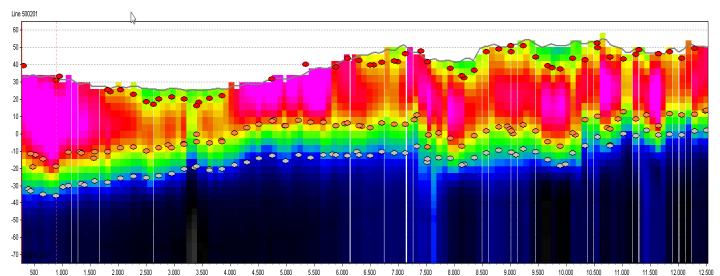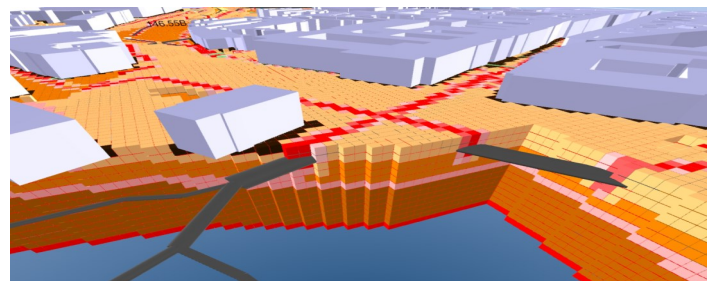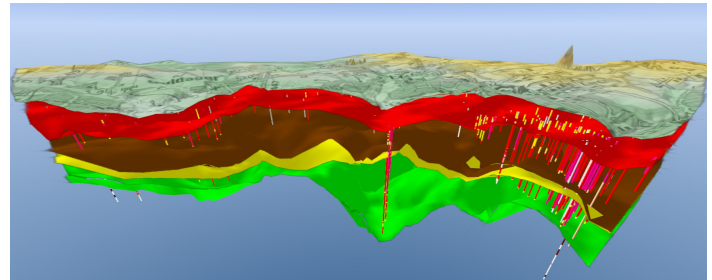
The courses can be planned around your data and case studies, giving you experience and results that are directly applicable to daily work in your organization. Our consultants have extensive experience in working with both small- and large-scale organizations.

GEOScene3D

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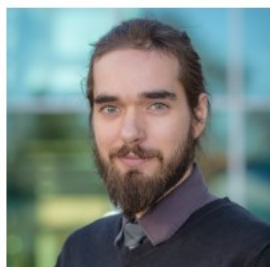
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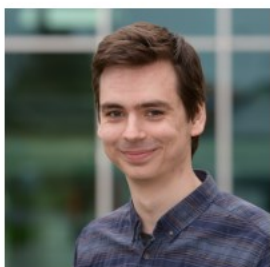Mobile: +45 31 26 84 23

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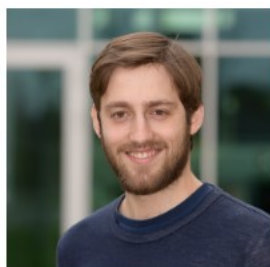
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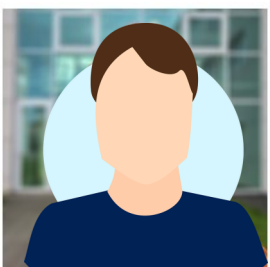
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