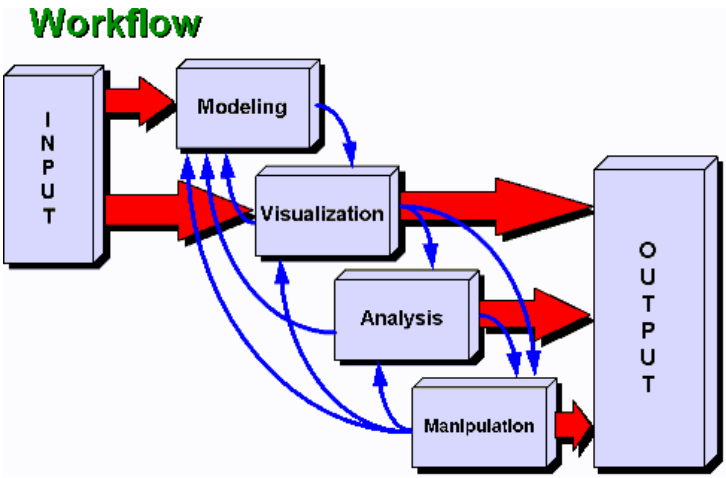
Voxel Training Class September 18-19, 1995

Introduction

This class will take us through most of the product and will allow you to become familiar with many functions in Voxel Analyst. This combined with the workflows that will be delivered with the product will should give you enough training to do any benchmark. (Getting Started Manual) Our current customer base has gotten up and running in 1.5 days. Remember Voxel Analyst has no software pre-requisites other than Windows NT 3.51 (Yes, it will be available on Windows 95) and few hardware pre-requisites. All data input files are ASCII so it can be integrated with any environment, be it MGE and MicroStation or Arc/Info and AutoCad.

The first thing to talk about is the product itself and how it is structured. The workflow diagram below is a good way to start and explains the importance of having more than just a visualization tool.



Voxel Analyst allows the scientist to visualize, analyze and manipulate volume data. This is a unique aspect of Voxel Analyst. Most of what people consider competing products are just visualization tools.

As the workflow suggests you can take input data which consists of generic ASCII files of 2.5D grids (x,y,z data) or sparsely sampled data like those from boreholes and create 3D mesh similar to a rubik's cube. This data can be modeled and visualized and remodel followed by data analysis. This may result in the decision to remodel again or visualize the data. Finally you can actually manipulate the modeled data in other words actually digitize/interpret the modeled data. This allows the scientist to manipulate the modeled results to best fit his/her understanding of the data. This becomes very important when trying to communicate the scientist's interpretation of the data to his/her peers. The real point of this diagram is to communicate the fact that Voxel Analyst is a product that allows users to not just visualize data but work and interact with the data in an iterative fashion.

This demonstration can be done stand-alone or can be continued from the ERMA chemplant demo. The demo dataset is from chemplant data set. For those of you not familiar with the chemplant data set the introduction that is written with the ERMA demo script can be used and goes as follows:

Site Background Information

First, I would like to give you some background about the site and what was manufactured here. The site is an inactive chemical plant that produced paints and pesticides from 1952 to 1982. The primary emphasis at this site is the cleanup of soils and the alleviation of the threat of contamination to ground and surface water resources in the area. The secondary problem at the site is the retrieval of all the barrels containing waste products, cleanup of the disposal areas, and the building of the containment vault on the site for hazardous waste storage. Discovery of the problem was initiated in 1979 by a resident of the subdivision south of the site. This subdivision **had** private drinking water wells and one of the local residents was taking a shower and passed out from chloroform gas coming from his shower head. He contacted the Michigan Dept. of Natural resources and so the story begins.....

We will continue where the chemplant demo ends by using the ModFlow .adf file. For those of you starting from scratch we will start by looking at the data that is input into Voxel Analyst for site analysis.

Files that we will be using for the class:

chem3d3.dgn	Design file
01surfac.grd	Surface grid file
02water.grd	Groundwater grid file
03bottom.grd	Clay layer grid file (Interpretation from ERMASG of the bottom of the water table.)
	Samples3.smp ASCII sample file of the contaminants in the subsurface
chemplnt.hdf	Resulting model from interpolation
topbotto.hdf	File used to show how volume is broken into voxels
chemplnt.ctr	Color file used in demonstration (Note: One color file has multiple color tables)

Special Instructions on loading Voxel on your machine:

- Click on setup.exe
- When you get to the change directory form choose your disk and change the path to exclude the word Analyst. The path should look like: C: \win32app\ingr\Voxel
- The product will load and create the icons that you need.

This exercise builds a demo session (.gva) for you, most of the time you will bring up this .gva file and it will load all the information that you need so all you have to do is turn levels on and off and continue with the Analyze and Manipulation portions of the demo. After you have gone through this demo save this as a session (.gva). A .gva file is an ASCII file that can be edited (specifically path names) so you can move it from one machine to another.

Bold text: **What you say and commands**
Bold Italics: ***Files and key-ins***
Normal text: General information and directions

Start of Demonstration

- **Double Click on the Voxel Icon**

  - Utilities

    Working Units

    Load from file (wherever demo dataset resides)
    \users\learning\chemplant\chem3d3.dgn
    This has to be done first to set up the working units before you load the data sets. This allows you to georeference the volumes that you will be building to maps. This file can be an AutoCad file or a MicroStation file. If you do not have a graphics file you can manually set this up.

1  *=30*

Because the x,y domain is usually a lot larger than the z-domain we will exaggerate the z so we can properly visualize the model. This is only a display change and will not affect an volume calculations that are done later.

2 File

Open

Dataset ***chemplnt.hdf*** **and** ***topbotto.hdf*** **(**hold Cntrl to pick multiple files)

This loads the model**s** that may have been created externally or within Voxel into memory. We will be using this model to d**isplay the contaminant data,** the **geological** and hydrogeological interpretations.

2.1 Open

Color File ***chemplnt.ctr***

This will load into memory the color file associated with this data set.

2.2 **Import**

Source Points

Dataset *samples*

Add File *samples3.smp* (This is an ASCII file)

We have now loaded up all the data that we will need to do the demo and we will be starting from scratch. If we have time we will review some of the modeling**/interpolation** aspect**s** of **the product.**

Design Elements

Input file name chem3d3.dgn

This file could be an AutoCad or MicroStation file. This will load the **Ustn file into Voxel Analyst so we can georeference our map to our volume.**

3 From Pull down Tool bar list make sure chemplant is the active dataset (You can now change dataset from the tool bar pull down)

4  **Outline**

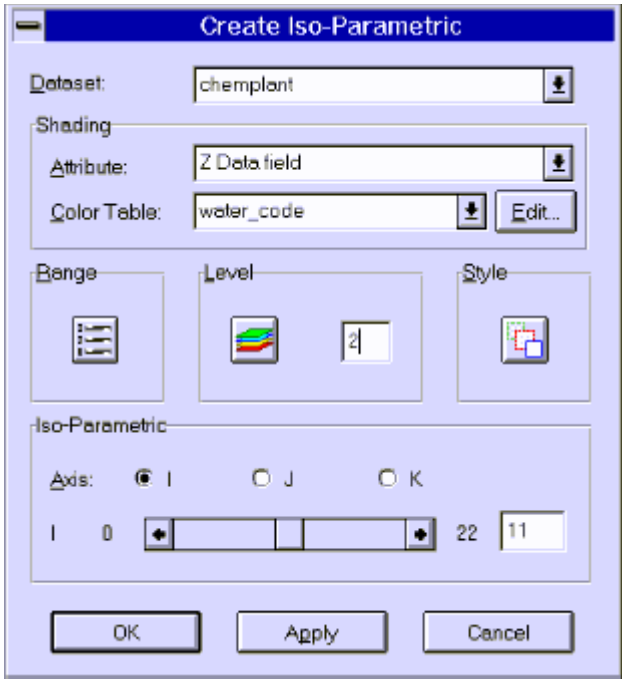
We will first place an outline of the site in graphics. Since the background is white we will be placing the outline in black. Similar to MicroStation we can place the different graphics on different levels, the outline will be placed on level 1.

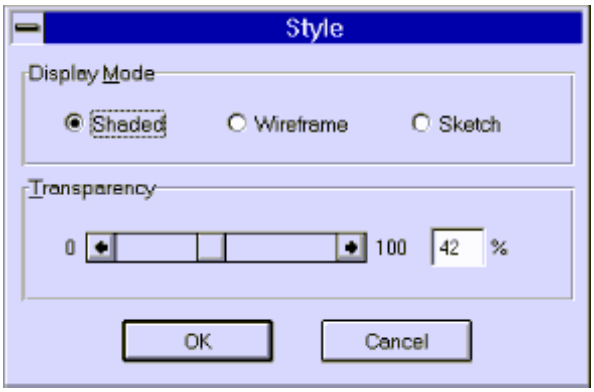
Place an outline as black when using the white background on level 1. The background color can be changed under Utilities > Preferences. Just click on the color to change the background.

5  **Vantage point allows us to interactively rotate the model.**

Put the vantage point menu up. Never let the model stop even when explaining something to the audience play with this, I have found it keeps the audience interested and hammers home the interactivity of the product.

6 **Iso-Parametric (Cross-section) allows us to place cross-sections. We will be placing horizontal cross-sections in graphics these section were used to define the extent of the model. The first section we will place is the water table surface which was generated from ModFlow. We are shading the model using elevation and the color table is blue to show the water table.**





We will put this display on level 2 and change the Transparency in Style option to somewhere under 50%. We are displaying it in 3D so we can see it in relation to the rest of the model.

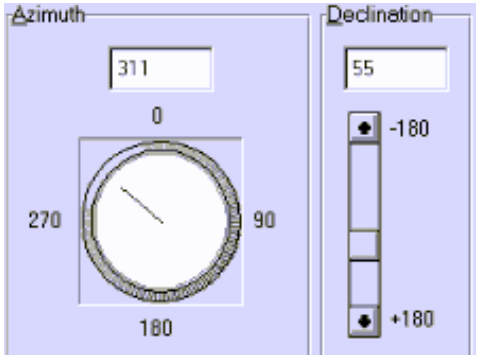
Only hit the Apply button when you are done. It is at this point you can continue with the chemplant story.
Once you have hit the apply button and placed the first section. Change the color table to Cplant Soils the level 3 and the I Axis to 22.

The next surface that we will place maybe a resulting surface from a geological interpretation. In this case we are going to place the clay aquitard (bottom of the water table) **which was the resulting interpretation from ERMA Site Geologist.**

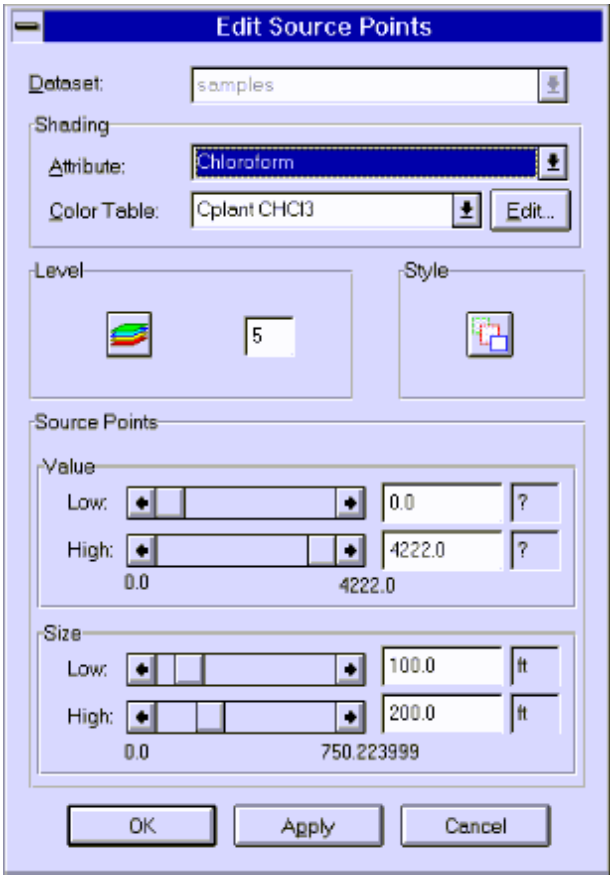
Move the I Axis slider to 0 change the level to 4 and hit OK.

This shows the digital elevation model of the surface. This may have been a Digital elevation model we got from the USGS. We have now described the extents of our Voxel Model. Now, lets take a look at the sample points that are found within the layers.

Play with the view control buttons so the audience can see inside the model and then turn off level 4 to turn the surface model off. To put the data set into a good view click on one of the iso icons  and then in the azimuth box click on app. 300. You now want to change the dataset pulldown to samples.

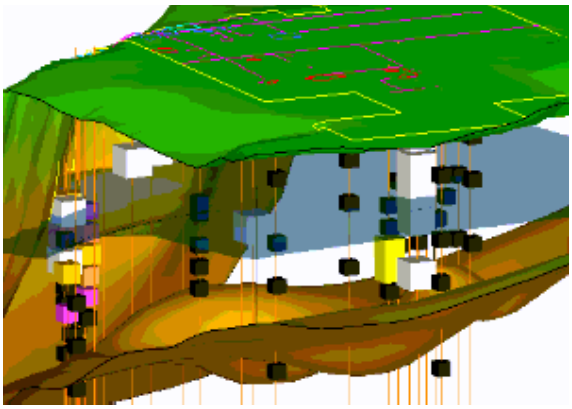


7  **Source points allows us to place the source points that we read into our model. We can scale the points and place them based on the value. The value slider can be used as a query tool to only display the points within a certain range. For example if I only want to see the points that range from 1000 -3000 all we have to do is move the slider and NOT create an SQL statement. The color table and the size sliders are used to show high and low values. This allows you to not only look at the color of the sample to determine the high values but the size of the sample. (3D bubble maps).**



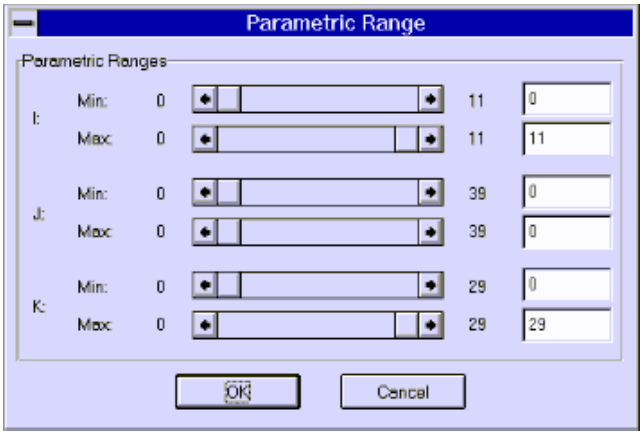
Set the values to appx. what I have in this picture. Make sure the sample points go on level 5. When you have placed the points change back to the chemplant model.

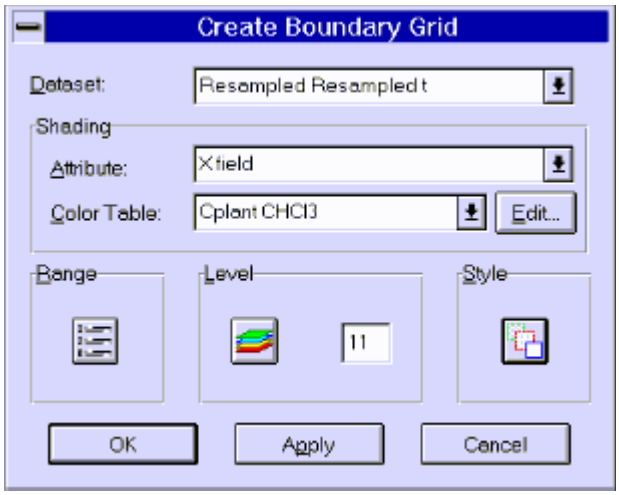
Turn on level 4 and rotate the display so the audience can see the samples in the subsurface.

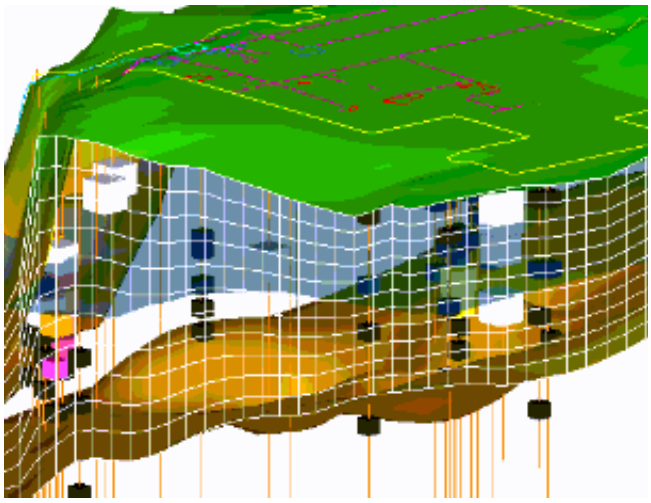


8 Change the data set to 

Now that we have shown the data needed to create the extents of the model and the sparsely sampled points. We next create a Voxel geometry that allows us to show the continuum of data. What I will show you next is the Voxel geometry used for this model. Voxel Analyst allows us to use grid files as the basis of our geometry and in this situation we resampled to densify the geometry in the z domain to add layers in between our 3 primary layers. First we will choose Boundary Grid to see the mesh and create displays of 2 edge walls so the display is not so confusing. Voxel Analyst allows us to input these grids and extrapolate the sample point information into all the voxels throughout the continuum of the model.

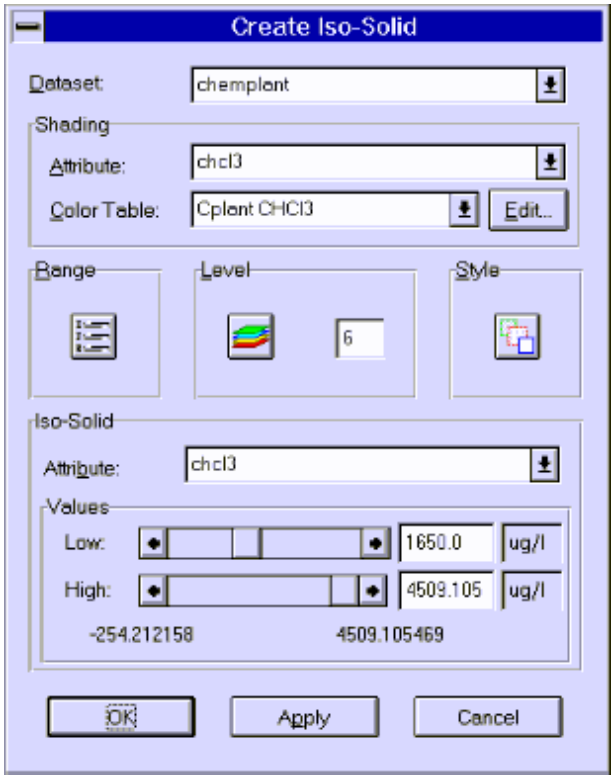






Change level to 11. Hit the Range button and Max value J-axis to 0, this way only the back of the mesh is displayed. Hit OK, then hit Apply. Hit the Range button again and change Max. value K-axis to 29. This way only the 2 outer walls are displayed and people will have a better understanding of how the sample points are interpolated into each of the Voxels representing the continuum of the model. When finished turn off level 4,11 and change datasets to

9 **Iso-solids can be placed that depict the contaminant, in this case chloroform. To generate the iso-solid I just have to key-in the low value which may be my regulatory limit and hit Apply. The software interactively creates the iso-solid.**



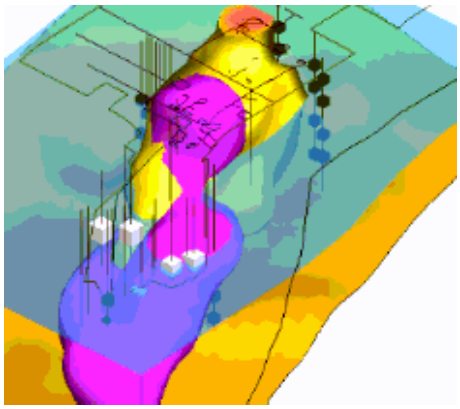
Set up the first Iso-solid like this and after hitting Apply set up the second one on level 7 as described below. **By changing the Shading attribute color table and Iso-solid attribute to Trichloroethlyene (c2hcl3) we set the low value to our EPA limit 1000 select OK to place the file out in graphics.**

Note: When setting values I find it best to double click on the fields to clear them.

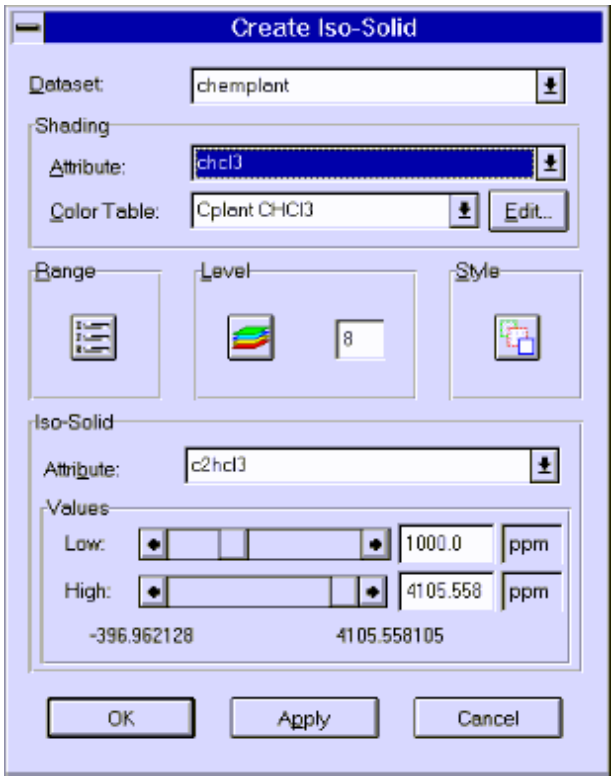
After you place the 2 solids in graphics your display should look like:

Here we see how the 2 plumes interact with each other and with the water table. Using Dynamics or Vantage point we can view the data from any angle or perspective.

Use Dynamics to spin the model if you have a GLZ card. After you have finished playing turn off level 6 and 7.



10 **As you have seen there are 2 attribute sections on the form. We have been putting the same attribute into each field. These fields allow us to perform what is called volume draping. This is a visual analysis technique that allows us to color code the iso-solid of one attribute by the values of another. In this example we are going to use the trichloroethlyene plume and color code it by chloroform values. This will show us where the high values of chloroform occur on the trichloroethylene plume.**



After you have done this you can bring up the level form and turn off and on level 6 so the audience can see how and where the chloroform plume intersects the trichloroethlyene plume.

Some or our current user who use MGE Kriging Modeler have found this to be very useful because it allows the Iso-solid model to be draped with standard error values which helps to statistically justify the models.

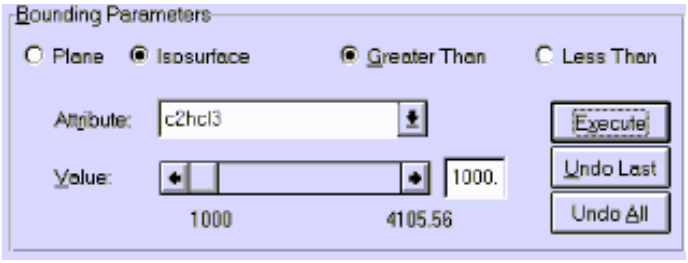
Turn off levels 3-8 and turn off the design file display 

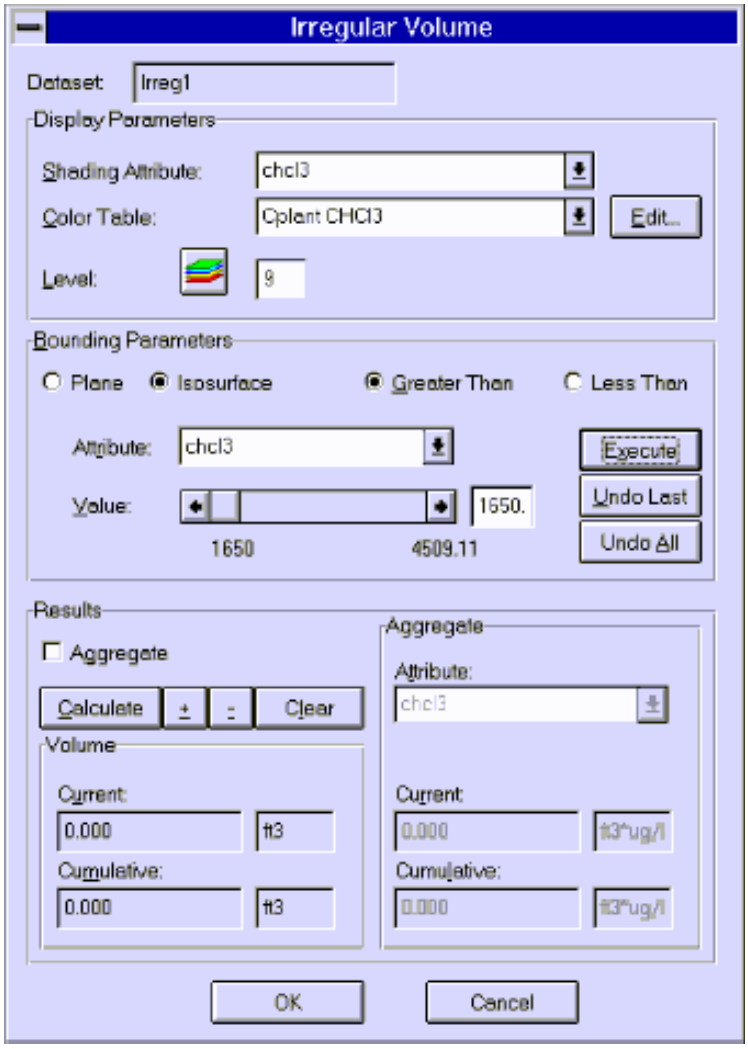
11 **Now that we have seen some of the visualization functions lets look at some of the analysis tools available. As you know GIS systems let you do Boolean queries, the problem is that they can only do points, lines and shapes all 2D elements. We want to take this a little further and do Boolean queries on volumes. You have seen us using 2 attributes in this demo, now lets say we know that our environmental problem only occurs when the 2 contaminants mix. In this example we will find the intersection of the 2 contaminants and their volumes above and below the water table.**

Note:Call up this form and if you do not see the software show you anything highlighted cancel the form and call it up again. (Sorry no picture)

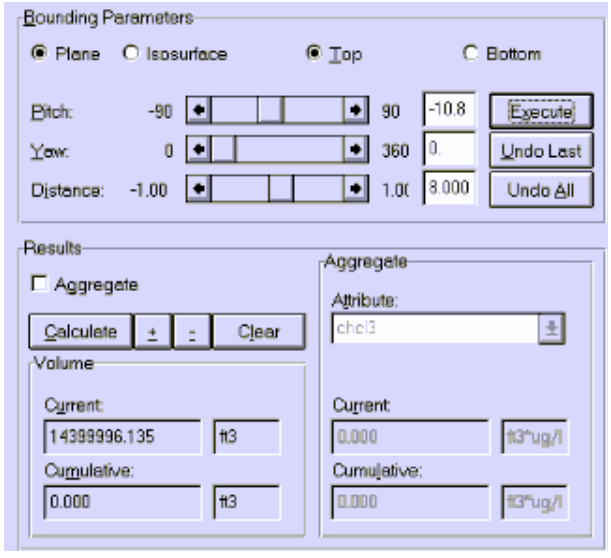
Analyze

Irregular Volume





In this example we are going to use the same values for the 2 contaminants that we have been using. First lets find all values of chloroform greater than 1650 and hit Execute. This results in the same plume we had seen earlier. Then lets modify the attribute to Trichloroethelyene and its value to 1000 and Execute.



We see that the plume now represents the intersection of the 2 plumes. At any time during these operations you can hit Calculate and find the volume of the plume. Now we want to take this a step further and find the volume above and below the water table. By choosing Plane instead of isosurface we can cut the volume by moving the sliders above or below the water table to find out how much contaminant you will have to dig vs pump.

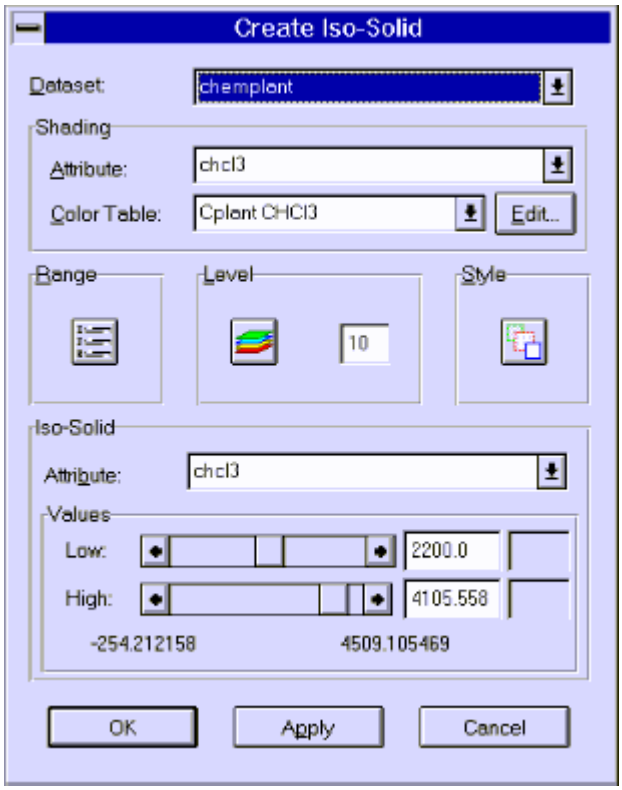
NOTE: If you change levels while the form is up it will update the screen so you can see the water table intersect the plume. After you execute this Undo Last and toggle Top to Bottom do it again and calculate volume. After you get out of this form play with dynamics again and them turn off level 9.

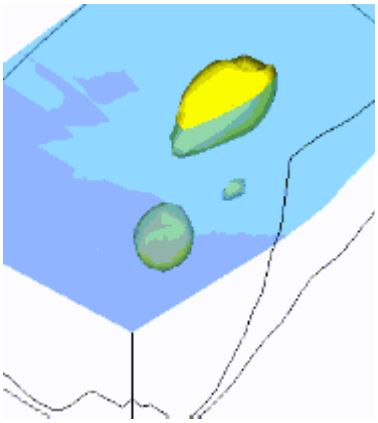
12 **Now that we have seen some the analysis tools lets look at some data manipulation options. As you (the audience) know there is no such thing as a modeling tool that fits exactly with what a geoscientist expects to see. What we have allowed the user to do in Voxel Analyst is to actually digitize volume data in 3D. For example in a situation we may have a lot of sample points at two ends of a site and none in the middle but we know the location of the contaminant source and groundwater flow caused migration. Lets look at an example similar to this.**

Change the dataset from Irreg to: chemplant

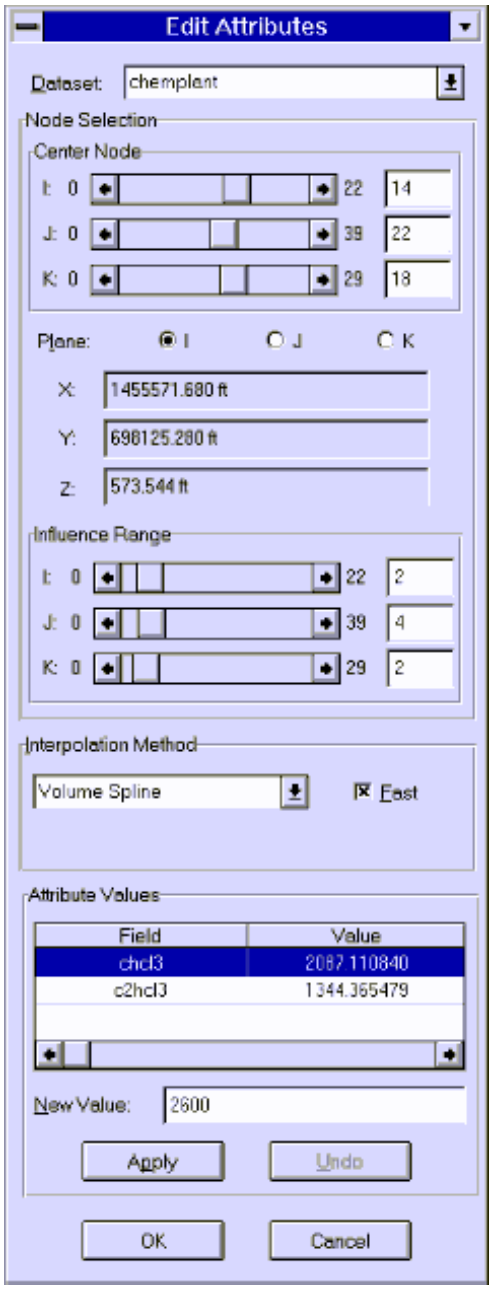
Place a chlorform Iso-solid on level 10 with a value of 2200.

We will place a chloroform iso-solid in graphics with a value of 2200. Here the hydrologists decides that the source of the plume near the lake is not isolated but part of a larger continuous plume connecting to the one at the north end of the site.





13 Dataset



Edit Attributes

As you can see from this form we can choose a specific point in the middle between the plumes.

You need to start with a top view  to get a point in the x,y direction that is in the middle and then toggle to the left view  to set up the z. The values on the form are correct. After you have set up the x, y change your view to an iso  and change the azimuth to around 300.

Now we want to set up an influence range to limit the interpolation to a 3D fence that we define. We will then choose an interpolation method to use. The splines are generally better for creating smooth connections between plumes. You have a choice of Fast or Not.....so fast. Fast just uses the cornerpoints of the cube while "NOT" uses all the nodes on each face of the cube.

Now we will choose chloroform and the New Value that we will key in is 2600. Then hit apply and you can see the connection is made. This change is now only stored in memory you will have to save this data set to keep it permanently. This way as interpretations are done you can store each iteration and do volume calculations to see differences.

Note: If you do not see the change after you hit apply cancel out and just rotate the model you should then see the change.

14 **Now that you have completed you model you may want to put a piece of it in a report.**

Edit

Fence copy ... place a fence anywhere around the model and open up a word document and place the image with Ctrl V

15 Save this Session so you can call it up at any time to do a quick demo. The save session will save everything similiar to a file design in Ustn except for the Irregular Volume and the Ustn design file that was imported.