Structural Geology Methods and Applications for Google Earth

by Gregory C. Herman , PhD

Introduction

This document provides guidance to generate and display 2D and 3D geological data in Google Earth. Three components are covered: 1) 3D cross sections, 2) oriented 2D and 3D geological symbols based on outcrop data, and 3) 3D well-field components based on Optical Borehole Imaging (OBI) data. Two additional software programs are used besides Google Earth (GE), including Google SketchUp (v. 8) and Microsoft (MS) Excel (designed and tested using 2000 and 2003). SketchUp is used to generate the structural symbols for mapping ground-based structures in GE, and to convert graphic image files of 2D cross sections into 3D Collada object models that are capable of being stretched, oriented and rotated in GE for display in profile view. Excel worksheets are used to generate KML scripts for the structural symbology and well-field visualization. The structure names, geographic coordinates, object orientations and descriptive variables are entered into Excel worksheets that write KML scripts to cell blocks. The script blocks are copied and pasted into ASCII text editors such as MS Notepad.exe, then saved as KML scripts that can be opened in GE. These computerized geological methods are made available to the pubic at no charge and are free downloads. They are distributed as is, with no other support or guidance other than that presented here. Please use these methods and applications at you own benefit and risk. gcherman@impacttectonics.org.

Contents

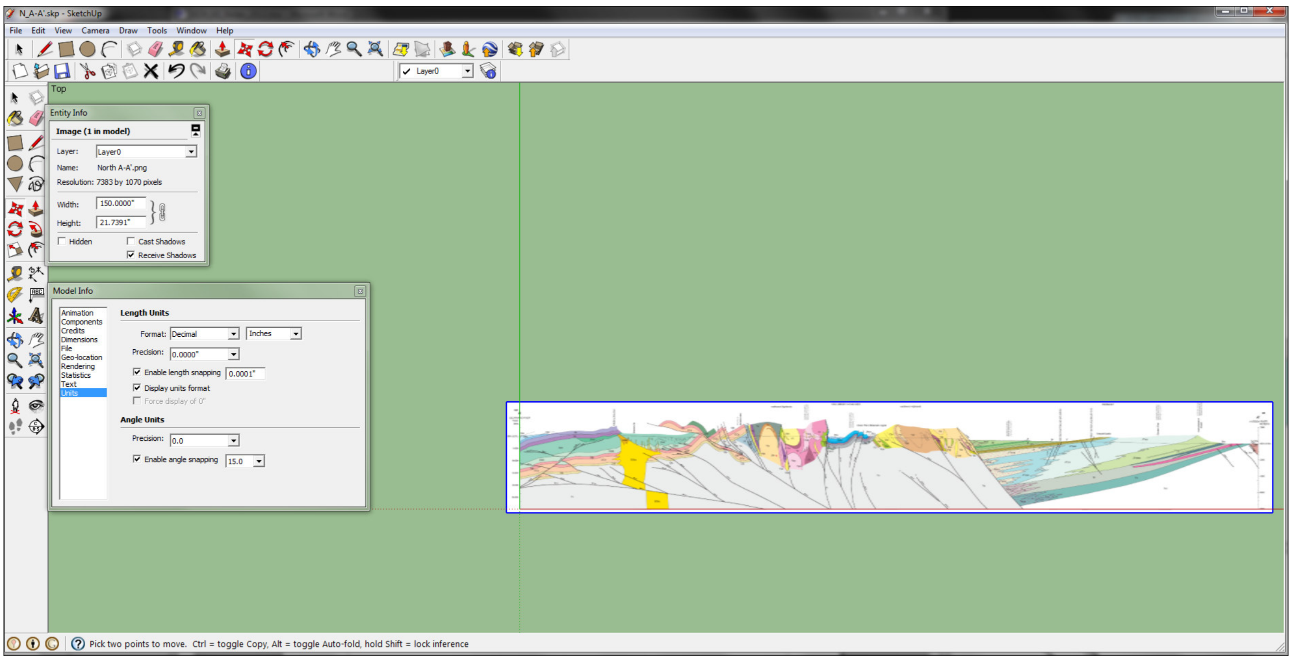
Reference

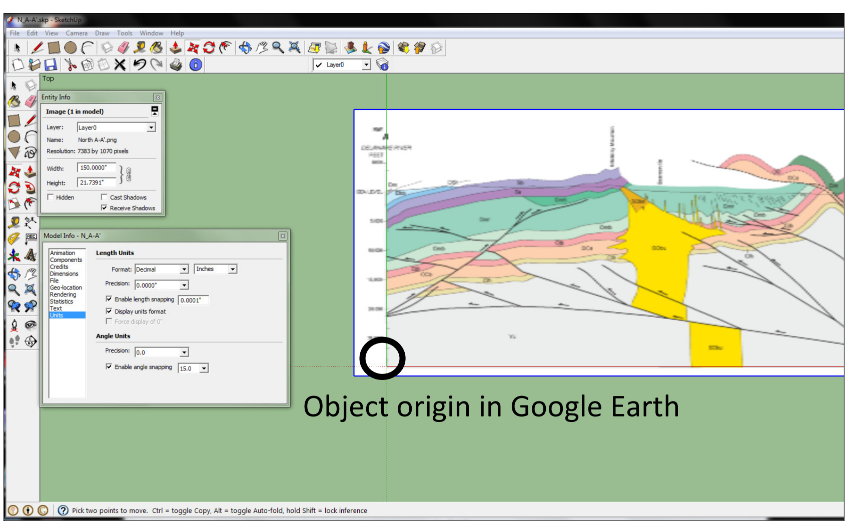
Drake, A. A., Jr., Volkert, R. A., Monteverde, D. H., Herman, G. C., Houghton, H. F., Parker, R. A., and Dalton, R. F., 1996, Bedrock geological map of northern New Jersey: U.S. Geological Survey Miscellaneous Investigation Series Map I-2540-A, scale 1:100,000, 2 sheets (http://njgeology.org/geodata/dgs04-6.htm).

A Custom Method for Representing Cross Sections in Google Earth

Two-dimensional cross sections can be displayed as georegistered, vertical cross sections in GE by converting digital images of 2D sections into 3D Collada model objects, then referencing the model objects within a custom KML script that specifies position, scale, and orientation variables for the 3D model in GE. KML stands for Keyhole Markup Language (KML), an XML notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers (Wikipedia, 2012). KML is an international standard of the Open Geospatial Consortium. XML (Extensible Markup Language) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable (Wikipedia, 2012).

Scan, covert, or Save As an existing cross section graphic file as a Portable Network Graphics (PNG) image using image-processing software. Use Google SketchUp software, to import (<File><Import>) the PNG file into model space. Be sure to access the <Window><Model Info> and <Window><Entity Info> windows to display the feature attributes, units, and other menu items. In the example below, a PNG graphic of dimensions 7383 wide x 1020 high pixels is brought into SketchUp in parallel space using a top view (<Camera><Parallel Projection> and <Camera><Top View>). The object dimensions in SketchUp are set at 150" Width x 21.7391" Height. The object is exported as a 3D Collada (*.cda) model (<File><Export><3D Model>) for reference within a KML file, and for opening in Google Earth.





Position the image in model space using an origin point relative to the where the X and Y axes cross in SketchUp. The X (0) and Y (0) coordinates are the reference point for Google Earth registration. The origin point is set equal to geographic coordinates entered into a KML script (see next page). The registration position can be other than the corners of an image.

Cross section A-A' from Drake and others, 1997).

KML Script for georegistering a Collada object model of a PNG image.

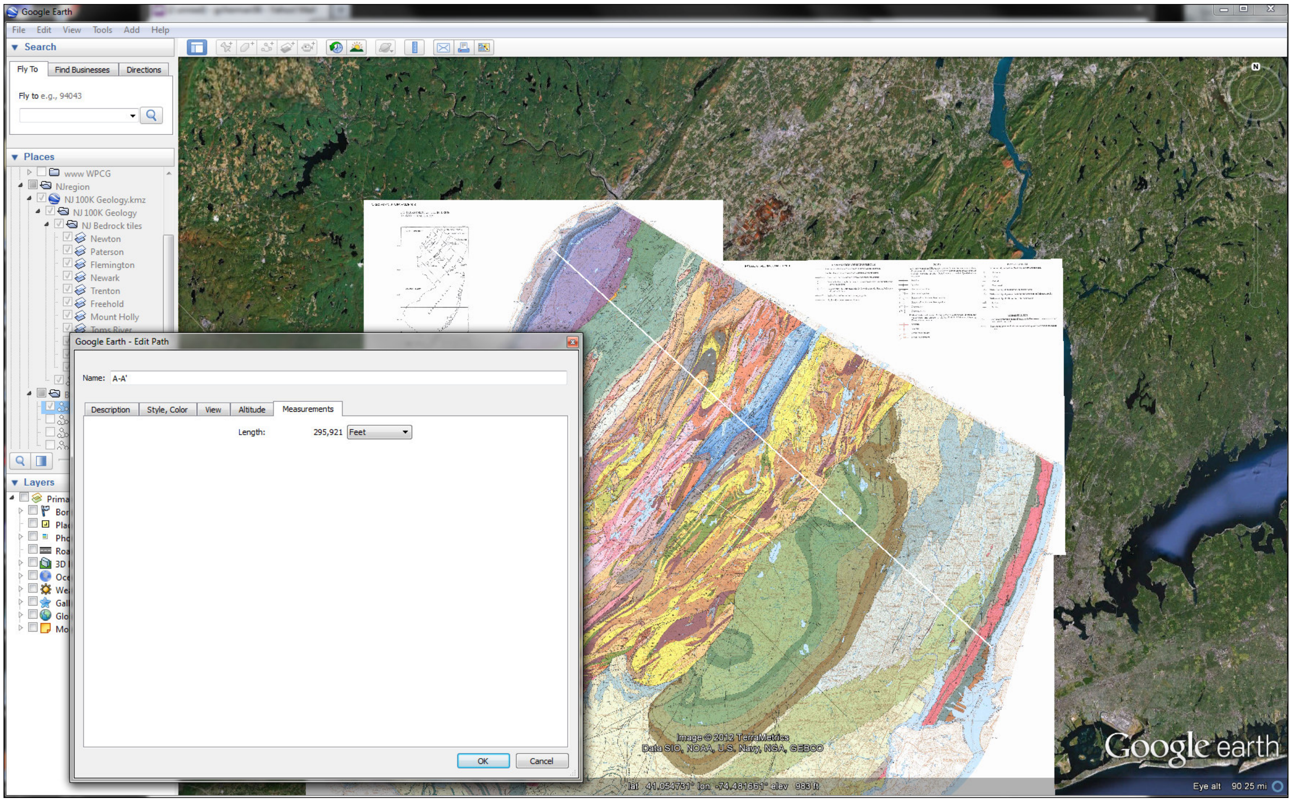
The following KML script can be used to georegister and display cross sections in vertical alignment within Google Earth. Copy and paste this script into an ASCII text editor like MS Notepad.exe, then save the file using a *.kml filename extension. Enter values highlighted in red. The appropriate values can be determined using techniques described below.

```
<kml xmlns="http://www.opengis.net/kml/2.2" xmlns:gx="http://www.google.com/kml/ext/2.2"
xmlns:kml="http://www.opengis.net/kml/2.2" xmlns:atom="http://www.w3.org/2005/Atom">
<Document>
<Style id="sn_noicon"><IconStyle><Icon></Icon></IconStyle><ListStyle></ListStyle></Style>
<Folder><name> Cross Section </name>
<Placemark>
<name> A-A' </name>
<LookAt>
<longitude> -74.4 </longitude>
<latitude> 40.6 </latitude>
<altitude> 200000 </altitude>
<heading> 0 </heading>
<tilt>  60  </tilt>
<range> 7000 </range></LookAt>
<Model id=" Xsec1 ">
<altitudeMode> relativeToGround </altitudeMode>
<Location>
<longitude> -74.808951 </longitude>
<latitude> 41.297594 </latitude>
<altitude> -5000.00 </altitude></Location>
<Orientation>
<heading> 42.2 </heading>
<tilt> -90 </tilt>
<roll> 0 </roll></Orientation>
<Scale>
<x>  24500 </x>
<y>  24500 </y>
<z>  24500 </z></Scale>
<Link>
<href> N_A-A'.dae </href></Link>
</Model></Placemark></Folder></Document></kml>
```

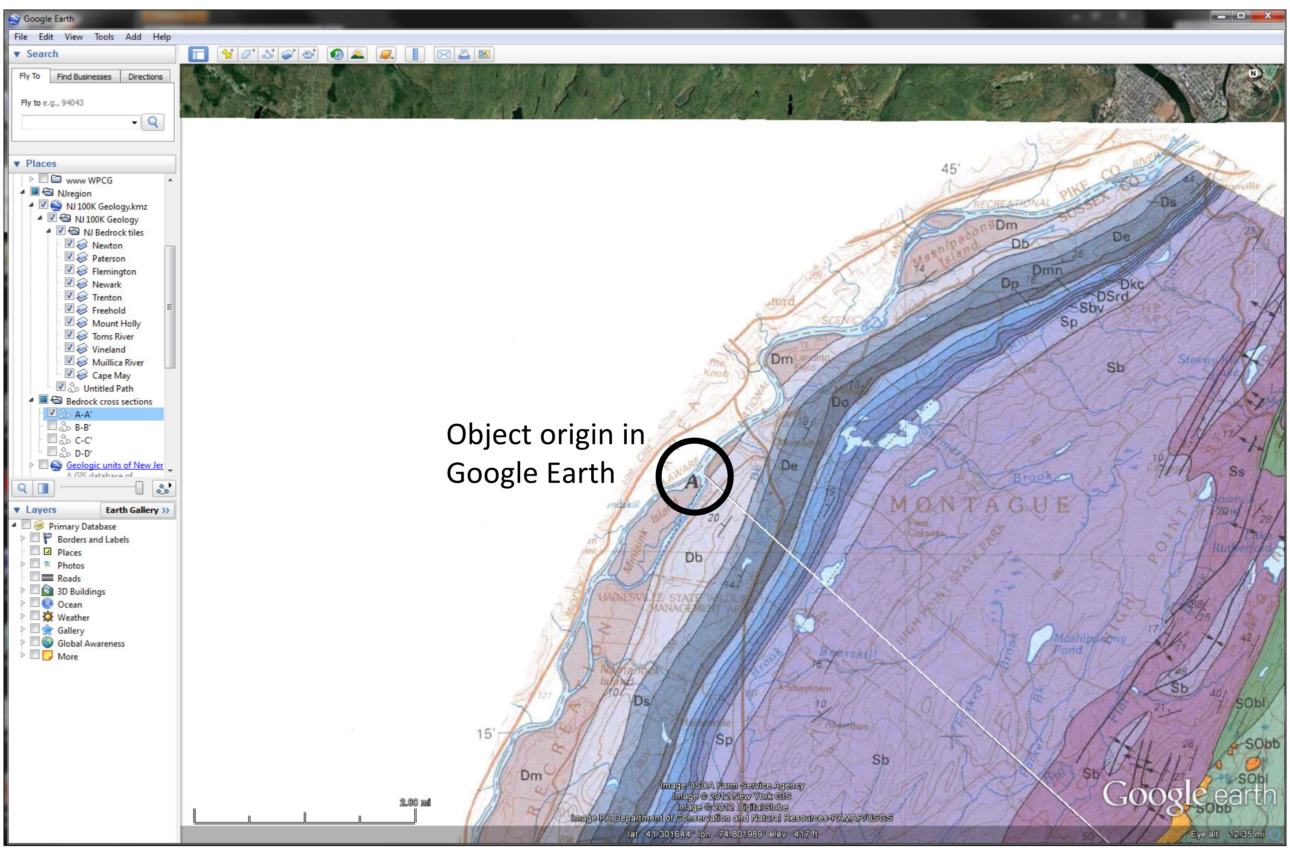
Positioning, Orienting, and Scaling Collada object models of a PNG images in Google Earth

To position the 3D model in GE, enter appropriate variables in the KML script in the <Location> and <Orientation> fields. The longitude and latitude are the GE latitude and longitude coordinates for the end of the section corresponding to the SketchUp X0 and Y0 origin of the object model (see previous image). To determine the coordinates to enter in to the KML script, position the mouse cursor in GE over the end of the section line coinciding with the object origin, then record and enter the coordinates into the <Location><latitude> field.

For the object orientation settings, the heading variable is with respect to a Northerly reference in GE and the position of the object within SketchUp. For this example, the object model is oriented with the longest dimension parallel to the X-axis (90^o) or East-West. The section trace has an approximate azimuth of 130^o, therefore the <heading> for our model is 130 – 90 = 40^o. A tilt of -90^o is used in order to position the object in a vertical direction in GE along the section trace line. Note that the final heading used in this example is 42.2, that was derived through trial and error. Leave the <roll> to zero unless you want to tilt the section along its length.



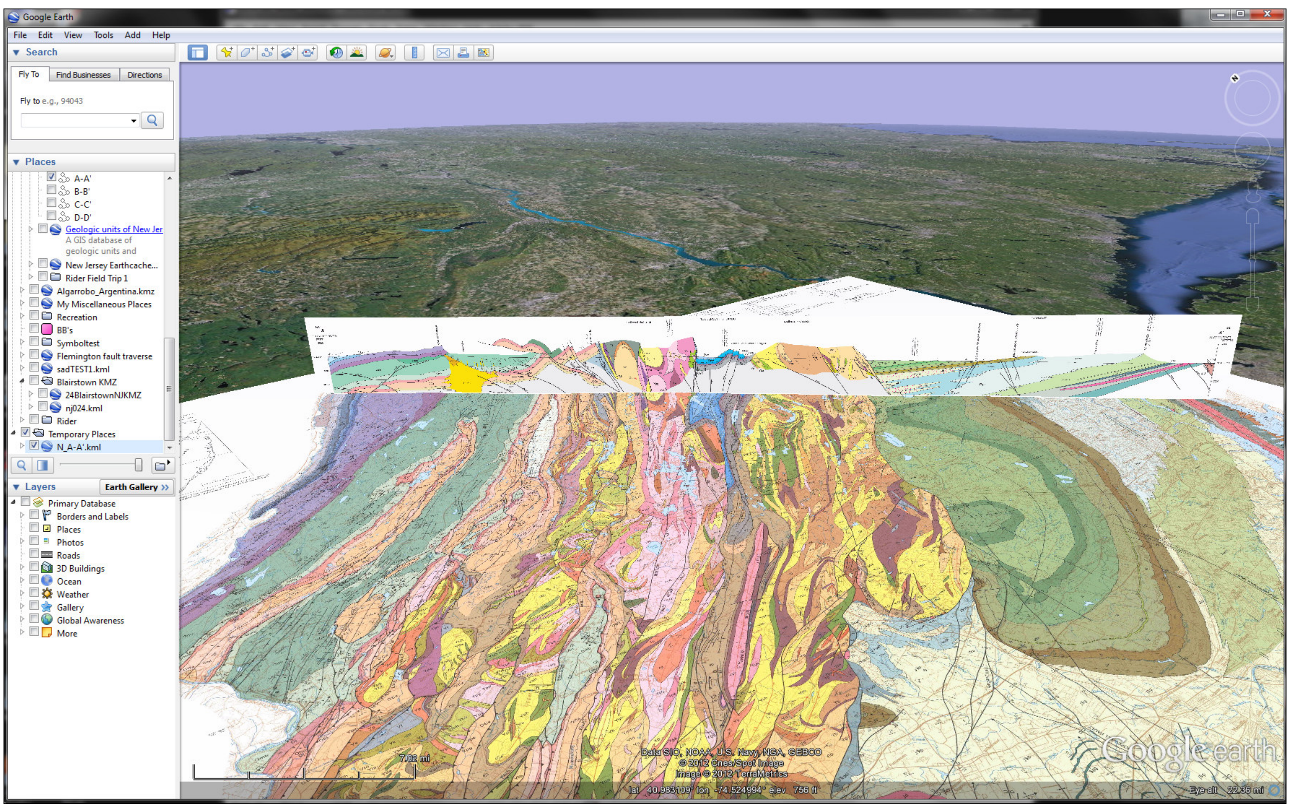
The cross-section trace for section A–A' is shown above. The origin of the model is positioned at one end of the cross-section trace as detailed below.



To estimate the scale the object, you will need two pieces of information: 1) the length of the section in GE, and 2) the length of the object in SketchUp. To determine the section length in GE, add a path that the section will be placed along. Determine the ground distance that the section covers by making the path object active in the <Places> window, <right click> on the path object to access it's <Properties>. Within the Edit Path window, highlight the <Measurements> Tab. The path length is displayed in the dimension of choice. For this example, the path length shown below is 295,291ft long.

An estimate of the scale to be entered into the KML script comes from dividing the actual length (295,291 ft) in GE by the Collada object length (150"/ 12" per ft = 12.5 ft), or in this example, 295,291/12.5 = 23,623. The <x> <y>and <z> Scale in the KML script should all be equal to 23,623 for a first attempt at a 1:1 display. However, the scale, origin coordinates, heading, and altitude will need to be adjusted iteratively and repeatedly by varying the values in the KML script, opening the script, viewing the results, and adjusting parameters slightly in order to achieve the desired registration. You can repeatedly change and save the KML, delete each old version, and open new ones for fine tuning the cross section display. Please note that the estimated scale was 23,623 whereas the scale that was finally used is 24,500.

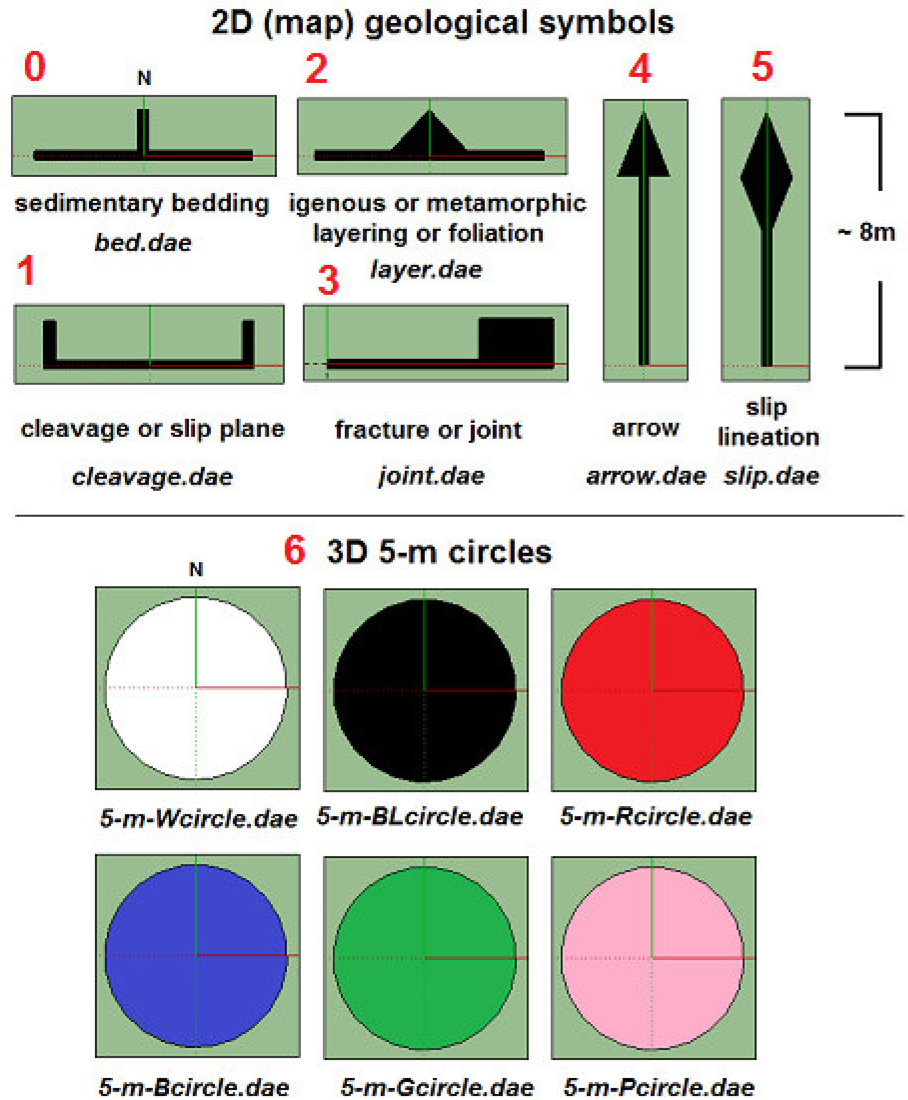
The <LookAt> parameters in the upper part of the script are used to control how the image is viewed when loaded. You will need to experiment with these in order to achieve the desired perspective. At any time during the loading and automatic zoom process, the zoom can be interrupted and stopped by clicking the left mouse button. Also, a vital GE function is interactive 3D display control by holding the mouse wheel button down when moving the mouse around. The mouse wheel is ordinarily used for interactive zoom control by rolling the wheel forward and backward.



Cross section A–A' is shown above. The origin of the model is positioned at one end of the cross-section trace as detailed below. Geology from Drake and others (1997).

2D and 3D Geological-Symbols in Google Earth

This application uses Microsoft Excel (Excel) map 2D structural-geological symbols and 3D circles (or ellipses) at specified coordinates (latitude-longitude) in GE. The 2D map symbols (nos. 0-5 below and 3D circles (no. 6) are *Collada* 3D object files (*.dae) made and exported using Google SketchUp 8 software. The methods of generating and plotting the different types and sizes of oriented symbols are detailed below.

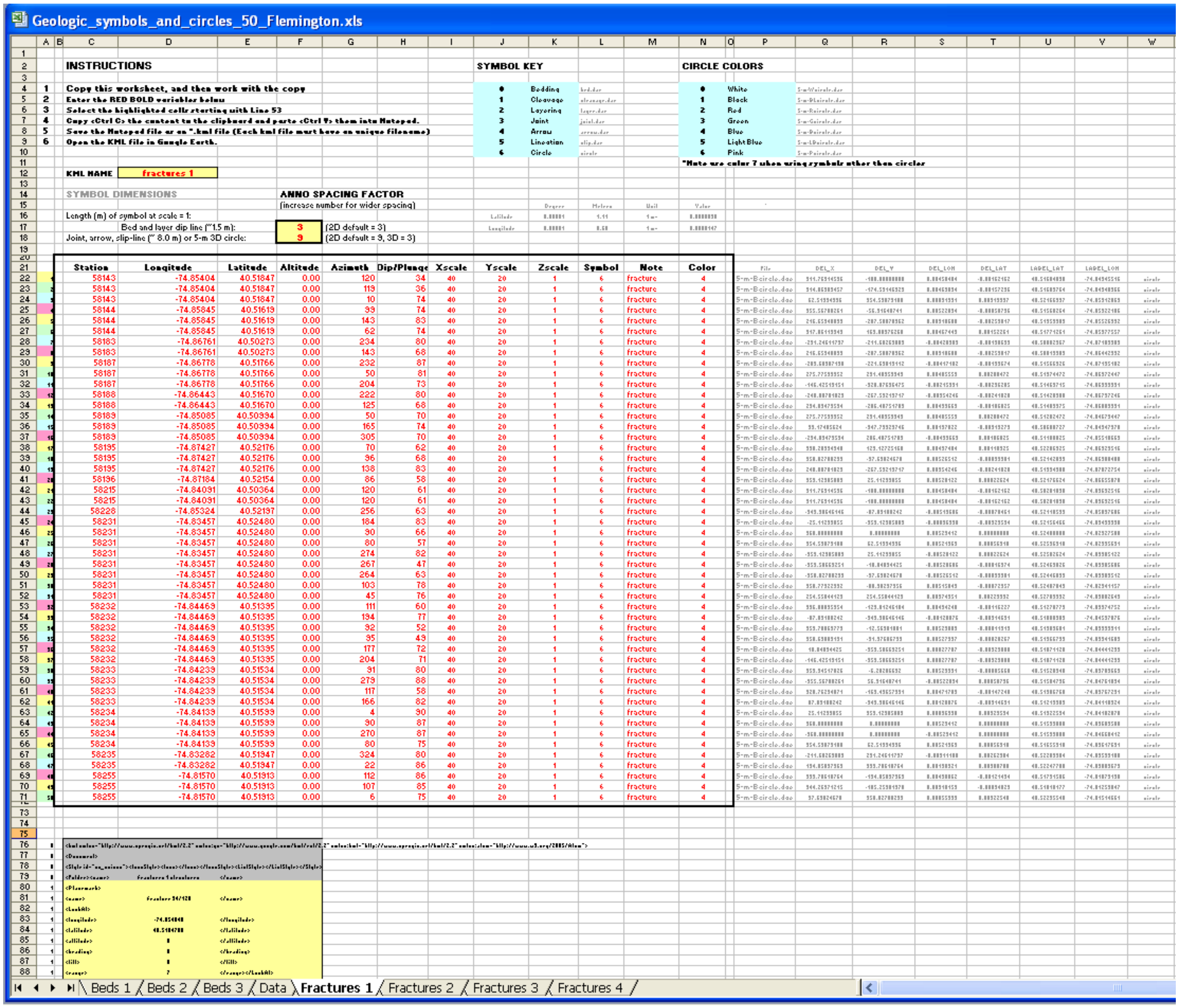


2D geological symbols (top) and 3D colored circles (bottom) that can be plotted in GE using the Excel Worksheet shown below. The red numbers are the symbol numbers used in the worksheet. The Collada object files (*.dae files) must reside in the directory that the KML script is opened from in order for GE to be able to read them.

The Excel (2000) workbook contains worksheets for generating up to 50 geological symbols that have geographic coordinates and structural orientations. The worksheets consist of cell blocks with numeric input, process code, and text output.

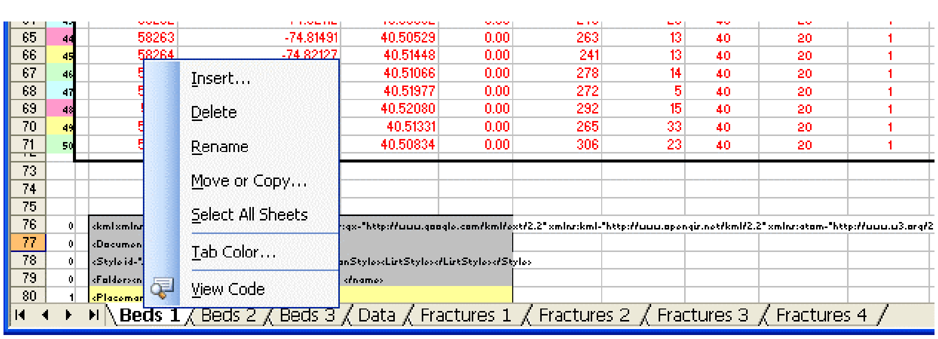
The output text block uses the KML form of the XML encoding language. The application is designed for use with geographic-coordinate input (decimal degrees) of longitude (X-coordinate), latitude (Y-coordinate) and altitude (Z-coordinate) in meters. Altitude values of 0 can be used for clamping structures to the ground. Structural geological coordinates for oriented planes and lines use the dip azimuth (0-359^{o}) and dip/plunge (0-90^{o}) format.

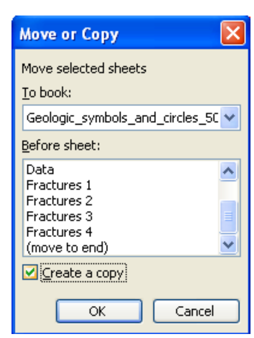
Annotation is generated for each symbol or plane using a azimuth/inclination format, (for example a plane with a dip azimuth of 128^{o} and an inclination of 86^{o} is annotated as123/68). Annotation spacing relative to the oriented symbols and planes is controlled by integer variables in cells F17 & F18 of the worksheet under the heading ANNO SPACING FACTOR. Two spacing options are available, one for symbols less than value 3 (bedding-0, cleavage-1, and layering-2), and for those >3. Placement values of 0 will result in having annotation placed at the center of each oriented object. The cell F17 value is used for bedding (symbol 0), cleavage (symbol 1), and layering (symbol 2). Cell F18 is used for the joint, arrow, and lineation symbol. The 2D default spacing for the first set of options is 3. The default spacing factor for 2D symbols 3-5 is 9, whereas the default 3D spacing factor for the circles (symbol 6) is 3.



The worksheet includes cells and cell blocks for data input and a cell block for data output. The input cells include cells above row 72 with red highlighted text, while the top of the output block is shown at the lower left. Worksheet details are shown in the next two pages. Notice the multiple worksheets at the lower left-hand position of the workbook.

The initial file should always be opened then saved as a new workbook in order to preserve the integrity of the initial file. (<File> <Save As> <Enter the directory path and file name for the new workbook.xls>. Using the new workbook, copy the worksheet (Right mouse click on the worksheet tab (shown below) then choose <Move or Copy>, and in the resulting window, check <Create a copy>, move the slider down and choose <move to end>. Copy as needed to use as many input files as needed.





MS Excel Worksheet for Generating KML Scripts for mapping oriented geological symbols

Data can be manually entered into the worksheet input cells, or copied and pasted in blocks from existing ASCII text files, other spreadsheets and database (*.dbf) files. An example is given with Geologic_symbols_and_circles_50.xls file. stem from NJGS Field data Management System (FMS) data files and associated GIS shapefile themes.

The worksheet input area includes cells with red characters (example below). These include the KML NAME, the ANNO SPACING FACTORS, and the block of red entry values outlined by black. Values for the Station, Longitude, Latitude, Altitude, Azimuth, Dip/Plunge, Xscale, Yscale, Zscale, Symbol, Note, and Color must be input. Ordinarily, the Station, Longitude, Latitude, and structural Azimuth and Dip/Plunge are copied from an ASCII text file or station shapefile *.dbf file.

The KML output script is written to colored cell blocks at the bottom of each worksheet. The script spans columns C through F. The symbol block lies on top of the annotation block. Each block begins with and ends with the gray cell blocks that must be preserved in their relative order for the script to work properly.

Geologic_symbols_and_circles_50_Flemington.xls

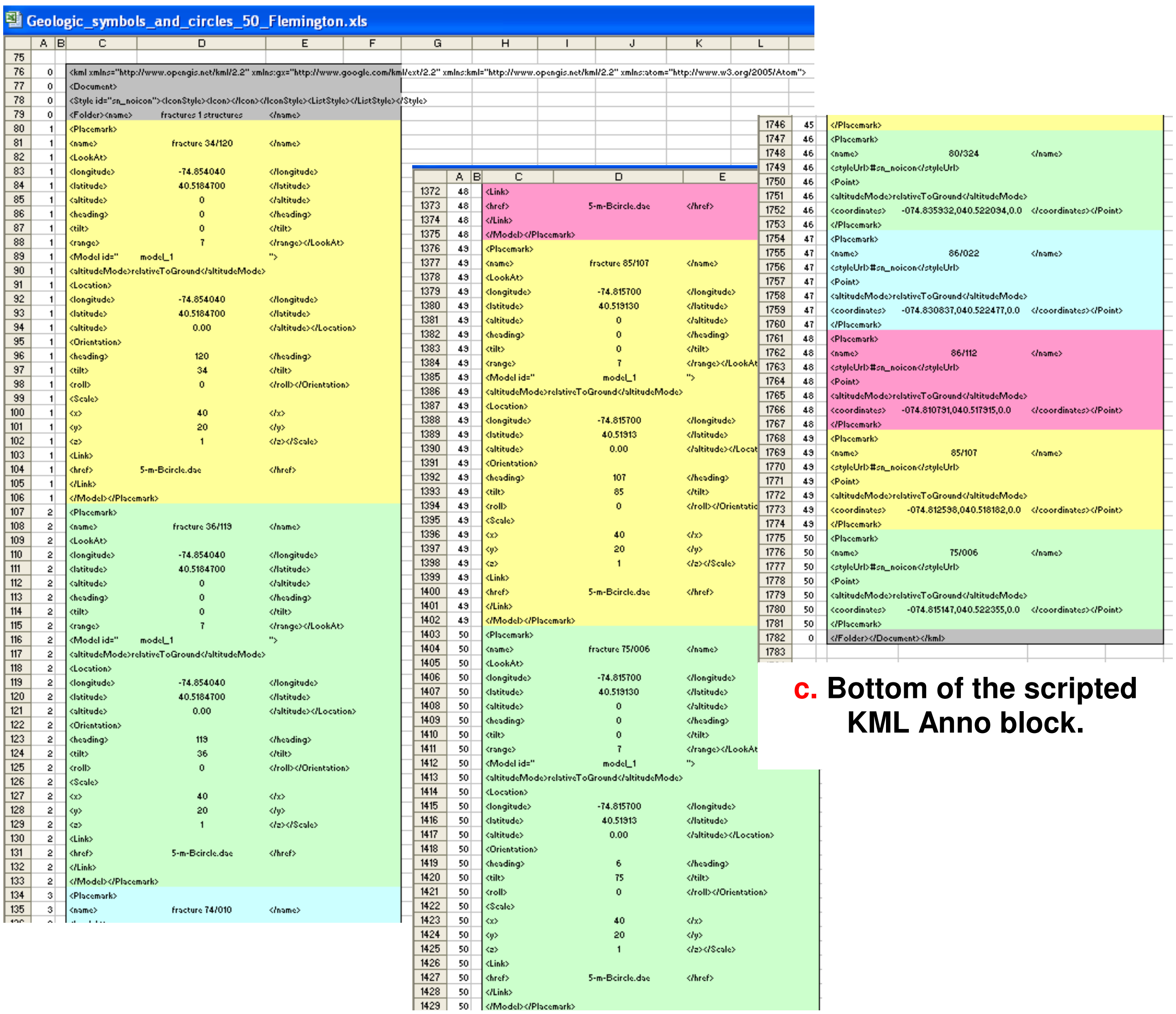
	A	C	J	K	L	N	O/P	Q
4	1	Copy this worksheet, and then work with the copy	0	Bedding	bed.dae	0	White	5-m-Wcircle.dae
5	2	Enter the RED BOLD variables below	1	Cleavage	cleavage.dae	1	Black	5-m-BLcircle.dae
6	3	Select the highlighted cells starting with Line 53	2	Layering	layer.dae	2	Red	5-m-Rcircle.dae
7	4	Copy <Ctrl C> the content to the clipboard and paste <Ctrl V> them into Notepad.	3	Joint	joint.dae	3	Green	5-m-Gcircle.dae
8	5	Save the Notepad file as an *.kml file (Each kml file must have an unique filename)	4	Arrow	arrow.dae	4	Blue	5-m-Bcircle.dae
9	6	Open the KML file in Google Earth.	5	Lineation	slip.dae	5	Light Blue	5-m-LBcircle.dae
10			6	Circle	circle	6	Pink	5-m-Pcircle.dae
11						*Note use color 7 when using symbols other than circles		
12		KML NAME: fractures 1						
14		SYMBOL DIMENSIONS / ANNO SPACING FACTOR						
15		(increase number for wider spacing)		Degree	Meters	Unit	Value	
16		Length (m) of symbol at scale = 1:	Latitude	0.00001	1.11	1 m=	0.0000090	
17		Bed and layer dip line (~1.5 m): 3 (2D default = 3)	Longitude	0.00001	0.68	1 m=	0.0000147	
18		Joint, arrow, slip-line (~ 8.0 m) or 5-m 3D circle: 9 (2D default = 9, 3D = 3)						

Row	B	Station	Longitude	Latitude	Altitude	Azimuth	Dip/Plunge	Xscale	Yscale	Zscale	Symbol	Note	Color	File	DEL_X	DEL_Y	DEL_LON
22	1	58143	-74.85404	40.51847	0.00	120	34	40	20	1	6	fracture	4	5-m-Bcircle.dae	311.76914536	-180.00000000	0.00458484
23	2	58143	-74.85404	40.51847	0.00	119	36	40	20	1	6	fracture	4	5-m-Bcircle.dae	314.86309457	-174.53146329	0.00463034
24	3	58143	-74.85404	40.51847	0.00	10	74	40	20	1	6	fracture	4	5-m-Bcircle.dae	62.51334396	354.53079108	0.00091931
25	4	58144	-74.85845	40.51619	0.00	99	74	40	20	1	6	fracture	4	5-m-Bcircle.dae	355.56780261	-56.31640741	0.00522894
26	5	58144	-74.85845	40.51619	0.00	143	83	40	20	1	6	fracture	4	5-m-Bcircle.dae	216.65340833	-287.50878362	0.00318608
27	6	58144	-74.85845	40.51619	0.00	62	74	40	20	1	6	fracture	4	5-m-Bcircle.dae	317.86113343	169.00976260	0.00467443
28	7	58183	-74.86761	40.50273	0.00	234	80	40	20	1	6	fracture	4	5-m-Bcircle.dae	-291.24611797	-211.60269083	-0.00428303
29	8	58183	-74.86761	40.50273	0.00	143	68	40	20	1	6	fracture	4	5-m-Bcircle.dae	216.65340833	-287.50878362	0.00318608
30	9	58187	-74.86778	40.51766	0.00	232	87	40	20	1	6	fracture	4	5-m-Bcircle.dae	-283.68387130	-221.63813112	-0.00417182
31	10	58187	-74.86778	40.51766	0.00	50	81	40	20	1	6	fracture	4	5-m-Bcircle.dae	275.77599952	231.40353949	0.00405553
32	11	58187	-74.86778	40.51766	0.00	204	73	40	20	1	6	fracture	4	5-m-Bcircle.dae	-146.42519151	-328.87636475	-0.00215331
33	12	58188	-74.86443	40.51670	0.00	222	80	40	20	1	6	fracture	4	5-m-Bcircle.dae	-240.88701829	-267.53213717	-0.00354246
34	13	58188	-74.86443	40.51670	0.00	125	68	40	20	1	6	fracture	4	5-m-Bcircle.dae	294.89473594	-206.48751709	0.00433669
35	14	58189	-74.85085	40.50994	0.00	50	70	40	20	1	6	fracture	4	5-m-Bcircle.dae	275.77599952	231.40353949	0.00405553
36	15	58189	-74.85085	40.50994	0.00	165	74	40	20	1	6	fracture	4	5-m-Bcircle.dae	93.17485624	-347.73329746	0.00137022
37	16	58189	-74.85085	40.50994	0.00	305	70	40	20	1	6	fracture	4	5-m-Bcircle.dae	-294.89473594	206.48751709	-0.00433669
38	17	58195	-74.87427	40.52176	0.00	70	62	40	20	1	6	fracture	4	5-m-Bcircle.dae	338.28934348	123.12725160	0.00497484
39	18	58195	-74.87427	40.52176	0.00	96	68	40	20	1	6	fracture	4	5-m-Bcircle.dae	358.02788233	-37.63024678	0.00526512
40	19	58195	-74.87427	40.52176	0.00	138	83	40	20	1	6	fracture	4	5-m-Bcircle.dae	240.88701829	-267.53213717	0.00354246
41	20	58196	-74.87184	40.52154	0.00	86	58	40	20	1	6	fracture	4	5-m-Bcircle.dae	359.12305809	25.11233055	0.00528122
42	21	58215	-74.84091	40.50364	0.00	120	61	40	20	1	6	fracture	4	5-m-Bcircle.dae	311.76914536	-180.00000000	0.00458484
43	22	58215	-74.84091	40.50364	0.00	120	61	40	20	1	6	fracture	4	5-m-Bcircle.dae	311.76914536	-180.00000000	0.00458484
44	23	58228	-74.85324	40.52197	0.00	256	63	40	20	1	6	fracture	4	5-m-Bcircle.dae	-349.30646146	-87.09188242	-0.00513686
45	24	58231	-74.83457	40.52480	0.00	184	83	40	20	1	6	fracture	4	5-m-Bcircle.dae	-25.11233055	-359.12305809	-0.00036930
46	25	58231	-74.83457	40.52480	0.00	90	66	40	20	1	6	fracture	4	5-m-Bcircle.dae	360.00000000	0.00000000	0.00529412
47	26	58231	-74.83457	40.52480	0.00	80	57	40	20	1	6	fracture	4	5-m-Bcircle.dae	354.53079108	62.51334396	0.00521369
48	27	58231	-74.83457	40.52480	0.00	274	82	40	20	1	6	fracture	4	5-m-Bcircle.dae	-359.12305809	25.11233055	-0.00528122
49	28	58231	-74.83457	40.52480	0.00	267	47	40	20	1	6	fracture	4	5-m-Bcircle.dae	-359.50663251	-18.84094425	-0.00528686
50	29	58231	-74.83457	40.52480	0.00	264	63	40	20	1	6	fracture	4	5-m-Bcircle.dae	-358.02788233	-37.63024678	-0.00526512
51	30	58231	-74.83457	40.52480	0.00	103	78	40	20	1	6	fracture	4	5-m-Bcircle.dae	350.77322332	-80.98237956	0.00515843
52	31	58231	-74.83457	40.52480	0.00	45	76	40	20	1	6	fracture	4	5-m-Bcircle.dae	254.55844123	254.55844123	0.00374351
53	32	58232	-74.84469	40.51395	0.00	111	60	40	20	1	6	fracture	4	5-m-Bcircle.dae	336.08895354	-129.01246184	0.00494248
54	33	58232	-74.84469	40.51395	0.00	194	77	40	20	1	6	fracture	4	5-m-Bcircle.dae	-87.09188242	-349.30646146	-0.00128076
55	34	58232	-74.84469	40.51395	0.00	92	52	40	20	1	6	fracture	4	5-m-Bcircle.dae	359.78069773	-12.56381881	0.00529089
56	35	58232	-74.84469	40.51395	0.00	95	49	40	20	1	6	fracture	4	5-m-Bcircle.dae	358.63009131	-31.37606739	0.00527397
57	36	58232	-74.84469	40.51395	0.00	177	72	40	20	1	6	fracture	4	5-m-Bcircle.dae	18.84094425	-359.50663251	0.00027707
58	37	58232	-74.84469	40.51395	0.00	204	71	40	20	1	6	fracture	4	5-m-Bcircle.dae	-146.42519151	-359.50663251	0.00027707
59	38	58233	-74.84239	40.51534	0.00	91	80	40	20	1	6	fracture	4	5-m-Bcircle.dae	359.94517026	-6.28286632	0.00529331
60	39	58233	-74.84239	40.51534	0.00	279	88	40	20	1	6	fracture	4	5-m-Bcircle.dae	-355.56780261	56.31640741	-0.00522894
61	40	58233	-74.84239	40.51534	0.00	117	58	40	20	1	6	fracture	4	5-m-Bcircle.dae	320.76234871	-163.43657991	0.00471709
62	41	58233	-74.84239	40.51534	0.00	166	82	40	20	1	6	fracture	4	5-m-Bcircle.dae	87.09188242	-349.30646146	0.00128076
63	42	58234	-74.84139	40.51599	0.00	4	90	40	20	1	6	fracture	4	5-m-Bcircle.dae	25.11233055	359.12305809	0.00036930
64	43	58234	-74.84139	40.51599	0.00	90	87	40	20	1	6	fracture	4	5-m-Bcircle.dae	360.00000000	0.00000000	0.00529412
65	44	58234	-74.84139	40.51599	0.00	270	87	40	20	1	6	fracture	4	5-m-Bcircle.dae	-360.00000000	0.00000000	-0.00529412
66	45	58234	-74.84139	40.51599	0.00	80	75	40	20	1	6	fracture	4	5-m-Bcircle.dae	354.53079108	62.51334396	0.00521369
67	46	58235	-74.83282	40.51947	0.00	324	80	40	20	1	6	fracture	4	5-m-Bcircle.dae	-211.60269083	291.24611797	-0.00311180
68	47	58235	-74.83282	40.51947	0.00	22	86	40	20	1	6	fracture	4	5-m-Bcircle.dae	134.85837363	333.78618764	0.00198321
69	48	58255	-74.81570	40.51913	0.00	112	86	40	20	1	6	fracture	4	5-m-Bcircle.dae	333.78618764	-134.85837363	0.00490862
70	49	58255	-74.81570	40.51913	0.00	107	85	40	20	1	6	fracture	4	5-m-Bcircle.dae	344.26971215	-105.25381370	0.00310153
71	50	58255	-74.81570	40.51913	0.00	6	75	40	20	1	6	fracture	4	5-m-Bcircle.dae	37.63024678	358.02788233	0.00055339

The worksheet input area includes cells with red characters. These include the KML NAME, the ANNO SPACING FACTORS, and the block of red entry values outlined by black. Values for the Station, Longitude, Latitude, Altitude, Azimuth, Dip/Plunge, Xscale, Yscale, Zscale, Symbol, Note, and Color must be input. Ordinarily, the Station, Longitude, Latitude, and structural Azimuth and Dip/Plunge are copied from an ASCII text file or station shapefile *.dbf file.

The scripted cells are converted to a KML file by highlighting the cell block, then copy and paste the contents to an ASCII text editor, such as MS Notepad.exe, then within Notepad, save the files as <File> <Save As> <Enterthefilename.kml>. Then open the saved KML file in GE <File> <Open> <Thesavedfile.kml>.

a. Top of the scripted KML cell block for symbols



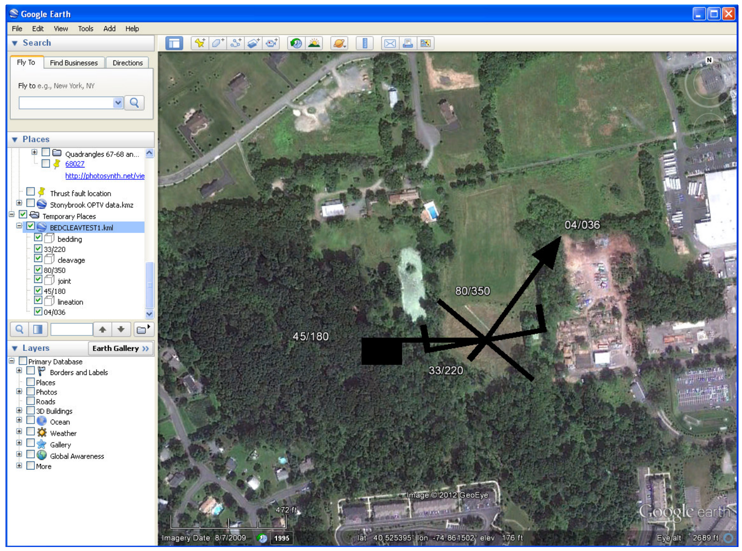
b. Bottom of the scripted KML cell block for symbols and Top of the Anno block.

c. Bottom of the scripted KML Anno block.

The KML output script is written to colored cell blocks at the bottom of each worksheet. The script spans columns C through F. The symbol block lies on top of the annotation block. Each block begins with and ends with the gray cell blocks that must be preserved in their relative order for the script to work properly.

KML Script for mapping 2D Collada object models of geological symbols

```
<kml xmlns="http://www.opengis.net/kml/2.2" xmlns:gx="http://www.google.com/kml/ext/2.2" xmlns:kml="http://www.opengis.net/kml/2.2"
xmlns:atom="http://www.w3.org/2005/Atom">
<Document>
<Style id="sn_noicon"><IconStyle><Icon></Icon></IconStyle><ListStyle></ListStyle></Style>
<Placemark>
<name>	58001	</name>
<LookAt>
<longitude>	-74.860957	</longitude>
<latitude>	40.524946	</latitude>
<altitude>	52	</altitude>
<heading>	0	</heading>
<tilt>	0	</tilt>
<range>	7	</range></LookAt>
<Model id="	model_1	">
<altitudeMode>relativeToGround</altitudeMode>
<Location>
<latitude>	40.524946	</latitude>
<longitude>	-74.860957	</longitude>
<altitude>	55	</altitude></Location>
<Orientation>
<heading>	220	</heading>
<tilt>	0	</tilt>
<roll>	0	</roll></Orientation>
<Scale>
<x>	20	</x>
<y>	20	</y>
<z>	1	</z></Scale>
<Link>
<href>	bed.dae	</href>
</Link></Model></Placemark>
<Placemark>
<name>	33/220	</name>
<styleUrl>#sn_noicon</styleUrl>
<Point>
<coordinates>	-074.861524,040.524532,52.0	</coordinates></Point></Placemark>
<Placemark>
<name>	58001	</name>
<LookAt>
<longitude>	-74.860957	</longitude>
<latitude>	40.524946	</latitude>
<altitude>	52	</altitude>
<heading>	0	</heading>
<tilt>	0	</tilt>
<range>	7	</range></LookAt>
<Model id="	model_1	">
<altitudeMode>relativeToGround</altitudeMode>
<Location>
<latitude>	40.524946	</latitude>
<longitude>	-74.860957	</longitude>
<altitude>	55	</altitude></Location>
<Orientation>
<heading>	350	</heading>
<tilt>	0	</tilt>
<roll>	0	</roll></Orientation>
<Scale>
<x>	20	</x>
<y>	20	</y>
<z>	1	</z></Scale>
<Link>
<href>	cleavage.dae	</href>
</Link></Model></Placemark>
<Placemark>
<name>	80/350	</name>
<styleUrl>#sn_noicon</styleUrl>
<Point>
```



The KML script on this and the following page was used to generate the display above, with one bedding, cleavage, joint, and lineation reading. You can copy and past this code into an ASCII text editor, save it as a *.kml file, and then open it in GE (also see Four_structures.txt). In this example, the script references 4 different objects (bed.dae, cleavage.dae, joint,dae, and arrow.dae).

You can alter the variables to generate your own oriented symbols at any location having ground-based structural geological data.

The MS Excel workbook Geologic_symbols_and_circles_50.xls can also be used for generating KML script for more or less symbols.

It is important to have the KML file in the same directory as the *.dae objects that are being referenced within the script.

```
<coordinates>	-074.861110,040.525478,52.0	</coordinates></Point></Placemark>
<Placemark>
<name>	58001	</name>
<LookAt>
<longitude>	40.524946 </longitude>
<latitude> -74.860957	</latitude>
<altitude> 52	</altitude>
<heading> 0	</heading>
<tilt>	0	</tilt>
<range>	7	</range></LookAt>
<Model id="	model_1	">
<altitudeMode>relativeToGround</altitudeMode>
<Location>
<latitude> 40.524946 </latitude>
<longitude>	-74.860957	</longitude>
<altitude> 55	</altitude></Location>
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<Scale>
<x>	20	</x>
<y>	20	</y>
<z>	1	</z></Scale>
<Link>
<href>	joint.dae	</href></Link></Model></Placemark>
<Placemark>
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<styleUrl>#sn_noicon</styleUrl>
<Point>
<coordinates>	-074.863604,040.524946,52.0	</coordinates></Point>
</Placemark>
<Placemark>
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<LookAt>
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<latitude> -74.860957	</latitude>
<altitude> 52	</altitude>
<heading> 0	</heading>
<tilt>	0	</tilt>
<range>	7	</range></LookAt>
<Model id="	model_1	">
<altitudeMode>relativeToGround</altitudeMode>
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<longitude>	-74.860957	</longitude>
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<y>	20	</y>
<z>	1	</z></Scale>
<Link>
<href>	arrow.dae </href></Link></Model></Placemark>
<Placemark>
<name>	04/036	</name>
<styleUrl>#sn_noicon</styleUrl>
<Point>
<coordinates>	-074.859401,040.526258,52.0	</coordinates></Point></Placemark>
</Document>
</kml>
```
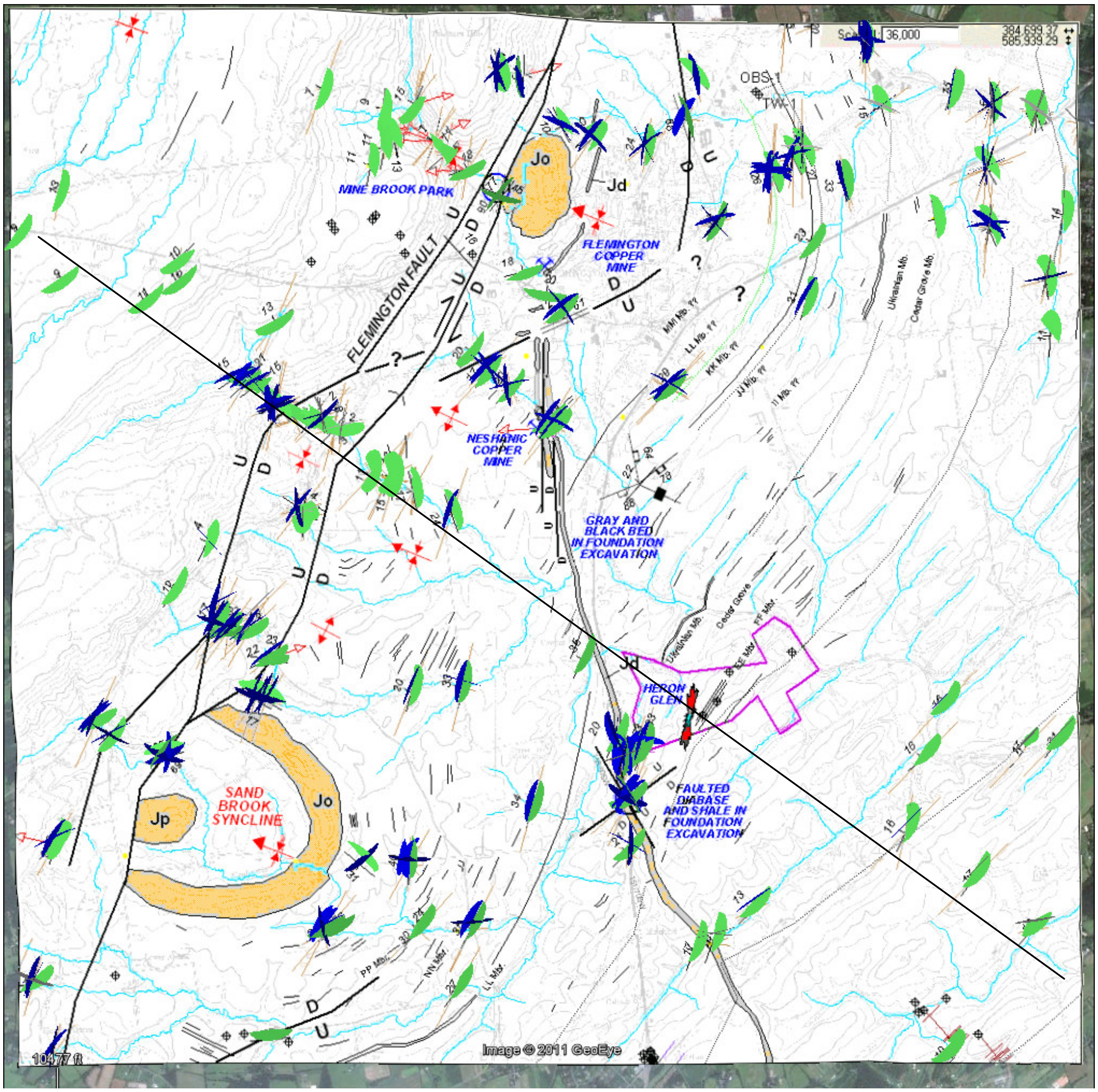
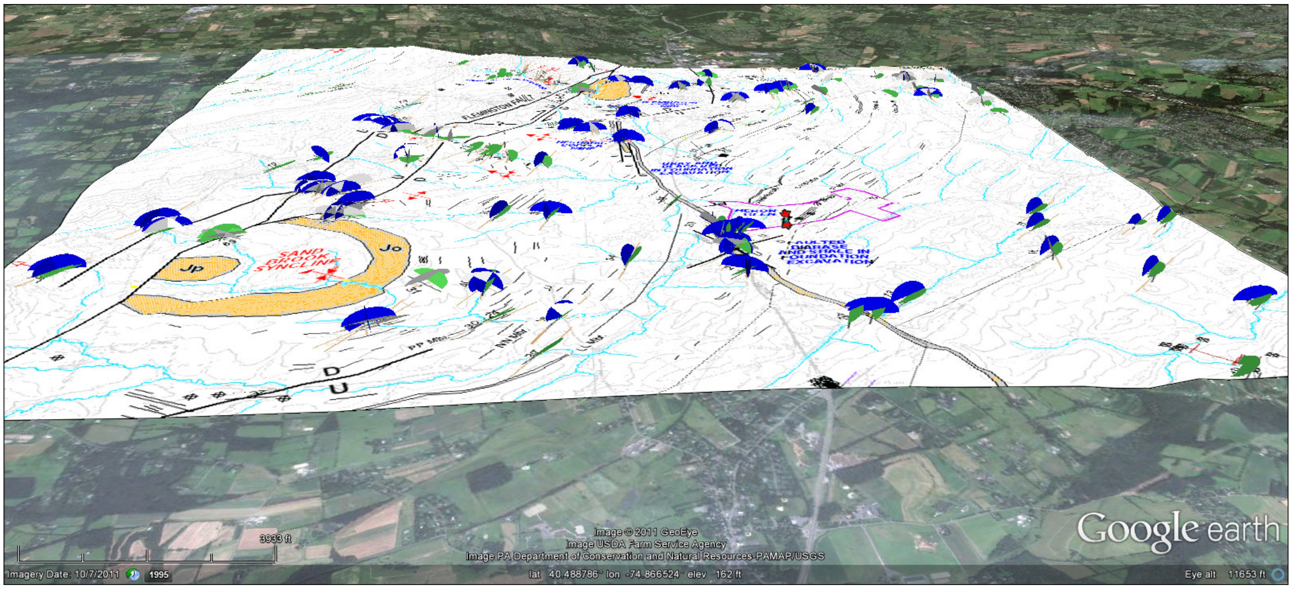

A KMZ example of 3D beds and fractures measured in outcropping Early Mesozoic bedrock from Flemington to Sand Brook, Hunterdon County, New Jersey

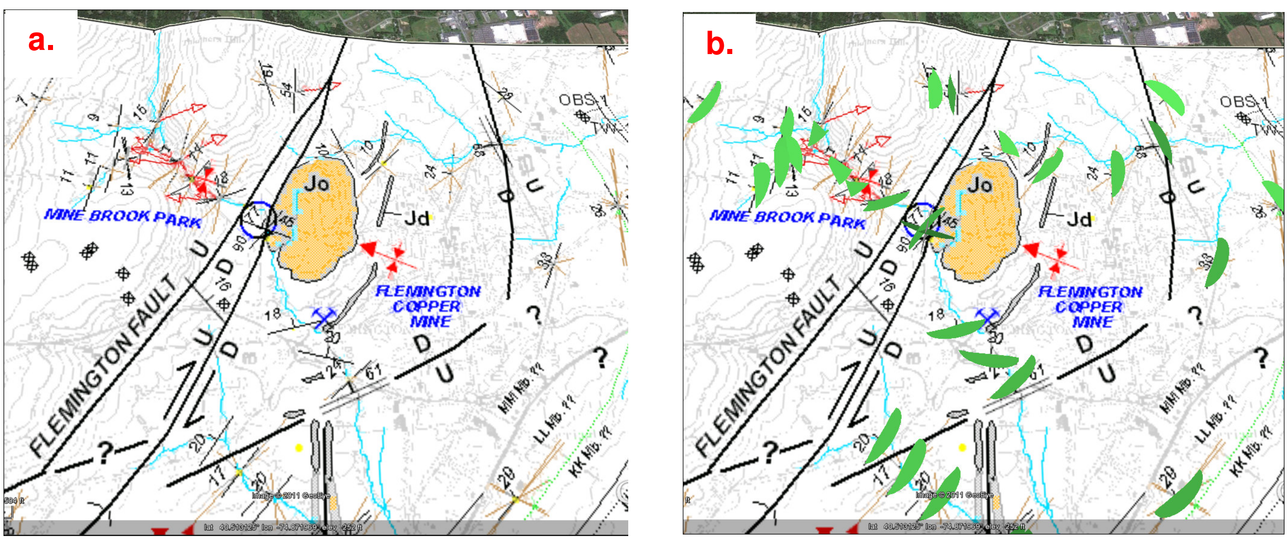
If less than 50 symbols are needed, simply delete the rows from the input and output blocks that correspond with unessential data or scripted values. To do this, drag the curser over the numbered rows along the extreme left-hand column of the worksheet in order to highlight the rows to be deleted. Once, highlighted, right click the mouse and choose <Delete>. The remaining rows will shift up to complete the blocks. Conversely, if you need to generate more than 50 symbols, you will need to copy the worksheet and fill out another, or multiple worksheets for the desired number of symbols. For example, the worksheet on page 7 shows eight worksheets, 3 for bedding symbols, 1 for the raw data, and 4 for fracture symbols. The figure below shows the results from the worksheet, including symbols for bedding planes (122 green ellipses) and fracture planes (200 blue ellipses). The symbols are shown on a registered image of the geological map.



The Flemington122011a.kmz file contains a registered geologic map (GIF image) of the Flemington - Sand Brook area. 3D bed (green) and fracture (blue) polygons (ellipses) are included that were generated using the parameters in the Geologic_symbols_and_circles_50_Flemington.xls workbook file.



An oblique view of the Flemington122011a.kmz file. Once the file is opened, depress the mouse wheel and drag the mouse around in order to control the oblique perspective.

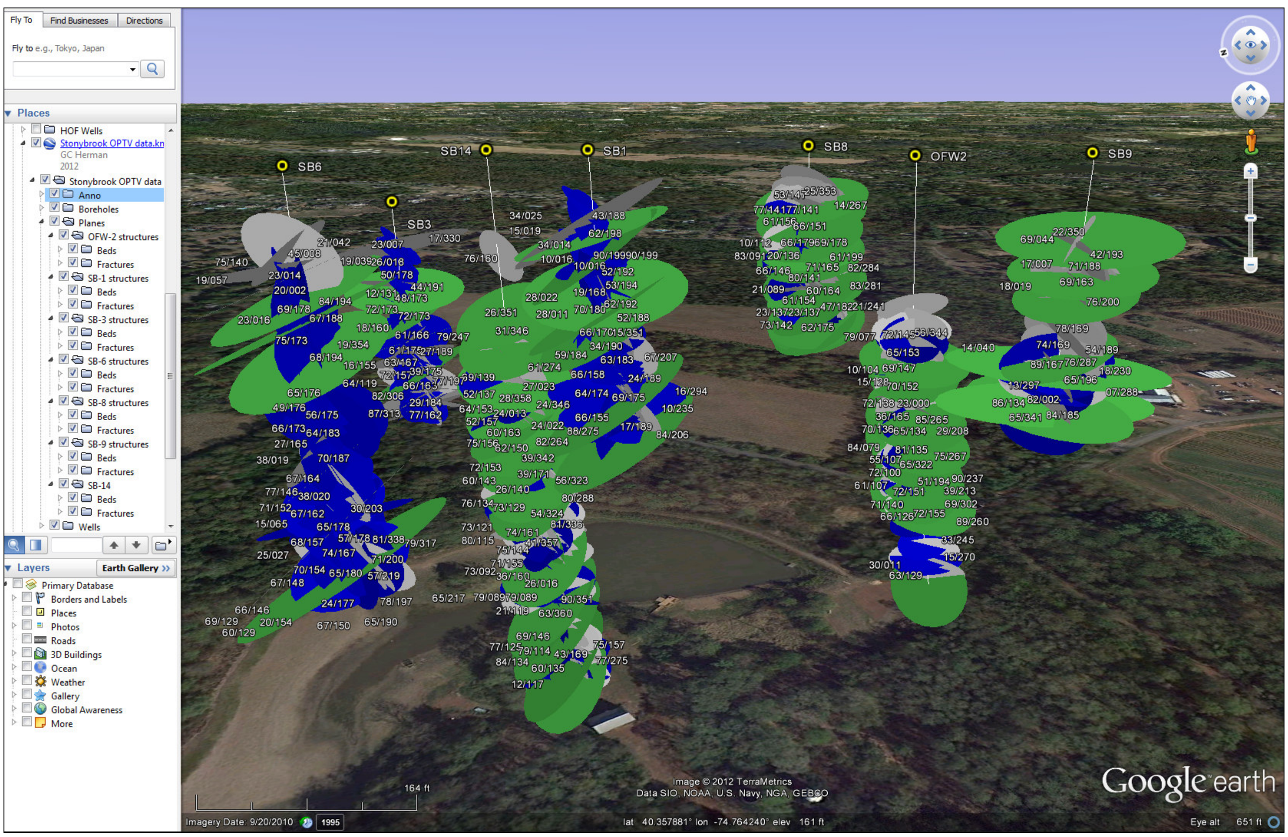


Detailed, oblique view of the Flemington122011a.kmz file showing only the geological map on the left (A) and the map with 3D ellipses of bedding planes on the right (B). The scalloped top edge of the image shows topographic profile along the top of the image. The vertical exaggeration is set at 3X in the GE <Tools><Options) menu. Many of the 3D polygons west of Mine Brook Park demonstrates the 'Rule of V's' by the way the inclined plane form a 'V' along cross-strike stream traces.

Generating 3D borehole traces and elliptical planes representing stratigraphic layering and other fractures from borehole televiewer data

The following methods were developed to use the 3D modeling capabilities of GE for the display of well-field data. GE can display three-dimensional well-field data, in a position hovering just above the Earth's surface, rather than in place below ground. Other programs are capable of below-ground visualization and require the purchase of a software license. GE is free.

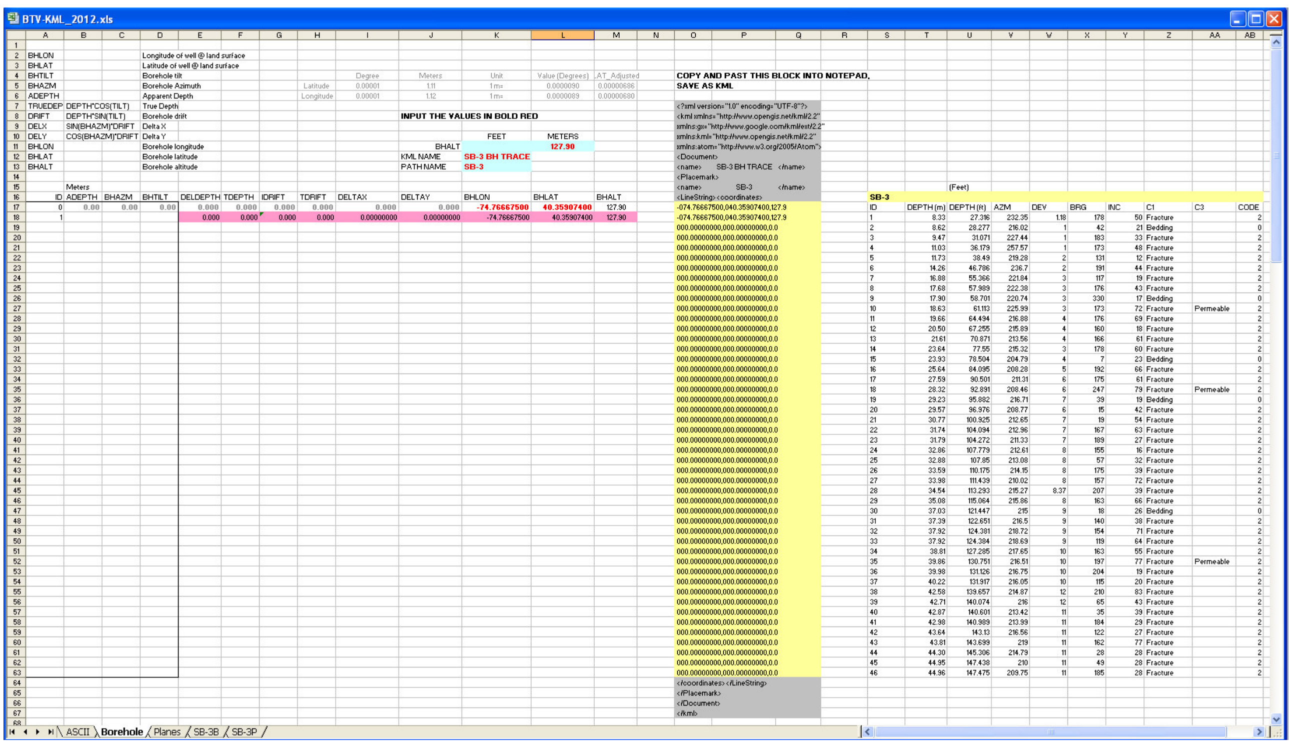
This application was developed using MS Excel, and is designed to be used with structured input in the form of ASCII files containing recorded incremental depth readings inlcuding borehole orientation parameters (telemetry),and structural planes measured in the bore wall imagery. Interpretation of the planes involves classification of primary stratigraphic layering and secondary fractures. These data are compiled using geophysical (acoustic and optical) borehole televiewer probes. Examples of televiewer output and KML input are given below, along with an example application for the Stony Brook-Millstone Watershed Preserve, research well field in Hopewell Township, Mercer County, New Jersey. Thanks to Ms. Bay Weber of the Stony Brook-Millstone Watershed Association providing access to the site and facilitating this work.



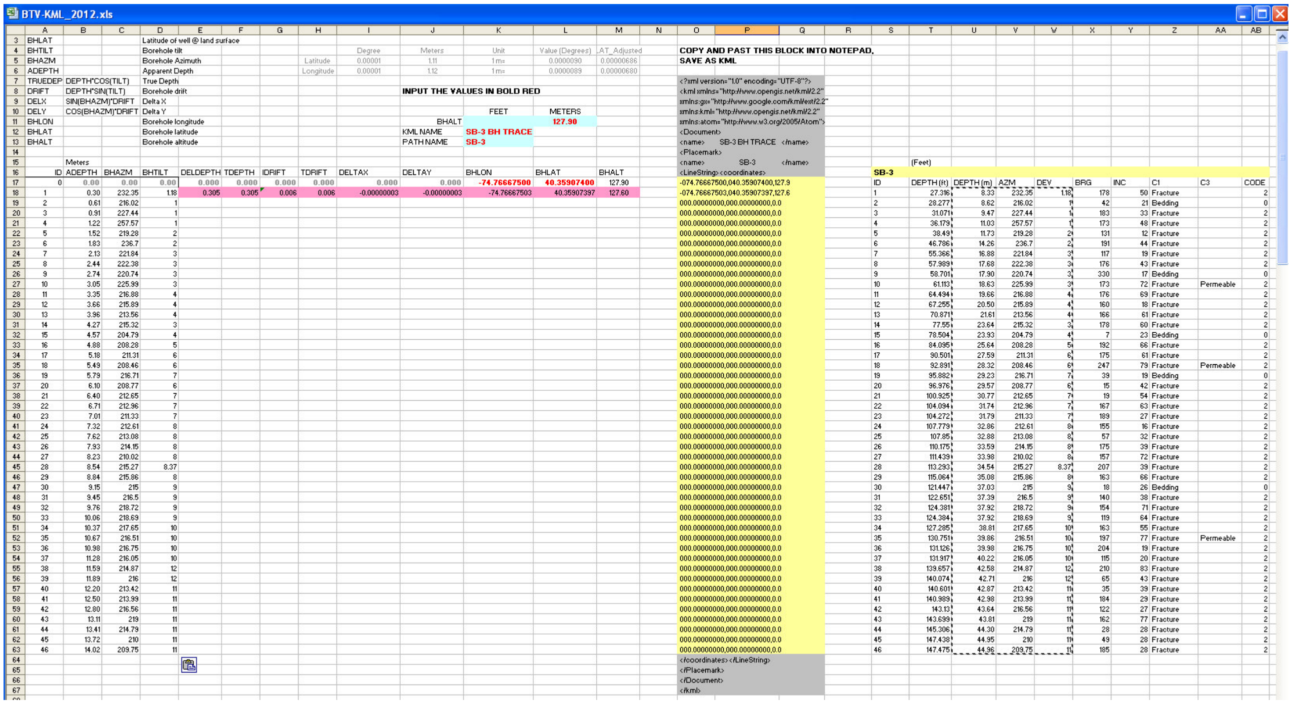
3D visualization of part of the Stony Brook-Millstone Watershed Preserve research well field. All well-field features were raised 80 m from their below-ground position to hover above the well-site. Borehole traces were generated for seven wells. Structural planes and structural annotation were generated along a centerline of the borehole in uncased parts of the well open to bedrock. Bedding planes were generated using 20m x 10m green ellipses whereas secondary fractures are blue and are half the size of bedding. The original research wells have 20 ft of 6" steel casing, whereas some of the newer supply and test wells have 50 ft of casing and are drilled deeper.

3D Borehole Traces

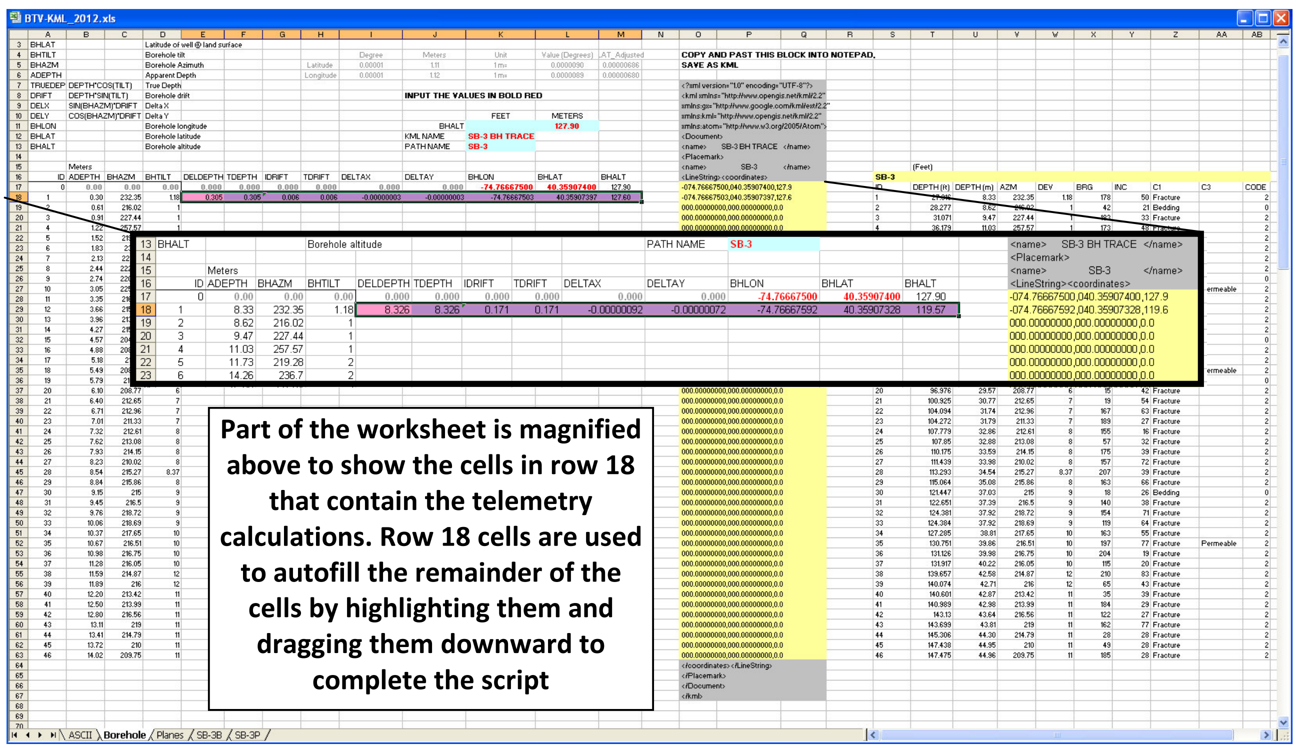
A MS Excel workbook application is illustrated and explained below that can be used to generate and visualize well-field 3D borehole traces and geological planes. The workbook contains two types of worksheets that are formatted for generating 3D boreholes and planes. The borehole worksheet is designed for use with borehole data obtained in open, uncased intervals in consolidated bedrock. It uses the geographic coordinates of the well head, and the elevation of the ground surface at the well head, as the starting point for generating the borehole telemetry. The telemetry of the borehole is based on incremental, subsurface measurements of the depths at which planes are measured in open intervals of the well. It therefore uses only parts of the BTV records rather than all of the telemetry data generated by the entire survey. The resulting borehole reprentation is therefore an approximation, based on a non-uniform sampling of the subsurface geology. The complete telemtry record could be used, but the method outlined here is designed so that the output from the borehole worksheet serves as coordinate input for the worksheet used for generating the planes. Therefore, the borehole trace is based on a starting location with location coordinates of the well at ground surface, and sequential readings in the subsurface beginning with the first measured structural plane below the cased part of the borehole. The worksheet for generating the borehole trace is covered first followed an explanation for the worksheet used for generating 3D subsurface planes.



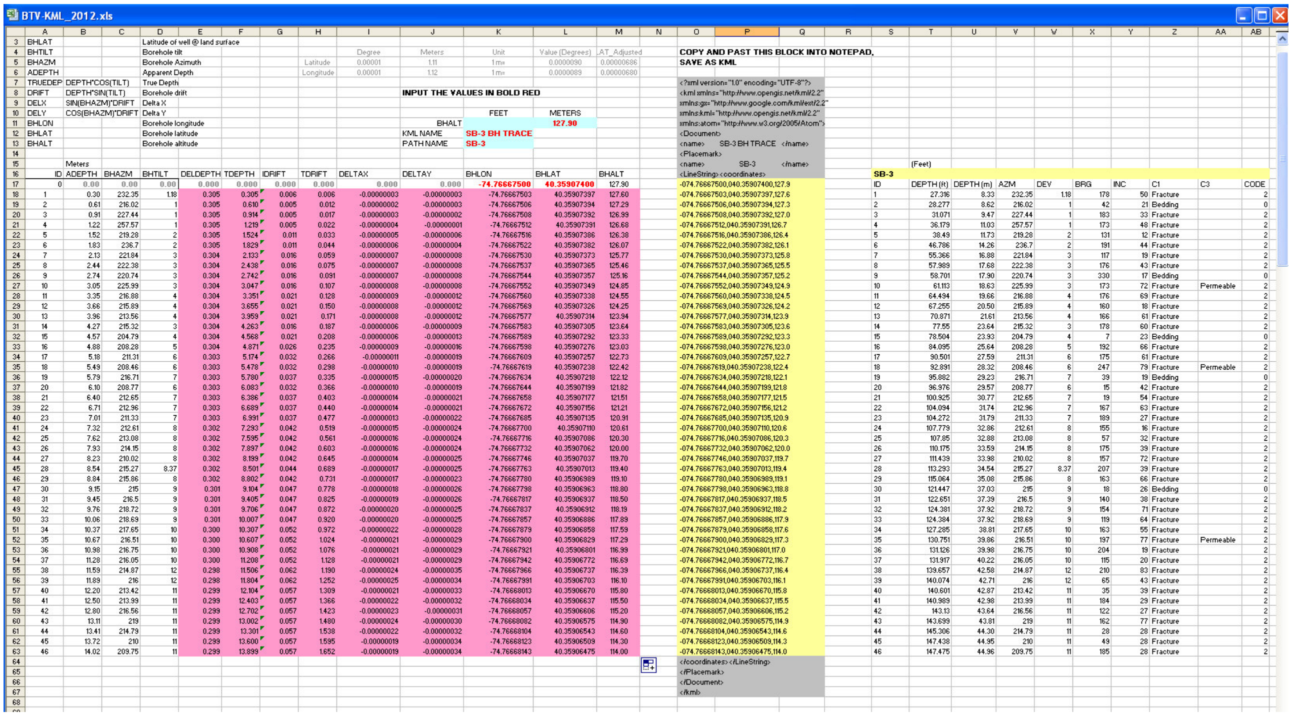
This worksheet is used for generating borehole traces based on BTV data. The surface value for the well location is entered as geographic coordinates in cells K17 and L17. Land surface elevation is added in cell L11. The other variables highlighted in red set the KML NAME and PATHNAME. The script is generated by first adding data values for the first 4 columns (A-D). Values for these fields are copied and pasted from an ASCII text file that was previously prepared as software output from a BTV interpretation. An example of a BTV data is shown in the columns to the right beginning with cell S18. Please note that the default units of vertical measurement in GE are meters. Therefore, if depth measurements were acquired using feet, then conversion to meters is first needed. <Copy> & <Paste> the values for the borehole telemetry (ID, ADEPTH, BHAZM, and BHTILT) to the left side in columns A-D as shown below.



In the example above, the first four columns on the left side of the borehole worksheet are filled by copying and pasting telemetry data from the BTV output file, shown on the right side of the KML script block in the worksheet.



Once the telemetry cells are filled, depress the left mouse button and drag the mouse to highlight cells E18 to M18 as shown above. With the cells highlighted, and the mouse button still depressed, grab the lower right-hand corner of cell M18 and drag the mouse downward to auto fill the remainder of the cells, and to write the KML script as shown below.

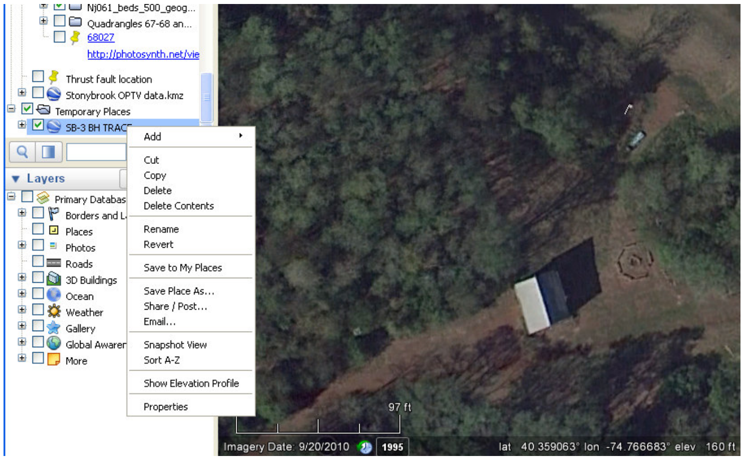


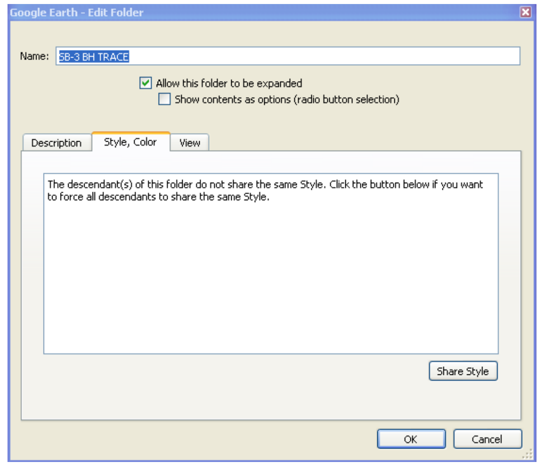
An example of a completed borehole worksheet with the KML script written to the middle block of cells including the gray cell blocks. Select and highlight the KML cell block, then <Copy> & <Paste> it to an ASCII text editor, save the text file as a *.KML file, and open in it GE.

An additional distance must be added to the starting elevation (BHALT) to make the path hover above the land surface. A distance of 80 m was added to all borehole elevations in the Stony Brook-Millstone well field , and is reflected in the formulation in cell L11 (47.9 + 80 = 127.9). The 80 m value was derived by assessing the depths of all wells in the well field, and using the lowest elevation reached by the deepest well as a guide. For example, the deepest well in the well field is OFW-2 (372.5 ft or about 113.6 m). The elevation of the well head for OFW-2 is 52.4 m. Therefore, the lowest elevation penetrated is about -62 m (52 – 114). An additional 80m value was added to all wells in order to make the bottom of the borehole trace of the deepest well hover about 18 m above ground surface.

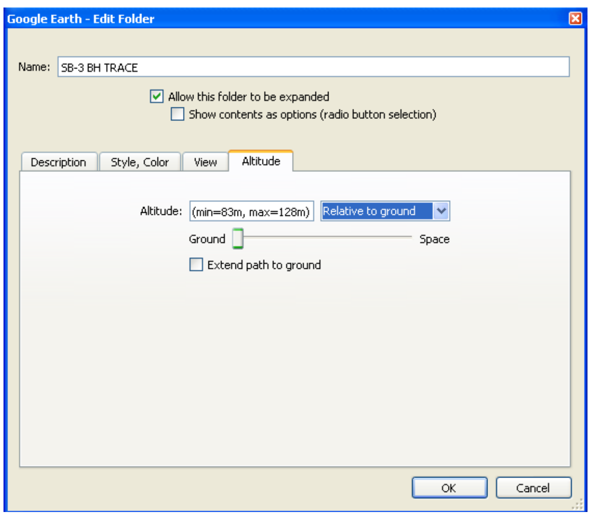
Once the KML script is completed, copy the block of cells containing the script to an ASCII text editor (recommend Notepad.exe in MS Windows). Save the text file with a *.KML filename extension. The file can then be opened in GE. One final step in needed in order to correctly display your data. When the file is opened, the default display mode has the 3D borehole trace clamped to the ground, so it will appear as a line trace on the land surface. Following is the procedure from switching to the default altitude mode to one that positions the trace *Relative to Ground Surface* and displays the data in its 3D alignment hovering above the ground surface:

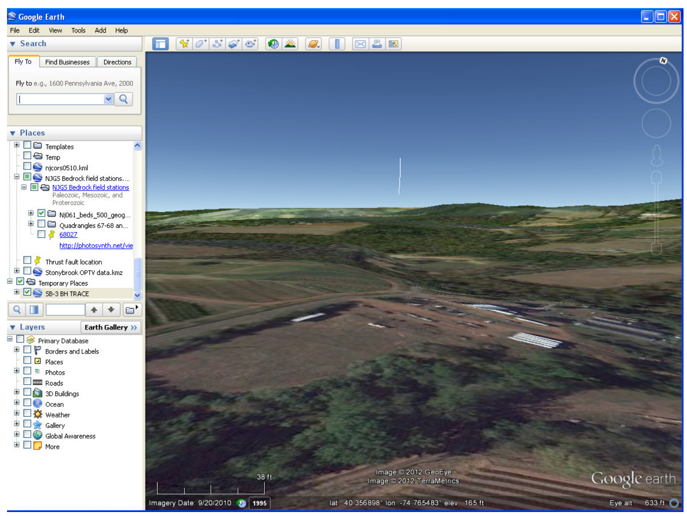
1) Load the KML. GE will automatically zoom to the new location.
2) Activate the object in the Temporary Places folder, then right click on the object to access its properties





3) When the Edit Folder window pops up, click on the <Share Style> Tab (below right)
4) The Edit Folder display then shows the <Altitude> Tab. Click on the <Altitude> Tab, and then set the display <Relative to Ground> as shown below.





3D Structural Planes

The process for generating 3D planes from BTV records along the trace of a borehole is similar to that outlined above for mapping oriented geological symbols. The main difference is that the location and elevation coordinates from the worksheet for a specific borehole are used as input for the coordinates in the worksheet for the correlative planes. Simply copy the block of cells containing the coordinates from the borehole worksheet (in columns BHLON, BHLAT, and BHALT), paste them into an ASCII text editor (like MS Notepad.exe), then cut & paste them into the worksheet for the planes (in columns Longitude, Latitude, and Altitude). *The intermediate step of copying them to an ASCII text editor is necessary because the coordinate values are calculated in the cells, and copying the cell values to a text editor preserves the coordinate values rather than the cell formulae.*

As with the geological symbols application outlined earlier, the maximum number of oriented planes that can be generated per worksheet is 50. Therefore, for BTV interpretations having more than 50 planes, it is necessary to generate more than one worksheet to complete the representation.

Two different workbooks are made available for download. The Stony_Brook-SB-6_OBI-KML.xls (362 KB) workbook is a pared down version of the Stony_Brook-OBI-KMLs.xls (2.27 MB) workbook . The former contains 3 worksheets containing the ASCII output from the BTV data file and borehole and plan worksheets for a single well (SB-6), whereas the latter contains 19 worksheets for 7 wells. Use the Stony_Brook-SB-6_OBI-KML.xls as a template for any new work, but make sure to copy the worksheet and rename it before proceeding in order to preserve the integrity of the templates. The Stony_Brook-SB-6_OBI-KML.xls workbook is used as a template because the BTV record for SB-6 contains records for more than 50 planes and therefore demonstrates how to use a couple of worksheets to generate 3D structures for a single borehole. Aspects of both workbooks are illustrated and further explained below.

A KMZ example of 3D well-field visualization for part of the Stony Brook-Millstone Watershed Preserve research well field, Hopewell Township, Mercer County, New Jersey.

ASCII text outputs from the BTV surveys conducted on each well were compiled in a single worksheet for use in the compilation and well-field-generation process.

Stonybrook-OBI-KMLs.xls

ADD ELEVATION 370/3.28	113	m

SB-1

ID	DEPTH	AZM	DEV	BRG	INC	CODE	C0	C1	C2	C3	C4
1	28	214	3	188	43	2		Fracture	Gently-in		Calcite-v
2	32	208	3	25	34	0	Bedding				
3	33	211	3	198	62	2	Tectonic	Fracture			Calcite-v
4	36	219	3	19	15	0	Bedding				
5	43	220	3	185	27	2		Fracture	Gently-in		Calcite-v
6	46	216	4	14	34	0	Bedding				
7	47	220	3	198	61	2	Tectonic	Fracture			Calcite-v
8	48	220	3	199	90	2	Tectonic	Fracture			Calcite-v
9	51	224	4	16	10	2		Fracture	Gently-in		Calcite-v
10	52	220	4	192	52	2		Fracture	Moderatel		Calcite-v
11	58	215	5	194	53	2		Fracture	Moderatel		Calcite-v
12	60	220	5	168	19	2		Fracture	Gently-in		Calcite-v
13	62	221	5	197	83	2	Tectonic	Fracture			Calcite-v
14	62	220	5	348	18	0	Bedding				
15	63	220	6	192	62	2	Tectonic	Fracture			Calcite-v
16	65	221	6	180	70	2	Tectonic	Fracture			Calcite-v
17	69	221	6	188	52	2		Fracture	Moderatel		Calcite-v
18	70	225	7	22	28	0	Bedding			Conductiv	
19	76	223	8	11	28	0	Bedding				
20	78	225	8	170	66	2	Tectonic	Fracture			Calcite-v
21	82	225	9	190	34	2		Fracture	Moderatel		Calcite-v
22	83	227	9	351	15	2		Fracture	Gently-in		Calcite-v
23	85	224	8	184	59	2		Fracture	Moderatel		Calcite-v
24	88	225	9	147	74	2	Tectonic	Fracture			Calcite-v
25	88	225	9	207	67	2	Tectonic	Fracture		Conductiv	Calcite-v
26	91	223	10	183	63	2	Tectonic	Fracture			Calcite-v
27	92	226	9	207	23	2		Fracture	Gently-in		Calcite-v
28	94	222	10	209	49	2		Fracture	Moderatel		Calcite-v
29	95	222	10	355	24	2		Fracture	Gently-in		Calcite-v
30	97	225	11	158	66	2	Tectonic	Fracture			Calcite-v
31	99	223	11	197	34	2		Fracture	Moderatel		Calcite-v
32	103	223	12	189	24	2		Fracture	Gently-in		Calcite-v
33	103	222	12	174	64	2	Tectonic	Fracture			Calcite-v
34	105	223	12	175	69	2	Tectonic	Fracture			Calcite-v
35	110	222	13	171	60	2		Fracture	Moderatel		Calcite-v
36	111	221	13	294	16	2		Fracture	Gently-in		Calcite-v
37	114	222	13	23	27	0	Bedding				
38	117	224	13	155	66	2	Tectonic	Fracture			Calcite-v
39	118	225	12	235	10	2		Fracture	Gently-in		Calcite-v
40	122	222	14	21	21	2		Fracture	Gently-in		Calcite-v
41	123	224	14	189	17	2		Fracture	Gently-in		Calcite-v
42	125	223	14	206	84	2	Tectonic	Fracture			Calcite-v
43	130	231	14	146	77	2	Tectonic	Fracture		Conductiv	Calcite-v
44	131	234	14	22	24	0	Bedding				

SB-3

ID	DEPTH	INC	BRG	CODE	AZM	DEV	C0	C1	C2	C3	C4
1	27.316	50	178	2	232.35	1.18		Fracture	Moderately-inclined		Calcite-vein
2	28.277	21	42	0	216.02	1	Bedding				
3	31.071	33	183	2	227.44	1		Fracture	Moderately-inclined		Calcite-vein
4	36.179	48	173	2	257.57	1		Fracture	Moderately-inclined		Calcite-vein
5	38.49	12	131	2	219.28	2		Fracture	Gently-inclined		Calcite-vein
6	46.786	44	191	2	236.7	2		Fracture	Moderately-inclined		Calcite-vein
7	55.366	19	117	2	221.84	3		Fracture	Gently-inclined		Calcite-vein
8	57.989	43	176	2	222.38	3		Fracture	Moderately-inclined		Calcite-vein
9	58.701	17	330	0	220.74	3	Bedding				
10	61.113	72	173	2	225.99	3	Tectonic	Fracture		Conductiv	Calcite-vein
11	64.494	69	176	2	216.88	4	Tectonic	Fracture			Calcite-vein
12	67.255	18	160	2	215.89	4		Fracture	Gently-inclined		Calcite-vein
13	70.871	61	166	2	213.56	4	Tectonic	Fracture			Calcite-vein
14	77.55	60	178	2	215.32	3	Tectonic	Fracture			Calcite-vein
15	78.504	23	7	0	204.79	4	Bedding				
16	84.095	66	192	2	208.28	5	Tectonic	Fracture			Calcite-vein
17	90.501	61	175	2	211.31	6	Tectonic	Fracture			Calcite-vein
18	92.891	79	247	2	208.46	6	Tectonic	Fracture		Conductiv	Calcite-vein
19	95.882	19	39	0	216.71	7	Bedding				
20	96.976	42	15	2	208.77	6		Fracture	Gently-inclined		Calcite-vein
21	100.925	54	19	2	212.65	7		Fracture	Moderately-inclined		Calcite-vein
22	104.094	63	167	2	212.96	7	Tectonic	Fracture			Calcite-vein
23	104.272	27	189	2	211.33	7		Fracture	Gently-inclined		Calcite-vein
24	107.779	16	155	2	212.61	8		Fracture	Gently-inclined		Calcite-vein
25	107.85	32	57	2	213.08	8		Fracture	Gently-inclined		Calcite-vein
26	110.175	39	175	2	214.15	8		Fracture	Moderately-inclined		Calcite-vein
27	111.439	72	157	2	210.02	8	Tectonic	Fracture	Conductive		Calcite-vein
28	113.293	39	207	2	215.27	8.37		Fracture	Moderately-inclined		Calcite-vein
29	115.064	66	163	2	215.86	8	Tectonic	Fracture			Calcite-vein
30	121.447	26	18	0	215	9	Bedding				
31	122.651	38	140	2	216.5	9		Fracture	Moderately-inclined		Calcite-vein
32	124.381	71	154	2	218.72	9	Tectonic	Fracture			Calcite-vein
33	124.384	64	119	2	218.69	9	Tectonic	Fracture			Calcite-vein
34	127.285	55	163	2	217.65	10		Fracture	Moderately-inclined		Calcite-vein
35	130.751	77	197	2	216.51	10	Tectonic	Fracture		Conductiv	Calcite-vein
36	131.126	19	204	2	216.75	10		Fracture	Gently-inclined		Calcite-vein
37	131.917	20	115	2	216.05	10		Fracture	Gently-inclined		Calcite-vein
38	139.657	83	210	2	214.87	12	Tectonic	Fracture			Calcite-vein
39	140.074	43	65	2	216	12		Fracture	Moderately-inclined		Calcite-vein
40	140.601	39	35	2	213.42	11		Fracture	Moderately-inclined		Calcite-vein
41	140.989	29	184	2	213.99	11		Fracture	Gently-inclined		Calcite-vein
42	143.13	27	122	2	216.56	11		Fracture	Gently-inclined		Calcite-vein
43	143.699	77	162	2	219	11	Tectonic	Fracture			Calcite-vein
44	145.306	28	28	2	214.79	11		Fracture	Gently-inclined		Calcite-vein
45	147.438	28	49	2	210	11		Fracture	Gently-inclined		Calcite-vein
46	147.475	28	185	2	209.75	11		Fracture	Gently-inclined		Calcite-vein

SB-8

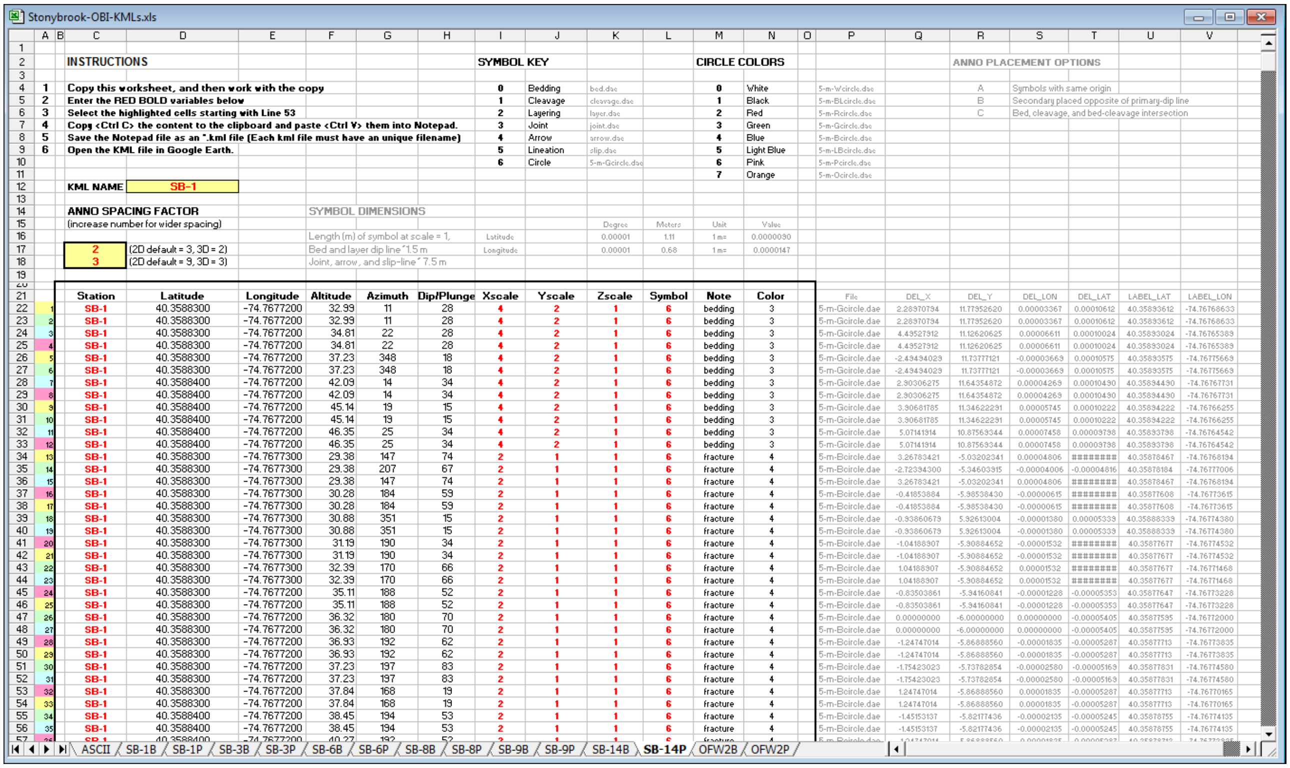
ID	DEPTH	INC	BRG	CODE	AZM	DEV	C0	C1	C2	C3	C4
1	22.426	51	165	2	289	3	Fracture	Moderately-inclined			
2	29.973	79	164	2	72	1	Tectonic	Fracture		Conductive	
3	30.408	53	147	2	72	1	Tectonic	Fracture		Conductive	
4	34.211	25	353	0	237	2	Bedding	Conductive			
5	36.011	77	141	2	7.35	1.01	Tectonic	Fracture		Conductiv	Calcite-vein
6	37.421	19	324	2	17	2		Fracture	Gently-inclined		Calcite-vein
7	38.226	14	267	2	208.18	2.5		Fracture	Gently-inclined		Calcite-vein
8	39.21	77	131	2	230	4	Tectonic	Fracture		Conductiv	Calcite-vein
9	41.068	72	159	2	247	4	Tectonic	Fracture		Conductiv	Calcite-vein
10	41.088	41	162	2	247	4	Tectonic	Fracture			Calcite-vein

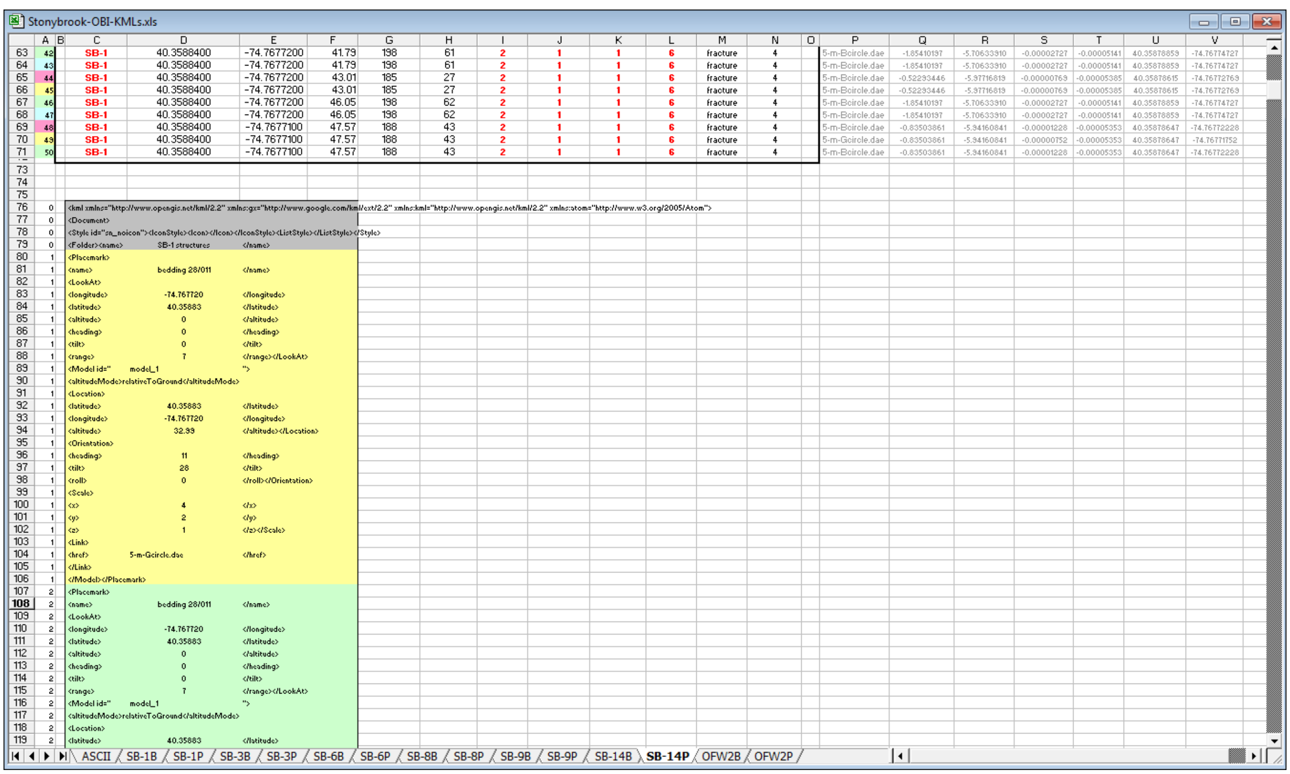
SB-9

ID	DEPTH	INC	BRG	CODE	AZM	DEV	C0	C1	C2	C3	C4
1	44.126	22	350	0	352.81	3	Bedding				
2	46.387	69	44	2	348.47	3	Tectonic	Fracture			Calcite-vein
3	52.314	42	193	2	355.36	4		Fracture	Moderatetly-inclined		Calcite-vein
4	58.814	71	188	2	0	4.01	Tectonic	Fracture			Calcite-vein
5	63.545	17	7	0	5.45	5	Bedding				
6	63.596	86	182	2	5.1	5	Tectonic	Fracture			Calcite-vein
7	67.116	85	162	2	5.65	5.35	Tectonic	Fracture			Calcite-vein
8	67.443	69	163	2	5	6	Tectonic	Fracture			Calcite-vein
9	76.903	18	19	0	4	7	Bedding				
10	79.883	76	200	2	4.93	7	Tectonic	Fracture			Calcite-vein

A worksheet was used to organize the digital output from the BTV records for 8 wells. Column abbreviations include AZM - Borehole azimuth, DEV - borehole deviation, BRG - Dip azimuth of measured plane, INC - Plane dip, CODE - 0 for bedding, 2 for fracture, C0 - C4 - Descriptive string variables.

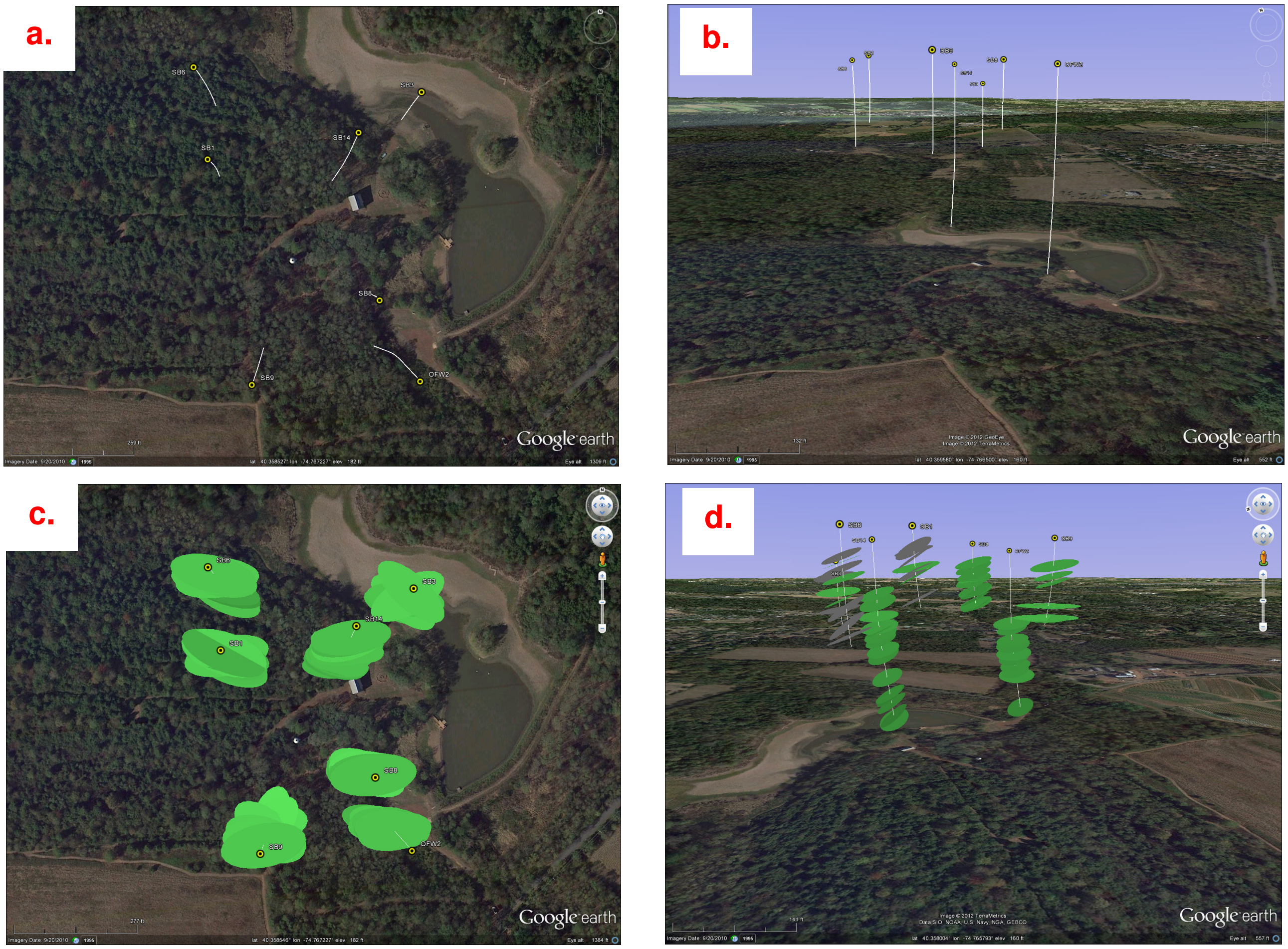
A worksheet for the planes measured in well SB-1 is shown below as two images in order to capture the different worksheet elements, including the data-input cells and the top of the KML script. Please note the number of worksheets at the bottom of each image and their arrangement in the workbook. The block of KML script beginning on line 76 in the example below, is similar as that illustrated on page 9 above.



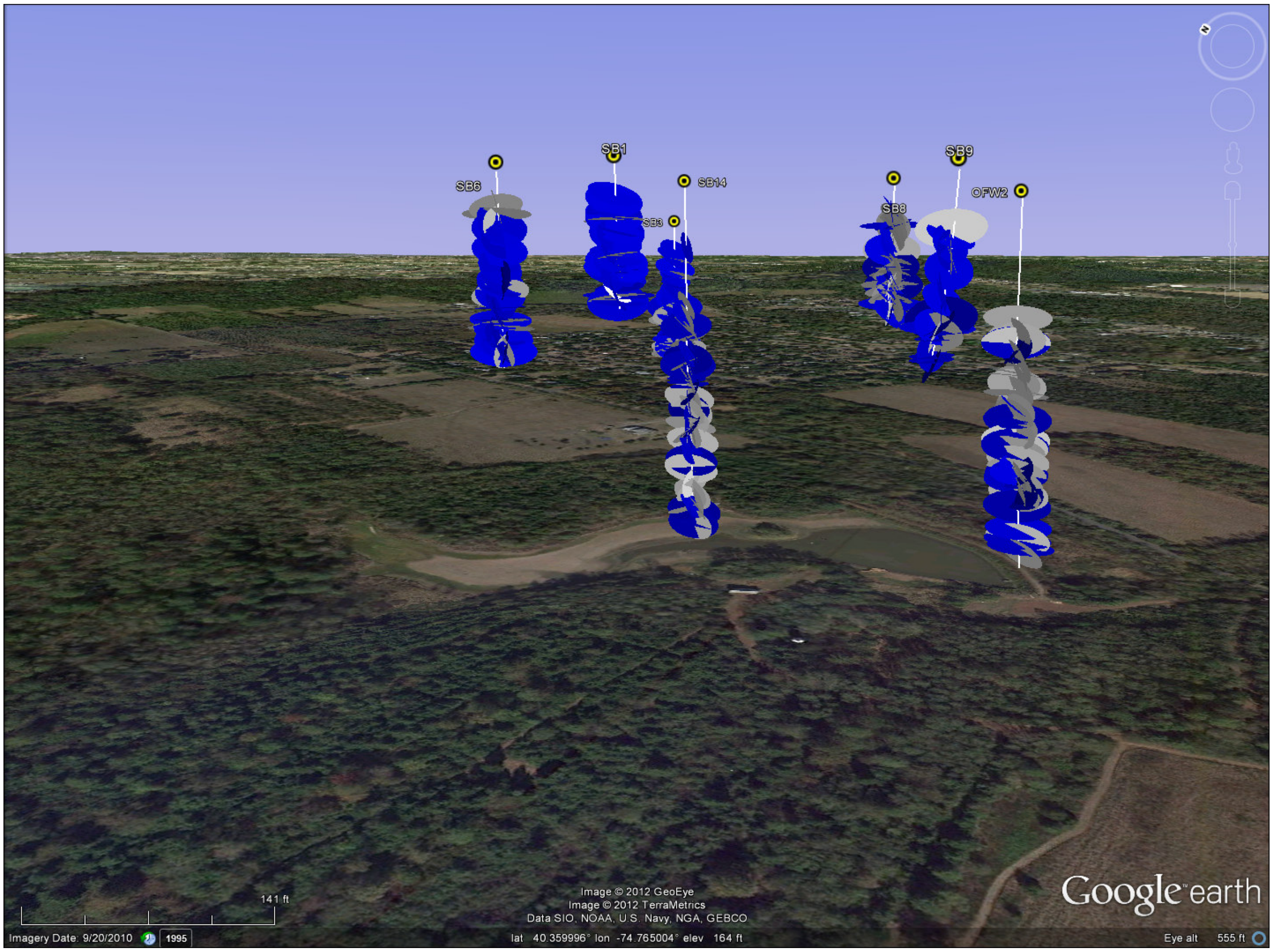


Open the Stony_Brook-SB-6_OBI-KML.xls workbook to see an example of how to use more than one worksheet to for wells having more than 50 planes.

The images below show different perspectives for the composite sets of boreholes (a and b) and boreholes with bedding planes (c and d). Remember that each sets of objects were raised 80m in order to hover above ground.



3D visualization of borehole traces and bedding ellipses for part of the Stony Brook-Millstone Watershed Preserve research well field, Hopewell Township, Mercer County, New Jersey. The features were raised 80m from their below-ground position to hover above ground. Borehole traces were generated for seven wells (a and b). Structural planes were generated throughout uncased parts of the well open to bedrock (c and d). Bedding planes were generated using 20m ellipses with a 2:1, strike:dip-direction ratio. Fractures (blue ellipses) are half the size of bedding with the same aspect.



3D visualization of non-bedding fracture planes in part of the Stony Brook-Millstone Watershed Preserve research well field, Hopewell Township, Mercer County, New Jersey. The features were raised 80m from their below-ground position to hover above ground. Structural planes were generated throughout uncased parts of the well open to bedrock (c and d). Bedding planes were generated using 10m ellipses with a 2:1, strike:dip-direction ratio.

Once all of the borehole traces, 3D planes, and annotation are generated and opened in GE, you may want to reorganize the data layers in order to turn on and off any features of choice as a group of objects. To do this, simply add folders to the GE object, and either drag each item to its new destination or use the cut & paste options to complete the reorganization. Be sure to clean up any remnant folders and save your work before exiting GE.

Be sure to remember to have the *.dae symbol files reside in the same directory that you have your KML script when it is opened in GE in order for it them to work properly.