Processing Analytical Data in 3D for the Homestake Mine, South Dakota

(Case-Study Demonstrating the RockWorks Playlist Capability)

3/13/22

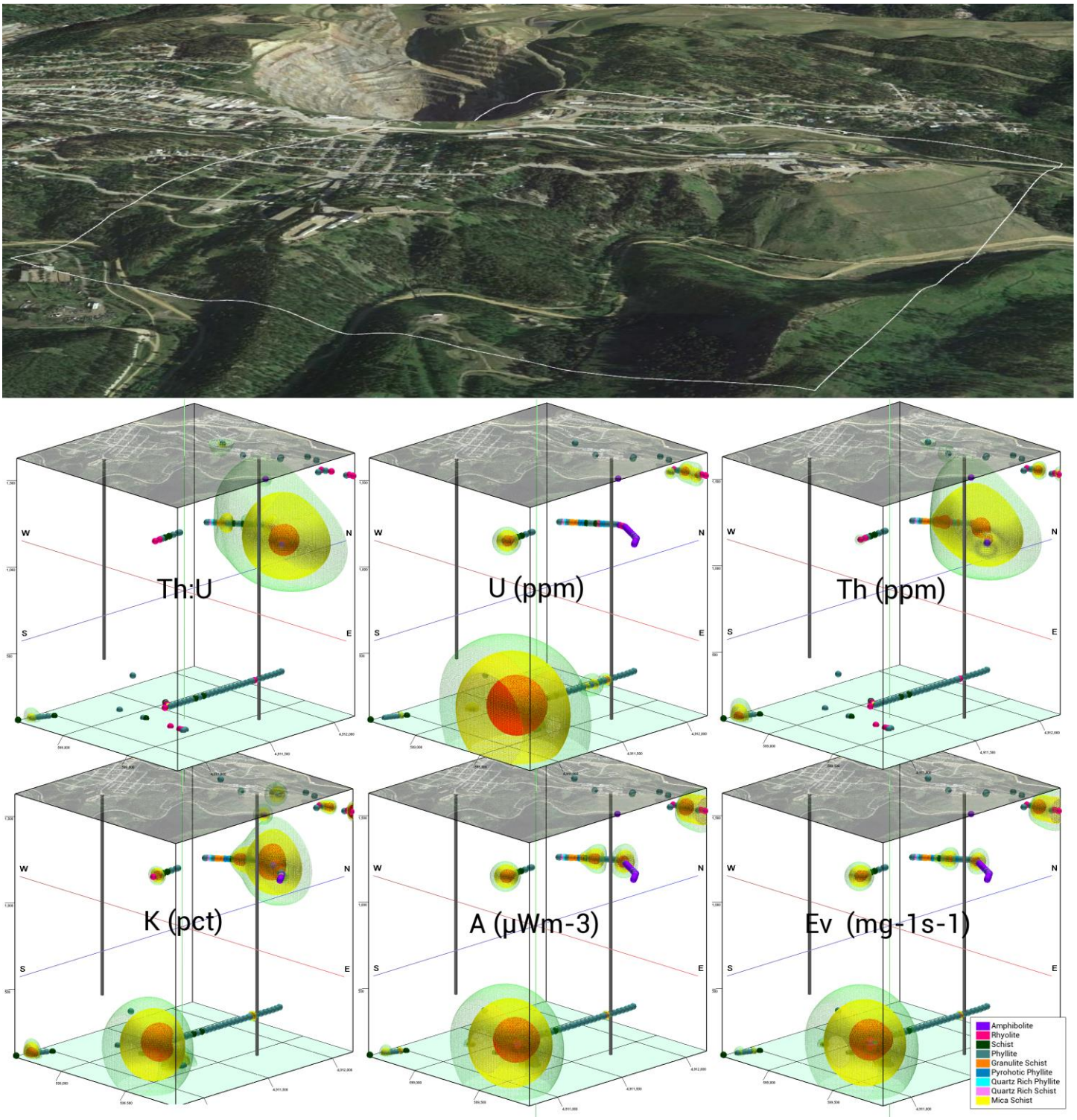
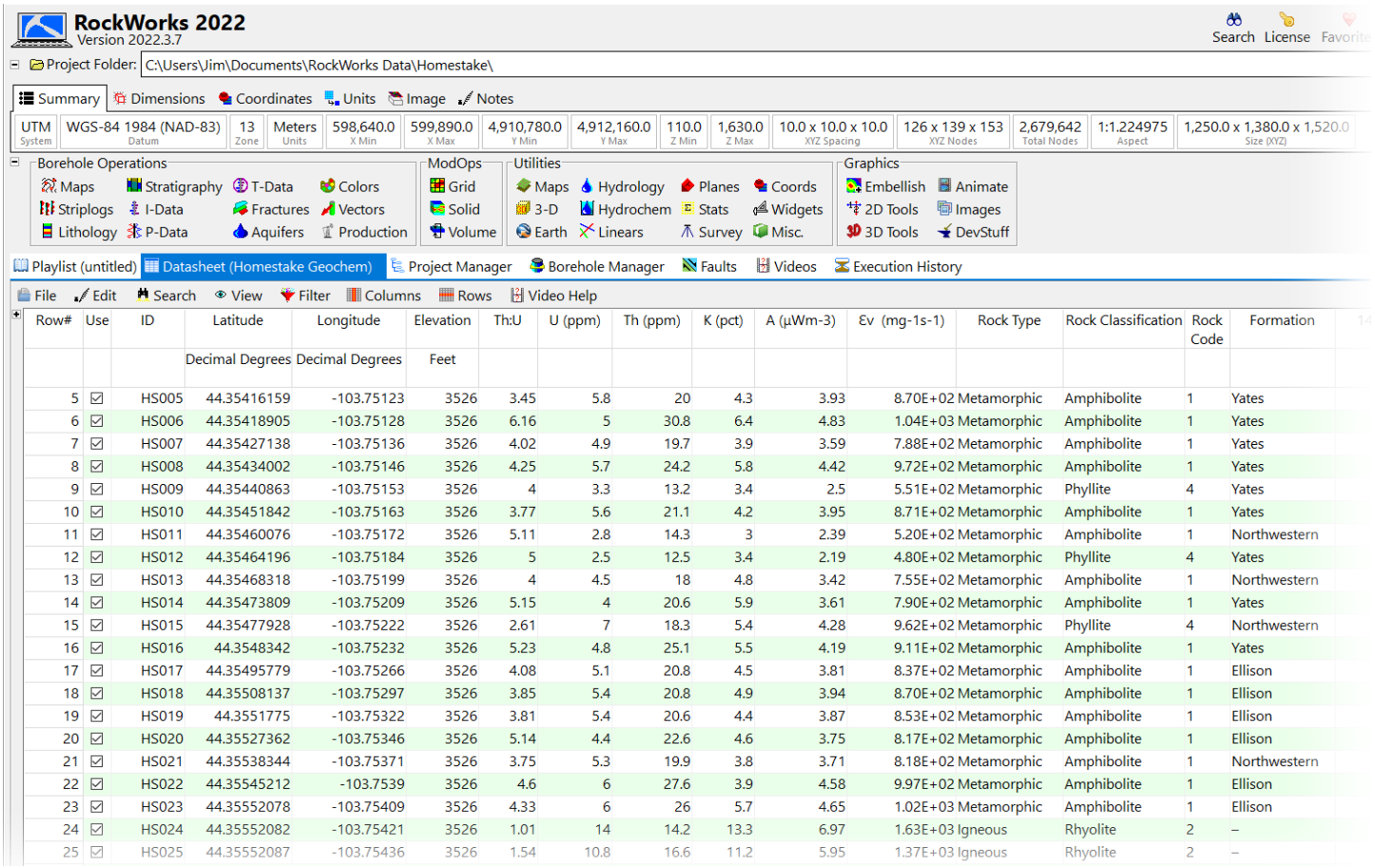


Figure 1. Study site and anomaly models.

Step 1. An Excel file containing subsurface geochemical data was copied into the RockWorks datasheet (Figure 2) by using the Windows clipboard copy/paste commands. This data was provided by Dylan Young who collected it as part of a research thesis relating to neutrino detection at the Sanford Underground Research Facility in the Northern Black Hills of South Dakota.



Row#	Use	ID	Latitude	Longitude	Elevation	Th:U	U (ppm)	Th (ppm)	K (pct)	A (µWm-3)	Ev (mg-1s-1)	Rock Type	Rock Classification	Rock Code	Formation
			Decimal Degrees	Decimal Degrees	Feet										
5	☑	HS005	44.35416159	-103.75123	3526	3.45	5.8	20	4.3	3.93	8.70E+02	Metamorphic	Amphibolite	1	Yates
6	☑	HS006	44.35418905	-103.75128	3526	6.16	5	30.8	6.4	4.83	1.04E+03	Metamorphic	Amphibolite	1	Yates
7	☑	HS007	44.35427138	-103.75136	3526	4.02	4.9	19.7	3.9	3.59	7.88E+02	Metamorphic	Amphibolite	1	Yates
8	☑	HS008	44.35434002	-103.75146	3526	4.25	5.7	24.2	5.8	4.42	9.72E+02	Metamorphic	Amphibolite	1	Yates
9	☑	HS009	44.35440863	-103.75153	3526	4	3.3	13.2	3.4	2.5	5.51E+02	Metamorphic	Phyllite	4	Yates
10	☑	HS010	44.35451842	-103.75163	3526	3.77	5.6	21.1	4.2	3.95	8.71E+02	Metamorphic	Amphibolite	1	Yates
11	☑	HS011	44.35460076	-103.75172	3526	5.11	2.8	14.3	3	2.39	5.20E+02	Metamorphic	Amphibolite	1	Northwestern
12	☑	HS012	44.35464196	-103.75184	3526	5	2.5	12.5	3.4	2.19	4.80E+02	Metamorphic	Phyllite	4	Yates
13	☑	HS013	44.35468318	-103.75199	3526	4	4.5	18	4.8	3.42	7.55E+02	Metamorphic	Amphibolite	1	Northwestern
14	☑	HS014	44.35473809	-103.75209	3526	5.15	4	20.6	5.9	3.61	7.90E+02	Metamorphic	Amphibolite	1	Yates
15	☑	HS015	44.35477928	-103.75222	3526	2.61	7	18.3	5.4	4.28	9.62E+02	Metamorphic	Phyllite	4	Northwestern
16	☑	HS016	44.3548342	-103.75232	3526	5.23	4.8	25.1	5.5	4.19	9.11E+02	Metamorphic	Amphibolite	1	Yates
17	☑	HS017	44.35495779	-103.75266	3526	4.08	5.1	20.8	4.5	3.81	8.37E+02	Metamorphic	Amphibolite	1	Ellison
18	☑	HS018	44.35508137	-103.75297	3526	3.85	5.4	20.8	4.9	3.94	8.70E+02	Metamorphic	Amphibolite	1	Ellison
19	☑	HS019	44.3551775	-103.75322	3526	3.81	5.4	20.6	4.4	3.87	8.53E+02	Metamorphic	Amphibolite	1	Ellison
20	☑	HS020	44.35527362	-103.75346	3526	5.14	4.4	22.6	4.6	3.75	8.17E+02	Metamorphic	Amphibolite	1	Ellison
21	☑	HS021	44.35538344	-103.75371	3526	3.75	5.3	19.9	3.8	3.71	8.18E+02	Metamorphic	Amphibolite	1	Northwestern
22	☑	HS022	44.35545212	-103.7539	3526	4.6	6	27.6	3.9	4.58	9.97E+02	Metamorphic	Amphibolite	1	Ellison
23	☑	HS023	44.35552078	-103.75409	3526	4.33	6	26	5.7	4.65	1.02E+03	Metamorphic	Amphibolite	1	Ellison
24	☑	HS024	44.35552082	-103.75421	3526	1.01	14	14.2	13.3	6.97	1.63E+03	Igneous	Rhyolite	2	–
25	☑	HS025	44.35552087	-103.75436	3526	1.54	10.8	16.6	11.2	5.95	1.37E+03	Igneous	Rhyolite	2	–

Figure 2

Step 2. The ***Dimensions / Scan / Datasheet -> Dimensions*** program (Figure 3) was used to automatically set the project dimensions and subsequently convert the data from longitude/latitude/feet to UTM meters.

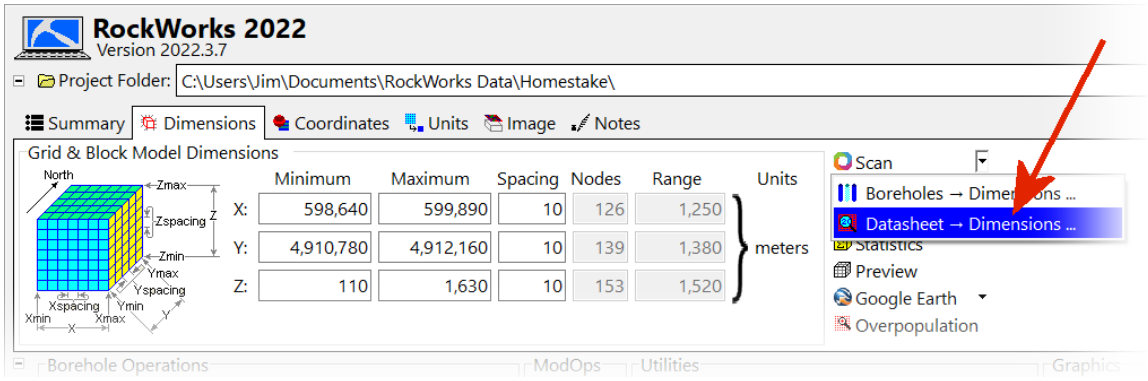


Figure 3

Step 3. The ***Dimensions / Google Earth / Simple*** program (Figure 4) was used to plot the aerial extents of the project within Google Earth. The Google Earth image (Figure 5) was saved for use within Step 4.

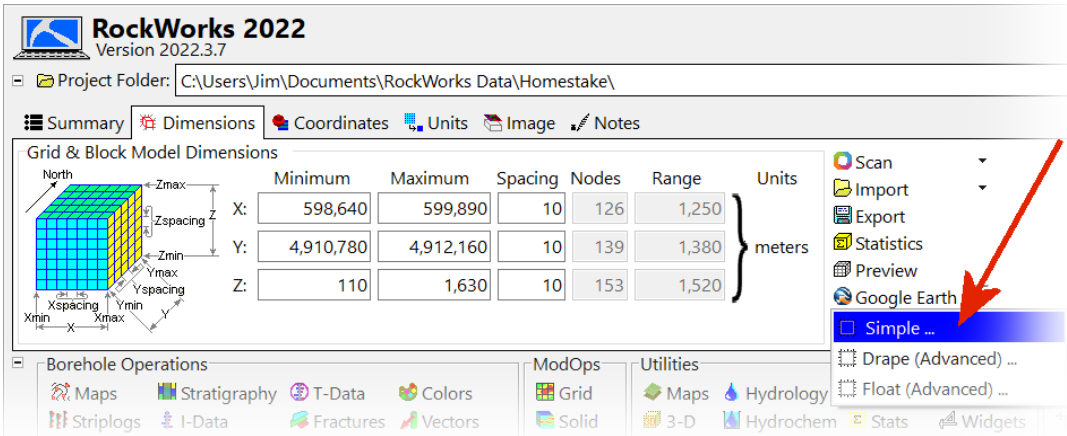


Figure 4

Figure 5

Step 4. The ***Graphics / Images / Georeference*** program (Figure 6) was used to crop, rotate, and register the coordinates of the Google Earth image for subsequent use as a floating later within the 3D diagrams.

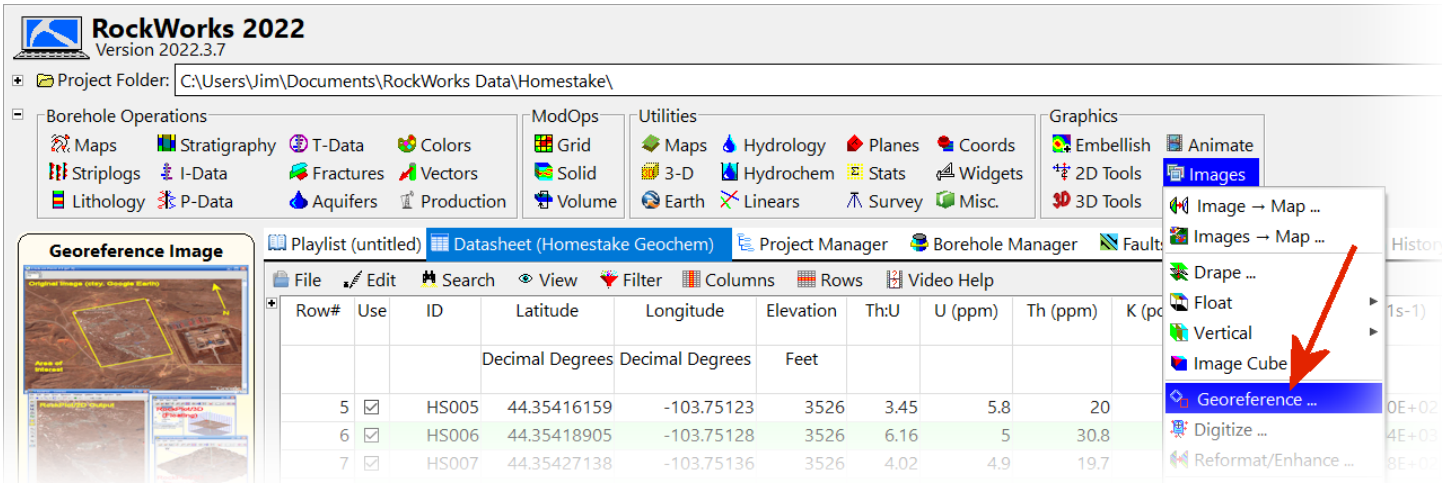
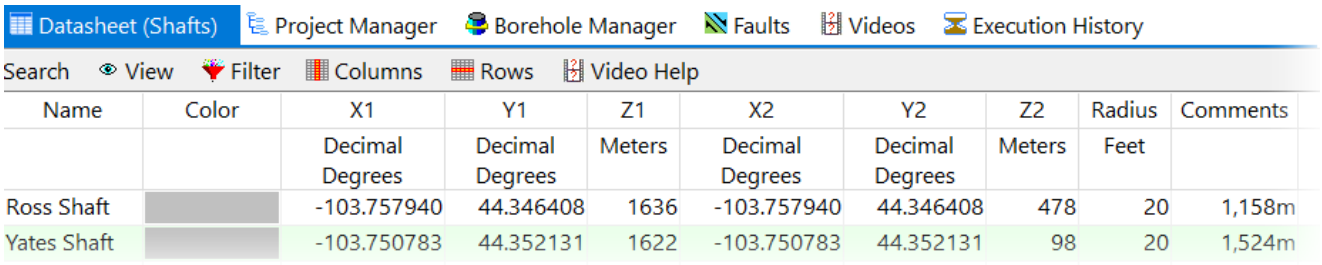


Figure 6

Step 5. A simple datasheet (Figure 6) was created with the XYZ coordinates (derived from Google Earth) for the two shafts that provide access to the underground laboratory.



Name	Color	X1	Y1	Z1	X2	Y2	Z2	Radius	Comments
		Decimal Degrees	Decimal Degrees	Meters	Decimal Degrees	Decimal Degrees	Meters	Feet	
Ross Shaft		-103.757940	44.346408	1636	-103.757940	44.346408	478	20	1,158m
Yates Shaft		-103.750783	44.352131	1622	-103.750783	44.352131	98	20	1,524m

Figure 6

Step 6. The ***Utilities / 3-D / Tubes*** program (Figure 8) was used to plot the shaft data as visual reference objects (Figure 8) within subsequent diagrams

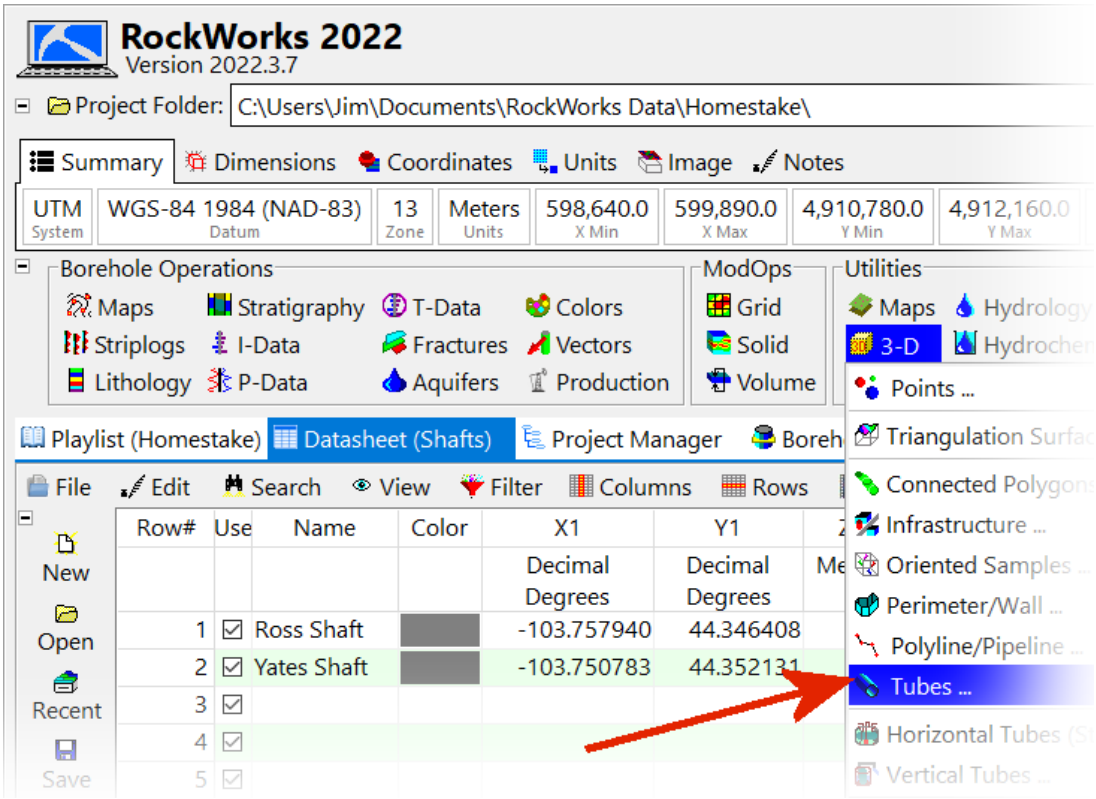


Figure 7

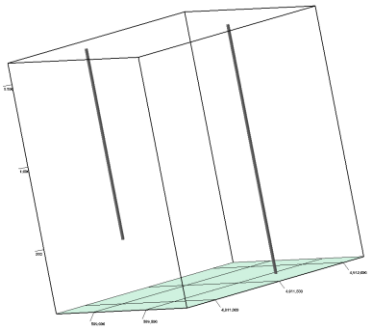


Figure 8

Step 7. The Utilities / 3D / Points program (Figure 7) was then used to create 3D diagrams (Figure 8) depicting the quantitative data within the datasheet columns as proportionally-sized and proportionally-colored (cold-to-hot) spheres.

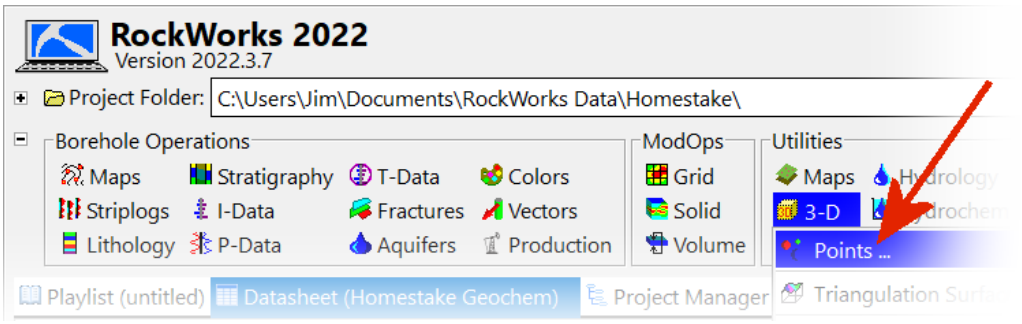


Figure 7

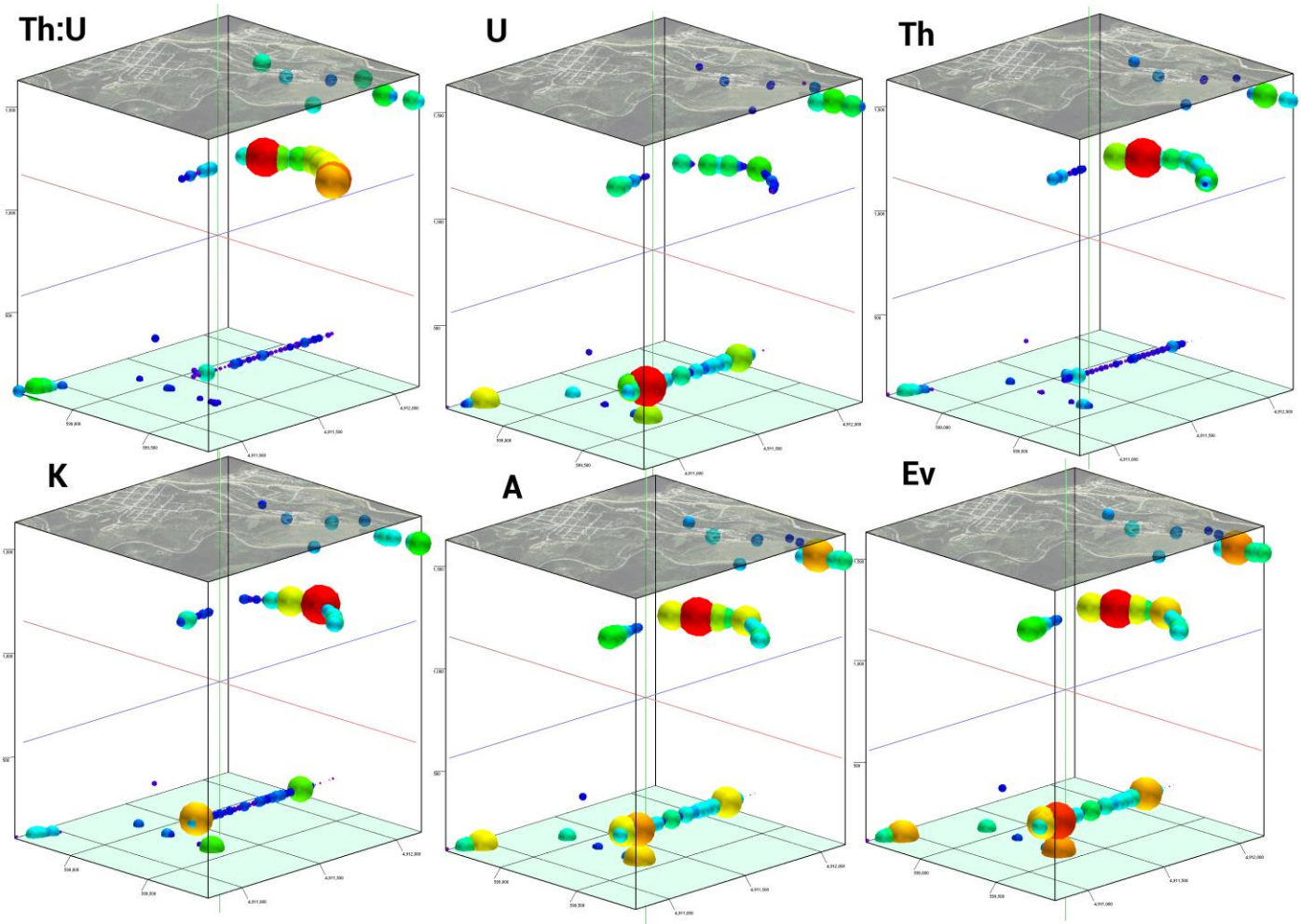


Figure 8

Step 8. In order to plot the rock types, arbitrary numeric codes were assigned to the rock classifications and a lookup table was created (Figure 9) for use within the Points program output (Figure 10).

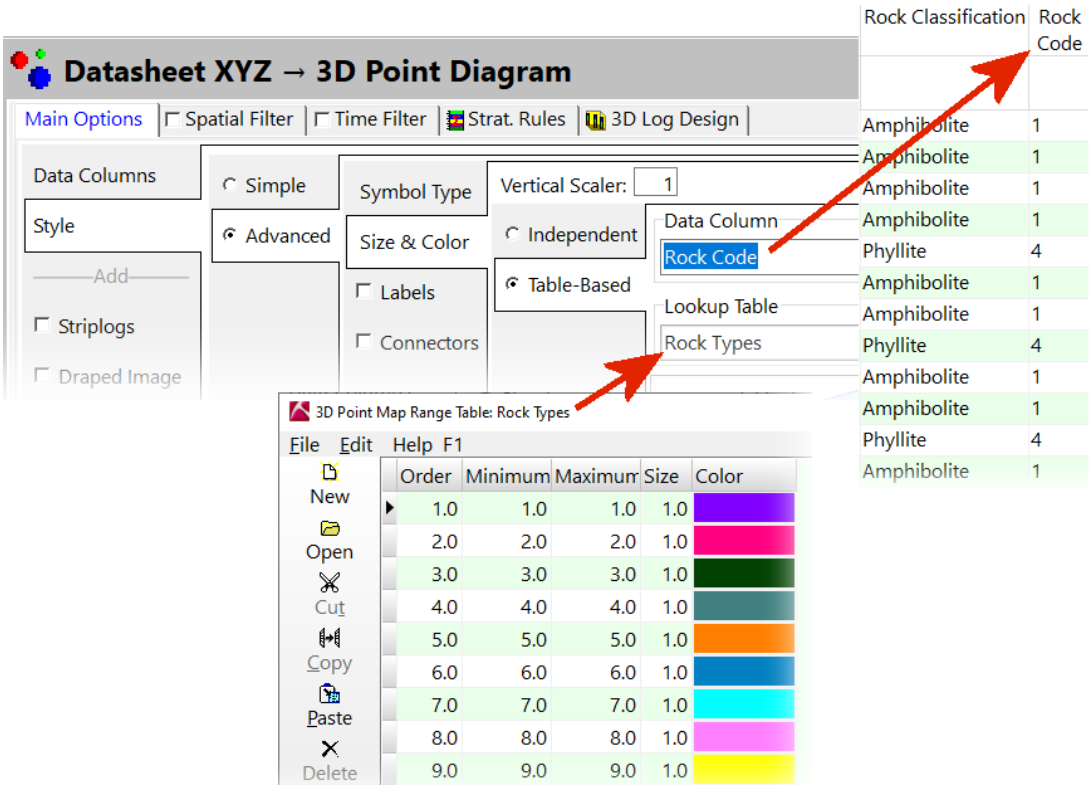


Figure 9

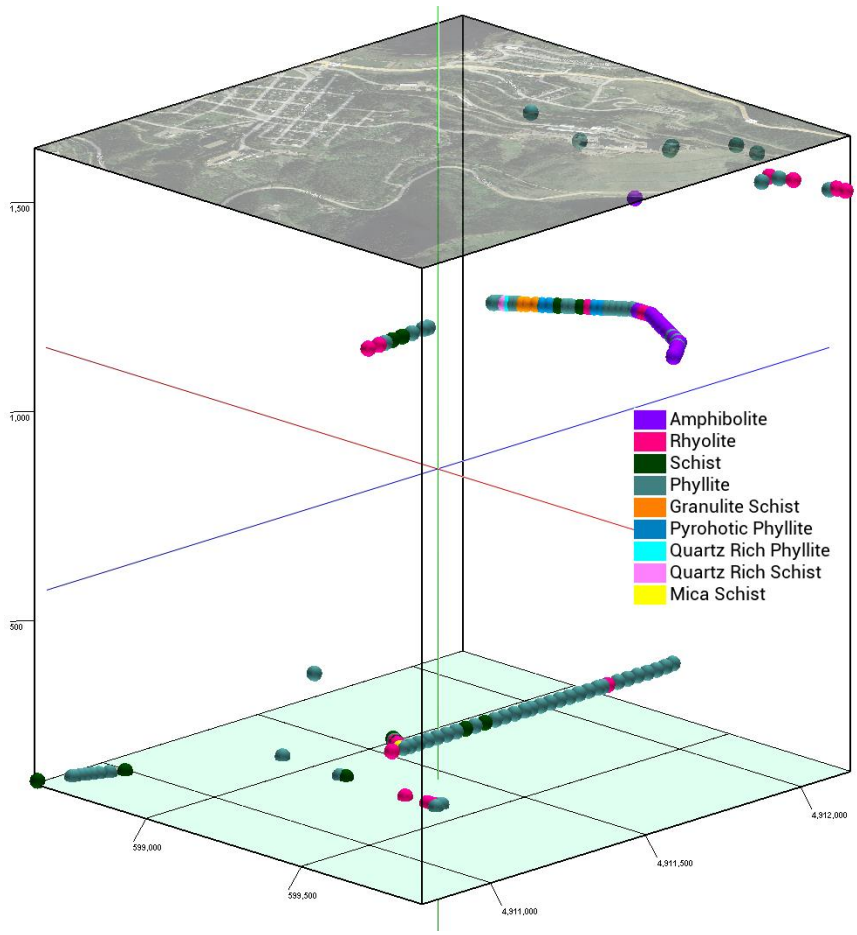


Figure 10

Step 9. The ***ModOps / Solid / Create / XYZG -> Solid*** program (Figure 11) was used to interpolate block models for each of the analytical data columns within the datasheet.

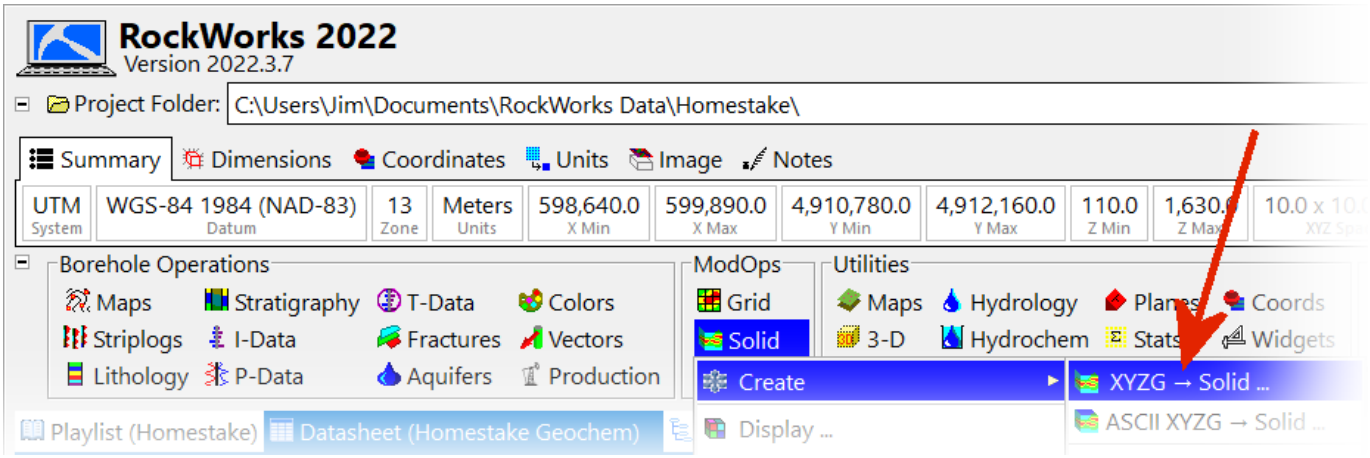


Figure 11

Step 10. The ***ModOps / Solid / Statistics / Standardize*** program (Figure 12) was used to standardize each of the models created within Step 9 such that the voxels represent positive deviations from the mean values.

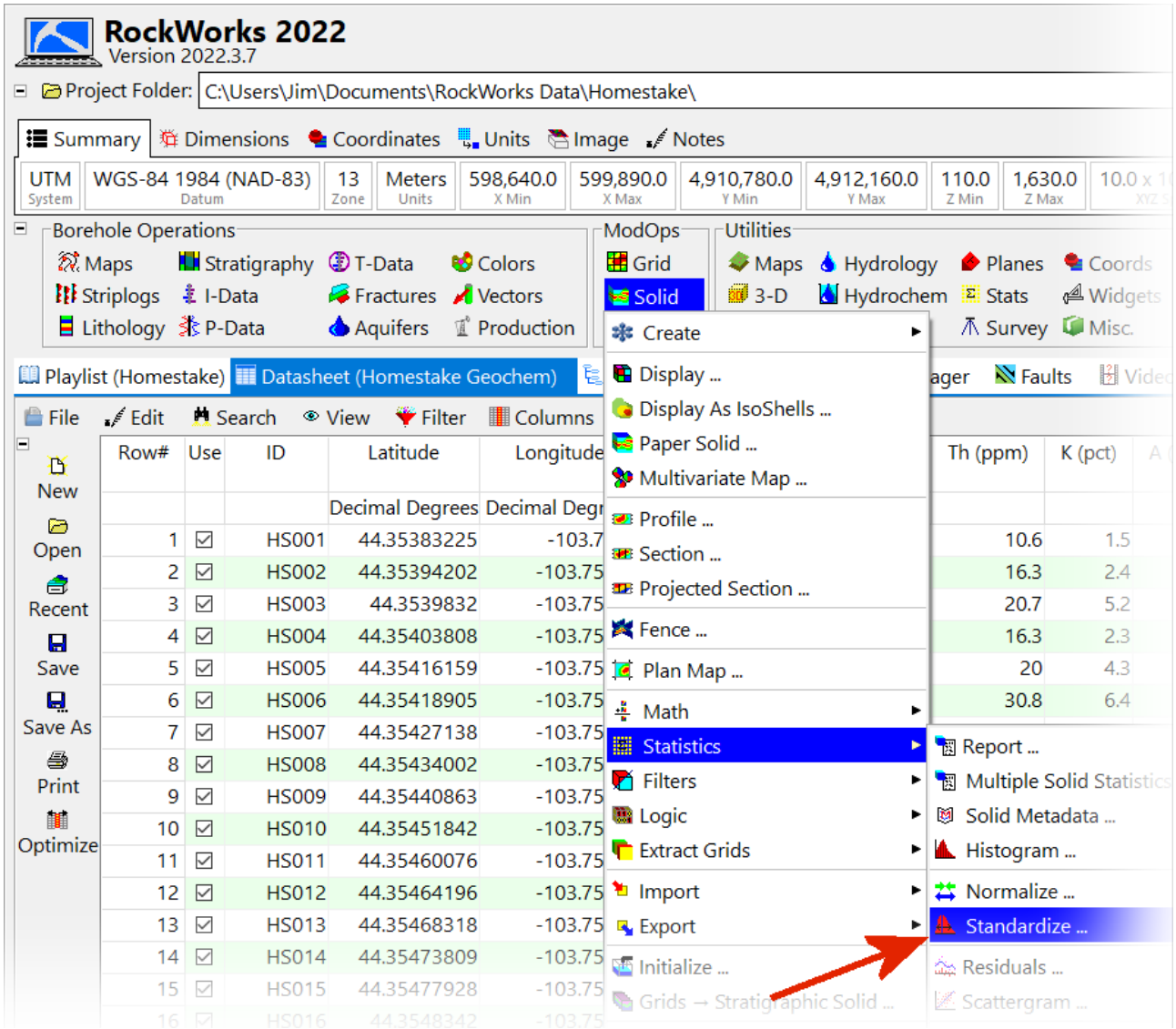


Figure 12

Step 11. Finally, the ***ModOps / Solid / Display as IsoShells*** program (Figure 13) was used to create the diagrams depicted within Figure 1.

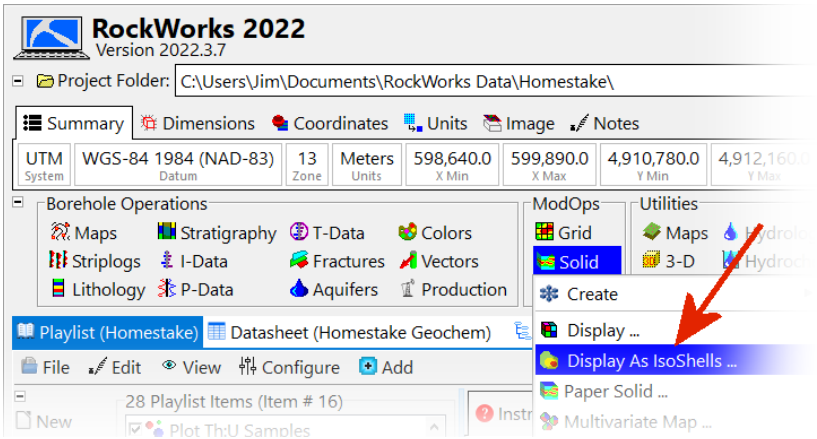


Figure 13

Automation

Steps 6 through 11 were saved as items within a RockWorks Playlist (Figure 14) as 28 items. The advantages of this approach include;

- All of the modeling and output can be re-generated with a single click of the ***Process Playlist*** button located at the base of the list.
- The Playlist provides a detailed list of the workflow strategy used to complete the task.
- As bad data or other mistakes are identified and corrected, all subsequent output can be easily re-generated.
- If the project extents are changed, all models can be readily re-generated based on the new dimensions.
- Double-clicking on an item within the Playlist will bring up the associated menu and all of the settings used for that particular step for examination or editing (e.g., experimenting with different interpolation algorithms).
- The Playlist provides an "audit trail" for examination by others (e.g., attorneys) to confirm the assumptions made by the user.
- The initial modeling workflow can be hastened by setting the project to low-resolution (i.e., large voxels). Once the workflow and results are satisfactory, the resolution can be increased (i.e., smaller voxels) and the entire process can be repeated. The time required during the low-resolution experimental phase may represent minutes whereas the time required for a final high-resolution rendering may represent hours.
- Playlists that may have required a significant amount of time to develop can be applied to other projects without suffering through a re-design.
- Playlists can be given to other users to shorten their learning curves or to allow non-technical users to easily reprocess the data as new information is added.
- The time spent keeping track of which menus were used (and in what order) and finding those menus (RockWorks has 800+ programs) if reprocessing is required will be eliminated by using Playlists.

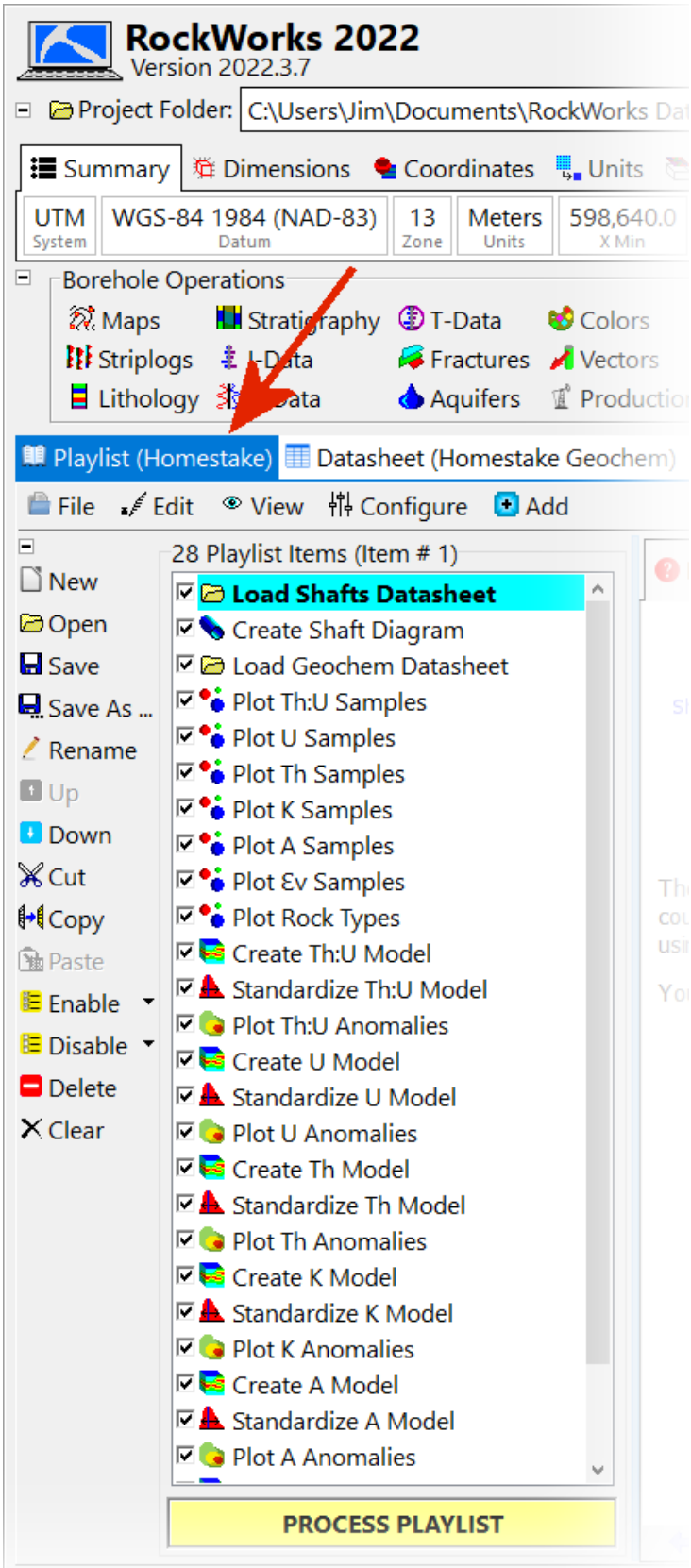


Figure 14

Acknowledgements

(1) Young, D.W., 2017, A radioelement analysis of the northern Black Hills, South Dakota, USA, University of North Dakota MS thesis. https://commons.und.edu/theses/2387/ RockWare sincerely thanks Mr. Young for providing the Excel datasheet and explanation that provided the basis for this case study.