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Mining District File Summary Sheet

DISTRICT	Rosebud
DIST_NO	4010
COUNTY If different from written on document	Pershing
TITLE If not obvious	Rosebud Mine – Resource Memos
AUTHOR	K. Allen ; E. H. Isaaks
DATE OF DOC(S)	1998
MULTI_DIST Y / (N?) Additional Dist_Nos:	
QUAD_NAME	Sulphur 7.5'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine ; Rosebud Mining Co., LLC ; Isaaks and Co ; East Zone
COMMODITY If not obvious	gold, silver
NOTES	correspondence about calculation resources 4p

Keep docs at about 250 pages if no oversized maps attached
(for every 1 oversized page (>11x17) with text reduce
the amount of pages by ~25)

	Initials	Date
SS:	DD	3/20/08
DB:		
SCANNED:		

Revised: 1/22/08

Resource Memos

6000 0597
4010

CINDY

Isaaks & Co.
Consultants in Spatial Statistics

COPY

July 26, 1998

Mr. Kurt Allen
Chief Geologist
The Rosebud Mining Company LLC
P.O. Box 2610
Winnemucca, NV 89446

Dear Kurt,

Based on my visit to Rosebud, July 21 and 22, 1998 and on discussions with you and Matt, I am submitting the following outline for modeling the East Zone as you requested. The contents of this letter are meant to be a summary of our discussions while I was on site. Perhaps the only thing we did not discuss explicitly is the procedure for *change-of-support*. However, this is identically the same procedure that we covered in the short course at Cour d' Alene.

This is the general outline discussed:

1. Compute 5 ft. down-the-hole composites. I would include the lithology for each composite if easily available. If 2 or more lithologies occur over a single composite, assign the composite one lithology by majority rule.
2. Define an ore reserve envelope. I think the ore reserve envelope that we defined using the *old block model* is a good start. But you must check the old model versus your new drilling to make sure that no useful drill hole data has been excluded. This is important. I used a search ellipsoid measuring 25 x 25 x 11 ft centered on each block. also dipped the search ellipsoid 30 degrees on an azimuth of 305 degrees (dip direction). You may decide to increase or decrease these radii on a closer examination of the ore envelope.
3. Compute the following statistics using only those composites within the ore envelope.
   - Histogram and grade-tonnage-metal above cutoff stats for gold.
   - Histogram and grade-tonnage-metal above cutoff stats for silver.
   - Scatterplot of Gold vs Silver.
   - Log-probability plot of Gold. This is the plot that you might use to get

preliminary indications of the domain thresholds. I probably wouldn't advise more than three grade domains (waste or ¡ 0.05, a high grade domain, and a domain for the remainder).

- Once you have selected candidates for the domain thresholds, make indicator maps (cross sections) of the indicator composite data. For example, plot a composite as yellow if the composite grade belongs to domain 1, green if it belongs to domain 2, red if it belongs to domain 3 etc. If the domain threshold values have been selected properly, the ideal indicator maps would show contiguous zones of similar colored composites. If any two composite colors appear to be spatially commingled (*a salt and pepper pattern*), then obviously the particular domain threshold that separates the two colors is useless. It's useless because it does not separate the two classes of grade into two spatial groups. And unless the grouping of classes of composite grades is spatial, the threshold value defining the split is useless.

4. Next, calculate and model a global Au variogram using all the composites within the ore zone envelope defined in step 2. Use the MedSystem rotation option in SAGE95. Try and get the nugget as low as possible (I think we had something around 5% of the sill which should be good for what we need.

5. Decluster the composite data within the ore zone envelope. You can do this using the program MEDOKXYZ.EXE as follows:

   - edit okxyz.par. Use the global Au variogram from step 4.
   - use all the composite data from the ore zone envelope as input data to MEDOKXYZ.
   - Respond to the prompt "INPUT BLOCK COORDINATES FILE" by naming the file containing the x,y,z block coordinates of the old block model used to define the ore zone envelope in step 2. MEDOKXYZ will use this file to determine which blocks to krige. In other words, it will krige the blocks in this file and none other.
   - When running the program, select option 5 – which will generate a file called GLOBAL.WTS. This file will contain the composite data with their declustering weights.
   - Note the variance of blocks and the ratio of block to composite variance required for HERCO.EXE. The program MEDOKXYZ.EXE will write this

information to the screen, but you must discretize the block in the file OKXYZ.PAR.

- calculate the DECLUSTERED GLOBAL MEAN within the ore zone envelope. This is the weighted average of the composite data in the file GLOBAL.WTS, using the declustering weights in the last column.

Retain the file called OK.OUT or OKXYZ.OUT. This file is also written by the program and contains the kriged block grades in column 4.

6. Calculate the proportion of total volume inside the ore zone envelope for each of the grade domains defined by your domain threshold values. For example, calculate the proportion of domain 1, domain 2, domain 3, etc. within the ore zone envelope. You should use the file GLOBAL.WTS obtained in step 6 as follows:
   - sort the file GLOBAL.WTS by composite grade (column 4).
   - To determine the proportion of domain 1, go to column 4 (column with composite grades) and locate the domain threshold value or cutoff grade.
   - Determine the proportion of domain 1 blocks by simply adding the corresponding declustering weights in the last column (5). The sum of these declustering weights is exactly the declustered proportion of domain 1.
   - repeat the previous steps for each domain.
7. Determine the proper contour intervals to apply to the kriged block estimates in the file OKXYZ.OUT (from step 5). For example if you sort OKXYZ.OUT by column 4 (the kriged block grade), it should be fairly easy to select cutoff values on the kriged block values such that the proportions of kriged blocks in each domain are equal to the domain proportions determined in step 6.
8. Proceed with the manual interpretation of the domain zones by cross sections etc. Construct cross sections (colored contoured using the threshold values from step 7) of the kriged blocks from step 5. Use these cross sections as an aid to the manual interpretation of the grade zones. (You may want to repeat step 5 with a finer block resolution).
9. Back tag the composites by domain once the domain model is finished. Each composite will now have two domain tags - the original by grade, and the second by back tagging according to domain the composite is located within. Compute the misclassification statistics. Calculate grade versus domain-boundary profiles. Examine for appropriateness of boundary surface. If the misclassifica-

tion stats are high and the boundary profiles show a broad transition zone, you probably should replace the domain boundary with a probabilistic interpretation using indicators.

10. Do the domain variography and block estimation by domain. Calculate global grade tonnage curves using the block grade estimates.
11. Calculate global grade tonnage curves using a change of support model. For example, calculate a 10x10x12 block histogram using the program HERCO.EXE. This program will expect a file containing the 5 ft composite data within the ore zone envelope and the ratio of the block to composite variance obtained from program MEDOKXYZ.EXE. The output from this program is a file called BLOCK.DAT. It contains 3 columns. The first column is the block grade. The second is the original composite grade, and the third will be the declustering weights. Calculate weighted grade tonnage curves using columns 1 and 3.
12. Compare the grade tonnage curves obtained from steps 10 and 11. They should be within 5 percent on grade and 10 percent on tonnage at the mining cutoff grade. If not, there is a problem somewhere.

Hopefully, you will get through all of this and the final model will pass the tests described above. If it doesn't, you may have to try a slightly different approach and replace the interpreted domain boundaries with probabilistic transition zones using indicators.

I enjoyed the visit to Rosebud and meeting with yourself, Matt, and Alex. If you have further questions please give me a call. I will be in the office July 27 to 31, and then off to Chile for a few weeks. But you can always reach me via email, even when I'm in Chile. Thanks again for the opportunity to work with you.

Yours sincerely,
Edward H. Isaaks