

DISTRICT	Rosebud
DIST_NO	4010
COUNTY	Pershing
If different from written on document	
TITLE	Observations on Rosebud Model and Mineral Inventory
If not obvious	
AUTHOR	Cameron D; Muerhoff, C; Clayton R; Johnson G
DATE OF DOC(S)	1995
MULTI_DIST Y / N?	
Additional Dist. Nos:	
QUAD_NAME	Sulphur 7 1/2'
P_M_C_NAME	Rosebud Mine; Hecla Mining Co.
(mine, claim & company names)	
COMMODITY	gold; silver
If not obvious	
NOTES	Correspondence; handwritten notes; resources; correspondence
	10 p

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)

SS:	DD	8/1/08
	Initials	Date
DB:		
	Initials	Date
SCANNED:		
	Initials	Date

D. CAMERON - COMMENTS ON 1995 RMI

66001849

4010



August 9, 1995

MEMORANDUM TO: George Johnson

FROM: Don Cameron *DC*

SUBJECT: Results of Audit of Rosebud Mineral Inventory

Ron Clayton requested that I explain my position on the Rosebud mineral inventory, as discussed in our meeting of August 3, 1995. Based on the review of the recent checking performed on the Rosebud mineral inventory by C. Muerhoff, MDA, and TWG, I believe there is sufficient documentation to support the Measured and Indicated inventory in Run DAT608N, a modification of the original 1994 mineral inventory. Table 1 is the comparison between the two runs:

Table 1. Comparison between 1994 Year-End Measured + Indicated Mineral Inventory and Check Run DAT608N.

RUN	TONS	GOLD (OPT)	OUNCES	%VAR OZ	%VAR TONS	%VAR GRADE
1994	983,476	0.528	519,068			
DAT608N	880,273	0.465	409,144	-21.2	-10.5	-11.9

The only difference between the reserves listed above is that Run DAT608N incorporates a restrictive search based on indicator variography. The original run incorporated a search based upon untransformed gold grades.

I recommend basing economic models on Run 608N until it is superseded by new information for the following reasons:

- The indicator search used for >2.0 opt Au composites in Zone 4 is more consistent with the geologist's belief that high-grade assays have minimal projections;
- 58,621 tons averaging 0.373 opt Au are included in the original Measured and Indicated inventory, but are estimated by only one composite;
- The drill logs and underground workings suggest more geologic complexity than can be incorporated in a 50-scale model;

} by definition,
Indicated includes
blocks estimated
by one composite
if geologically
reasonable.

- Section plots of DAT608N appear reasonable (exception, section 725SW) with respect to geologic interpretation, drillhole composite grades, and extrapolated block grades.

But remember, hard geologic boundaries were always more restrictive than statistical boundaries

The sensitivity analysis performed by MDA and summarized on the accompanying table shows that the search parameters imposed on the highest grade composites has the most impact on grade and ounces. I cannot endorse the 1994 calculation because the search distances allowed for estimation of blocks by composites were 30 - 95% greater than the variogram ranges. According to MDA, the variogram range is 0 feet when uncut composites >3 opt Au are incorporated. Ranges from indicator variograms are generally liberal because they are variograms based on transformed data, i.e., data with less variation after the transformation.

Blocks estimated by less than two composites should not be considered Measured or Indicated. The reduced tonnage in DAT608N, caused largely by unestimated blocks in the model, partially balances the extra tons in the 1994 model estimated by one composite.

All Measured blocks were derived from ≥ 2 composites

Distal to the chimney, the higher grade zones are narrow and somewhat irregular. There may be overestimation in these fringe areas caused by overprojection of grade polygons, especially if high grades are localized along high-angle faults, as suggested in drill logs.

The 1994 geologic and grade domain interpretations are generally reasonable, especially in the chimney area. (Although the tonnage, grade and ounces listed as Measured and Indicated in the 1994 mineral inventory are optimistic, there is good potential near-term for upgrading those areas that appear as unestimated gaps in DAT608N, and along the dip projections in the chimney area by drilling and drifting in 1995.) Also, there may be some longer-term potential for upgrading the reserves in the East and North zones by fill-in drilling.

c: R. Clayton
C. Muerhoff
F. Stahlbush
R. Tschauder

Attachment: 1

07/27/95

A	B	C	D	E	F	G	H
1	ROSEBUD SENSITIVITY ANALYSIS						
2							
3	TEST RUNS	VARIABLE PARAMETERS*	TONS	GOLD(OPT)	OUNCE	%VAR OZ	%VAR TONS
4	CURRENT DAT608D	Orig. Search, 10' comps., max 2/h, 5/blk	983,476	0.528	519,068		
5	DAT608M	Orig. Search, 10' comps, max 2/h, 10/blk	935,499	0.529	495,181	-4.6	-4.9
6	DAT608N	Indic. Search, 10'comps, max 2/h, 5/blk	880,273	0.465	409,144	-21.2	-10.5
7	DAT608O	Orig. Search, 10' comps, max 2/h, 16/blk, 2/oct	867,850	0.629	545,524	5.1	-11.8
8	DAT608Y	Indic. Search, 10' comps, max 2/h, 16/blk, 2/oct	849,488	0.475	403,518	-22.3	-13.6
9	DAT6085	Orig. Search, 5' comps, max 2/h, 5/blk	987,663	0.515	508,704	-2.0	0.4
10	DAT608X	Indic. Search, 5' comps, max 2/h, 5/blk	845,541	0.463	391,392	-24.6	-14.0
11							
12		* Minimum samples/block the same					
13							
14							
15							
16							
17							
18							
					OXSA DNF		


OXSADNF

07/27/95



June 12, 1995

MEMORANDUM TO: Charlie Muerhoff

FROM: Don Cameron 

SUBJECT: Suggestions for Checking Current Rosebud Resource Model

At your request, following is a brief summary of some suggestions made last Thursday for checking the sensitivity of the current Rosebud mineral inventory model to estimation parameters. In my experience, these can sometimes have a significant impact on the overall grade, tons, or distribution of the ore-grade material:

- 1) Increase maximum number of composites to 10, from 5;
- 2) Substitute maximum number of composites/hole with octant search maximum of two or three samples/octant;
- 3) Decrease search radius in high-grade domains to 75% of range of variogram of uncut composites, or 20 feet if variogram shows pure nugget effect;

Only one parameter should be changed with each re-run, therefore a minimum of three runs are necessary to perform these checks. Additionally, I recommend making a run changing all of the parameters, provided the initial comparisons look reasonable. Results from the original run reported in your January 20, 1995 Mineral Inventory should be tabulated with the new data for comparison. Small changes between runs are expected, but should not cause concern. What constitutes "small" is somewhat subjective, of course.

Sensitivity of reserve classification to search parameters should also be evaluated by increasing the minimum number of composites for Measured and Indicated to two, and Inferred to one or less. This reflects a personal bias that using one sample for an estimate is inadequate for defining Indicated in a new mine. Perhaps you could impose this classification condition on the original model parameters, and then on the run which incorporates all the search changes.

Octant search can be used to limit Indicated and Measured reserves to those blocks with data in more than one octant, or for the latter, in opposing octants. Meds doesn't appear to allow those options.

None of the above tests fully check the validity of the reserve methodology applied to Rosebud. A manual sectional polygon reserve would be the least expensive alternative method to provide a complete check. Multiple indicator kriging using the present geologic domains and perhaps the 0.01 outer grade contour would also be an appropriate check since the method is very different.

c: R. Tschauder

July 10, 1995

Telephone conversation w/ D. Cameron after review of 608D-Y

- ask Steve R. to bring the original variograms with him on the 13th.
- "search radius is the most important thing"
- "why use 2 comp/hole with the octant search? Might do some funny stuff because of that restriction"
(talk to SR about that).

Wants to do 2 more runs:

1. 10 sample composites / block
original search ranges
octant search w/ 2 samples per octant
ELIMINATE restriction of 2 samples / hole
2. s.a.s. only with indicator ranges.

To: C. Muerhoff
Fax #: 702-427-7781
Re: Winter's Review
Date: August 28, 1995
Pages: 1, including this cover sheet.

FACSIMILE

Charlie--

While I concur with some of TWC's observations, I question the need to perform additional reserve estimation at this time.

First of all, the money spent on the computer exercise could better be spent testing some of the uncertain areas with drillholes and drifting. In this respect, the specific areas of concern listed in Table 1 of their report might be good areas to focus some of the drilling and drifting. Second, use of the indicator run (DAT608N) for feasibility results in a drop of 110,000 ounces of gold from the original run, which covers TWC's estimate of overestimation (<50,000 ounces). I don't believe additional computer manipulations are going to necessarily produce a significantly more accurate number. The geologic assumptions and spacing of the drillholes are much more critical, and these will be improved by the underground development that you already have planned.

From the desk of...

Donald E. Cameron
Senior Staff Geologist
Hecla Mining Company
6500 Mineral Drive
Coeur d'Alene, ID 83814

208-769-0412
Fax: 208-769-4122

**HECLA MINING COMPANY
ROSEBUD PROJECT**

August 15, 1995

Memorandum to: Ron Clayton

From: Charlie Muerhoff

Subject: Comments on D. Cameron's memorandum *Results of Audit of
Rosebud Mineral Inventory*

All but the last paragraph was spent trashing the original resource estimate, then the last paragraph introduces a "cover your ass" mentality that nullifies any possible reasonable points made within the preceeding text. As far as I am concerned,

"if there are enough erratic high-grade values to affect the result seriously, then there may also be enough high-grade values to justify the inclusion of all"

If there are enough high-grade values to affect the resource estimate seriously, then there may be enough high-grade values to justify the inclusion of all into the estimate.

As far as coarse gold or "nugget effect" is concerned: should a deposit only be considered worthwhile only if it contains no high-grade or coarse gold? Does the assumption of coarse gold or the presence of high-grade gold mean a high assay must be judged to be erratically high, and must therefore be either heavily cut or ignored?

High-grade is spotty, but spots often come to make mines and mines are made, not found.

60001849

4016

April 28, 1995

MEMORANDUM

To: C. Muerhoff

From: D. Cameron *[Signature]*

RE: Observations on Rosebud Geologic Model and Mineral Inventory.

As we agreed at the recent exploration meeting, I've set down a brief summary of concerns I have with the mineral inventory. I hope we can discuss these on site in the near future. My concern is not with workmanship or overall geologic interpretation, but with identifying potential problem areas.

① The mapping in the decline appears to be deficient in distinguishing rock units, mineralization types and major and minor faults. It does not appear that the mapping has been reconciled with the 50-scale sections. This is a critical area since a high proportion of the mineral inventory is contained in a small portion of the deposit volume. Do you think the decline should be re-mapped and sampled for ore controls?

With regard to the block model, the primary concern is that I understand from you that it hasn't been thoroughly checked. The polygon calculation reported is not a complete check. An essential check of the inventory is section-by-section so that you can see all of the drill hole data with the interpretation overlain on the block model. Plan checking will also have to be done because currently there is only one cross-section for every 5 block rows (50-spaced sections, 10x10x10' blocks). Unfortunately, the block model is oriented skew to the sections and the long axis of the South orebody. That condition is neither appropriate for reserve estimation nor for operations engineering and geology. ① ②

② The resource model is very elaborate considering the drill-spacing and limited underground development. The numerous grade classifications and interpretations of the boundaries assume more knowledge of the deposit than appears to be warranted by the drilling.

The model has the potential to bias the reserve in the following manner:

- ③ 1) By restriction of kriging to only 2 assays/hole;
- ④ 2) Limiting the data search to within interpreted assay envelopes;
- ⑤ 3) Narrowing and modifying the search radii for the high-grade samples.

*explain the
geologic
connection*

⑥ It's not obvious how these biases will affect the reserve *a priori*. One of the reasons we do geostatistical reserves is to define the grade boundaries for us. This is because the process of

*there is
no separation
loop*

We realize the possibility for bias, but we checked it already

sampling a mining block with drillholes will generate a distribution of values about the true mean block grade, and any one drillhole grade is not likely to equal the true grade. Yes, there may be a need to restrict high grade values, but the approach here appears to introduce several non-geologic biases listed above. Has probability kriging been evaluated? The method is unbiased and can incorporate geologic controls which are in the present model. It is designed to deal with outliers both as a function of their values and their abundance. Probability kriging has been successfully applied at Stillwater, Sunbeam and Jerritt Canyon among other deposits.

not valid ?

Some other specific footnotes are listed below:

10 ft vs 2 maximum / 2 lot less in some places
 Drill holes were assayed on nominal 5-foot intervals, but composites were prepared on 10-foot intervals. Why was the data composited in this manner? For a selective mining situation such as Rosebud wouldn't you want to use the smallest logical composite length?

- Restricting the number of samples per block to 5 will create a very locally-derived block grade, but not necessarily a more accurate one. Changing this parameter can really affect a resource calculation. Why was 5 samples chosen as the maximum number of samples per block?

then cross-validation → reduces the effective search distance
 Quadrant search restriction is an alternative way to prevent one drillhole from unduly influencing a block grade and can be used in the classification of resource as Proven, Probable and Possible, as well.

all it does is decluster data. complex orientation of the deposit cannot suit for quadrant
 The resource classification status should also be checked against the sections.

- The polygonal resource is lower grade than the geostat resource. This is a warning flag that something is out of the ordinary here.

- Stopping plans were being plotted out on 10-foot benches during the visit. The stopes changed orientation from level-to-level. This has the potential to reduce the number of faces available for production because mining will have to be completed on a level before moving upward. But I'm more confident in stating that multiple stope orientations within an orebody will hamper geologic control during mining. Is drill spacing adequate to conduct selective mining on 10x10x10' blocks?

In summary, the mineral inventory is a concern to me because:

1) The geologic model for the highest grade area does not incorporate the development mapping;

2) The estimation method rests on a series of non-geologic assumptions which appear to be arbitrary and for which the effects are not clear; *the effects are unbiased.*

3) The geostat resource is a machine number presently unchecked. *in the process*

I look forward to discussing this with you at Rosebud, and no doubt you can allay some of these

maybe, but this contradicts ③ or no composites at all. This is what we wanted - not a global smoothing

maybe we can use it as a check of classification only. used w/ restriction

the suggestion of no human input

quadrant searches tend to approach a polygonal model why would we want to ignore point data

concerns outright. If not, it's far better to address problem areas at this stage in the project than when development is underway. Let's set a day or two in mid-May to meet.

c: R. Tschauder
File