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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 analytical procedures and quality control
AUTHOR	Lisle R; Vance R; Langstaff G
DATE OF DOC(S)	1997-1998
MULTI_DIST Y / (N?) Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Rosebud property Newmont Exploration Ltd; Rosebud Joint Venture
COMMODITY If not obvious	gold; silver
NOTES	Correspondence about analytical procedures and quality control; assays; geology 12p.

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: DP 9/10/08
Initials Date

DB:
Initials Date

SCANNED:
Initials Date

Revised: 1/22/08

Analytical Procedures/Quality Control

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Newmont Exploration Ltd.
Rosebud Joint Venture

To: Rick Lisle **Date:** September 30, 1997
cc: Randy Vance

Fr: George Langstaff

Subj: Proposal to Discontinue Continuous Assays of Drill Cuttings and Core

Character of Ore at the Rosebud Mine
Ore bodies identified at the Rosebud Mine occur at depths of 500 to 900 ft. within a thick sequence of Miocene volcanic and epiclastic rocks overlying Jurassic-Triassic metasedimentary rocks. The South, North, and East ore bodies have dimensions of 300 to 1000 ft. long, 100 to 250 ft. wide, and 10 to 60 ft. thick.

The ore occurs in stockworks and disseminations associated with strong argillic alteration and, locally, silicification (Muerhoff and Holmes, 1995). Chloritization and pyritization locally occur within and outside ore zones. Brewer (1991) reported that electrum had been identified in veinlets of qtz+py±other sulfides, qtz+aspy+Ag-sulfosalt+Ag-selenide, and calcite+minor qtz+Ag-minerals. Late kaolinite veinlets were apparently barren. Current workers see a correlation between gold grades and the presence of veins and veinlets with various combinations of clay, quartz, marcasite, and possibly other sulfides (K. Allen and R.Kastelic, personal communication, 1997). Recent experiments with PIMA suggest illite and less common dickite in argillic alteration and in veinlets, with or without other minerals, may also be associated with gold mineralization.

Cutoff grade for ore bodies in the Rosebud Mine is .14 opt Au. Ore is generally surrounded by zones with greater than .05 opt Au (Hecla's mine model) but the thickness and consistency of these halos has not been quantified. Not all zones with elevated gold concentrations have high-grade, minable cores.

Proposal
Current exploration at the Rosebud property includes assaying for gold and silver in continuous five-foot intervals for the full extent of a drill hole. This procedure is apparently mandated by a company-wide Newmont practice. However, this procedure is not appropriate at Rosebud because

- the ore is relatively high-grade, sulfide ore rather than the oxidized ore or heap-leachable ore found in many sediment-hosted deposits,
- the ore bodies are restricted to areas of strong alteration and common veining,
- visible alteration is more extensive than the ore bodies and unaltered rock in the mine is not ore (the mine geologists are confident they can recognize ore zones visually),
- current targets are deep and may underlie over a thousand feet of unaltered volcanic rocks,

- drill holes sited to intersect blind ore bodies may not encounter any significant alteration or mineralization.

I propose that the choice of which intervals in a drill hole to assay be left to the discretion of the geologist(s) on the project. Guidelines could be established to avoid missing any potential ore zones, such as assaying all samples with any evidence of alteration or veining, always assaying the pale Dozer Formation (where argillic alteration may be hard to distinguish), etc. Given the amount of unaltered material that has been drilled in exploration holes at Rosebud, the potential cost savings is significant.

Costs and Potential Savings

A fire assay with AA finish for gold and silver costs $11.55 at American Assay Laboratories, or $2.31/ft. Randy has estimated average reverse-circulation drilling costs to be $14.41/ft. Assay costs are thus 14% of the combined drilling and assay costs.

For example,

- not assaying 800 ft of unaltered rock in a 1,000-ft deep hole would save $1,848.00, or enough to continue the hole another 128 ft,
- not asssaying 295 ft in a 1,000-ft deep hole would save enough money to have ICP multielement and Se analyses done on 20-ft composites for the entire hole,
- not analyzing 13,000 ft of samples for the planned 1998 program would save $30,000, or 10% of the $300,000 which was recently reduced from the Winnemucca exploration budget.

Conclusion

Assaying every sample from a drill hole makes sense for targets which lack conspicuous alteration; or where gold is not consistently associated with alteration; or where low-grade, heap-leachable material is potential ore. This is the case at most sediment-hosted, disseminated gold deposits but not at Rosebud, nor at most volcanic-hosted gold deposits. I believe it would be in the best interests of the Rosebud project to discontinue having all the samples from a drill hole assayed automatically. Guidelines can be established to determine which samples will be asssayed. Samples will continue to be collected at 5-ft intervals in any case so that any samples not assayed initially can be assayed later.

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** December 8, 1997

Fr: George Langstaff

Subj: **Breakdown of Quality Control Process at American Assay Labs**

On Nov. 14, I submitted 3 quality control samples with the r.c. samples for RS-420. For this hole, the upper 840 feet of samples were analyzed in 20-feet composites of 4 samples. To get a qualitative appreciation of the effects of dilution (as for a thin, high-grade vein), I substituted 6.6 ppm Au standards for samples 225-230 and 600-605 (the actual r.c. samples are still in our warehouse). I also submitted a standard as sample "875B".

The preliminary results we have received for RS-420 indicate that the two substituted standards were relabeled "225-230B" and "600-605B" and analyzed separately from the 220-240 and 600-620 (actually only 3 samples each) composites.

American Assay Labs' handling of samples 225-230 and 600-605 indicates that standards receive special treatment, even to the point of relabeling samples. Special treatment nullifies the objective of submitting standards for analysis. AAL may be analyzing the standards at a different time and using more careful procedures than for normal samples. It is also possible that they do multiple analyses to verify their results (remember the standard which was not analyzed due to "insufficient sample").

I talked to Todd Process on Dec. 8th. He didn't seem as concerned as I would have hoped about the way the two standards were handled. He said he would review the "prep sheets" and talk to the prep supervisor. He also offered to redo the two composites with the remainder of the standards. Apparently the compositing is done with 60 g splits of the 400 g pulverized fraction so the dilution of a standard would not be too severe. Todd also assured me that samples are run in 50-sample batches and different holes or samples from different clients are generally run in separate batches. Our standards are fired along with the regular samples in the order shown on the results tables.

There may yet be some value in submitting standards as we have been doing but we should probably try something sneakier. I don't have any ideas on that right now.

Should I continue submitting standards as in the past at 1standard per 40 samples?

Should I be submitting standards with the core samples?

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** December 22, 1997

Fr: George Langstaff

Subj: **Reanalyses by American Assay Labs**

Looking through the drill hole files, I discovered that American Assay labs did ICP analyses on 20-ft composites for the rc samples (0-500 ft) from RS-411 rather than on those from RS-410, which has a deep core tail. Todd Process said that the ICP analyses for RS-410 have in fact been done (I'm waiting for the fax). Todd agreed that we had not asked for ICP analyses for RS-411 on the submittal form but he thought somebody may have called in and requested it. Unless Kurt or you asked for the analyses, we won't have to pay for the ICP analyses for RS-411.

For holes RS-424, 425, and 426, I submitted unaltered cuttings spiked with standards for quality control. Because we have no way of weighing the samples and spikes, we can't calculate exactly what the results should be. However, I am more concerned about the labs precision, which we can determine by having splits from the coarse rejects pulverized and analyzed again. If you concur, I will have American Assay redo the following 8 samples:

Hole No.	Sample No.	Contents	Weighted Au Conc.	Expected Au (ppb)
RS-424	270B	RS-420 230' + MS-3	900g@2ppb+50g@1007ppb	54
RS-424	590B	RS-420 605' + G03	1200g@2ppb+50g@6627ppb	267
RS-425	75B	RS-424 cuttings from sump		0?
RS-425	440B	RS-424 cuttings + G01	1000g@2ppb+50g@12884ppb	615
RS-425	910B	RS-424 cuttings from sump		0?
RS-425	980B	RS-424 cuttings+G01+G03	1000g@2ppb+50g@12884ppb +50g@6627ppb	888
RS-426	445B	RS-424 cuttings+G01+G01	1000g@2ppb+100g@12884ppb	1173
RS-426	625B	RS-424 cuttings + G03	1000g@2ppb+50g@6627ppb	317

When I called him, Todd also mentioned he was looking for Te data from the Se analyses we had done (of RS-408?) and the redundancy of ICP and AA silver analyses we are doing now. He has apparently discussed both issues with you in more detail. I added Se to the analyses for RS-426 rc samples, as you requested, but didn't change the silver analyses.

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** December 30, 1997

Fr: George Langstaff

Subj: **Lapse in Assay Quality**

Results for the rc samples for RS-423, submitted on 12/2, may not be as accurate as previous results. Three of 5 analyses of standards were lower than the accepted range; one other was low but in the accepted range and the fifth was near the upper limit of the accepted range. However, none of the results for RS-423 were greater than 50 ppb so the lapse in accuracy is probably not important.

Someone at American Assay Labs must be reading the submittal forms now. I wrote that they should not analyze a blank pulp of 97-380, which I submitted with RS-424. To my surprise, they didn't. Now if we could only figure out why they still copy Kurt Allen for results from the exploration drilling.

Rosebud files

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** February 3, 1998

From: George Langstaff

Subj: **Au Assay Results for "Unaltered" R.C. Samples**

Below, I have tabulated the gold results for those r.c. samples in drill holes RS-409 to RS-425 which, at a glance, do not appear to be altered, i.e., they are various shades of dark grey to reddish brown to black and lack visible pyrite. For perspective, I have included gold results for the intervals immediately above and below the unaltered intervals.

Drill Hole	Unaltered Interval	Au (ppb) in Unaltered Rock	Au (ppb) Above	Au (ppb) Below
RS-409	435-440'	all <5	72 @ 430-435'	<5
	455-460'	all <5	5 @ 450-455'	<5
RS-410	55-65'	all <5	<5	<5
	85-95'	all <5	<5	<5
	110-145'	all <5	<5	10 @ 145-150'
	155-165'	all <5	6 @ 150-155	<5
	365-370'	all <5	<5	<5
	395-405'	all <5	<5	25 @ 410-415'
	485-500'	all <5	<5	<5
RS-411	340-355'	all <5	<5	<5
	405-500'	all <5	30 @ 395-400'	<5
RS-412	85-95'	all <5	30 @ 75-80'	<5
	125-205'	all <5	<5	<5
	450-485'	all <5	15 @ 440-445'	<5
	490-500'	all <5	<5	<5
RS-413	365-375'	all <5	<5	<5
RS-414	170-220'	all <5	<5	<5
RS-415	255-265'	all <5	<5	<5
RS-416	35-100'	15 @ 70-75' all other <5	<5	7 @ 100-105'
	325-375'	all <5	5 @ 320-325'	<5
	510-525'	all <5	17 @ 505-510'	<5
RS-417	0-20'	all <5	N/A	8 @ 35-40'
	270-275'	all <5	<5	10 @ 290-295'
	310-360'	all <5	12 @ 305-310'	14 @ 75-80'
	435-515'	5 @ 485-490' all other <5	<5	<5

RS-418	10-105'	9 @ 75-80' all other <5	<5	<5
	205-235'	all <5	<5	<5
	505-550'	all <5	<5	<5
RS-419	10-65'	84/90 @ 45-50' all other <5	<5	<5
	85-215'	7 @ 85-90' 6 @145-150' 20 @ 150-155' all other <5	<5	<5
	250-350'	all <5	<5	<5
	535-550'	6 @ 535-540' all other <5	<5	T.D.
RS-420	5-665'	5 @ 80-100' all other <5	<5	<5
	680-735'	all <5	<5	<5
	740-850'	6 @ 840-845' all other <5	<5	<5
	945-955'	all <5	<5	<5
RS-421	85-185'	6 @ 130-135' all other <5	<5	<5
	220-265'	all <5	5 @ 215-220'	72 @ 280-285'
RS-422	100-135'	all <5	<5	45 @ 140-145'
	150-180'	all <5	45 @ 140-145'	<5
	275-585'	10 @ 445-450' 5 @ 550-555' 7 @ 580-585' all other <5	<5	8 @ 595-600'
	740-810'	all <5	<5	16 @ 815-820'
	830-945'	9 @ 920-925' all other <5	15 @ 820-825'	13 @ 955-960'
RS-423	40-80'	all <5	25 @ 20-25'	8 @ 90-95'
	100-115'	all <5	<5	<5
	120-165'	all <5	<5	12 @ 170-175'
	195-220'	all <5	<5	7 @ 230-235'
	240-260'	all <5	7 @ 230-235'	<5
	330-340'	all <5	48 @ 325-330'	37 @ 345-350'
	395-400'	all <5	22 @ 385-390'	34 @ 400-405'
	615-685'	all <5	28 @ 605-610'	16 @ 695-700'
	815-1140'	all <5	<5	T.D.

RS-424	355-1410'	23 @ 625-630' 5 @ 845-850' 14 @ 850-855' 17 @ 1235-1240' 51 @ 1240-1245' all other <5	38 @ 345-350'	<5
RS-425	185-835'	10 @ 585-590' 6-10 @ 730-750' 11 @ 765-770' 18 @ 785-790' 17 @ 805-810' 42 @ 825-830' all other <5	<5	<5
	845-865'	all <5	<5	25 @ 865-870'
	885-900'	< 5 to 52	25 @ 865-870'	54 @ 905-910'
	1025-1115'	26 @ 1085-1090' 11 @ 1090-1095' all other <5	<5	<5 @ 1115-1130'
	1130-1150'	5 @ 1140-1150' all other <5	<5 @ 1115-1130'	<5 @ 1150-1160'
	1160-1170'	all <5	<5 @ 1150-1160'	10-86 @ 1180-1190'
	1195-1200'	16	59 @ 1190-1195'	136 @ 1200-1205'
	1235-1245'	14, 22	26-18 @ 1220-1235'	13-27 @ 1245-1265'
	1300-1310'	all <5	<5	<5
	1345-1350'	all <5	<5	24 @ 1365-1370'
	1385-1405'	<5 to 17	47 @ 1380-1385'	22 @ 1415-1420'

Most unaltered samples have less than detectable gold. As the laboratory's detection limit is 5 ppb, results that are 10 ppb (twice the detection limit) or less probably are not significantly different from background. Reexamination of the samples with more than 10 ppb gold revealed that many are contaminated by altered rock (commonly with visible pyrite) or vein chips, presumably from higher in the hole: 70-75' in RS-416; 625-630', 845-855', and 1235-1245' in RS-424; and 1085-1090' and 1385-1405' in RS-425. Of the others:

- the 20 ppb sample at 150-155' in RS-419 has chips of calcite veins and green waxy clay veins although these are not currently known to be gold-bearing,
- the 87 ppb (average of 2 assays) sample at 45-50' in RS-419 has no obvious exotic, altered chips but does have red clay which could be indicative of contamination from the surface (although there are no anomalous samples shallower in the hole and this sample is the only sample with >5 pbb above 150-155'),
- the 11 ppb sample at 1090-1095' in RS-425 has LCMs so contamination is a possibility even though no altered chips are evident in the sample,

- the 14 ppb to 22 ppb samples in narrow unaltered intervals at 1195-1200' and 1235-1245' in RS-425 are bracketed by samples with up to 59 ppb gold and it would be remarkable if they have not been contaminated even though no exotic chips are evident, and
- the 20 ft intervals between samples with 11 ppb to 40 ppb at 770', 790', 810', and 830' in RS-425 (in the reverse circulation portion of the hole) suggest sampling problems rather than gold-enriched unaltered rocks - perhaps the 6 ppb to 10 ppb samples at 730-750' were the sources of contamination and have had their gold concentrations underestimated.

It is of course possible that samples for analysis were contaminated but exotic chips were not collected in the respective chip samples. The fact that none of the unaltered samples has more than 100 ppb gold even where apparently contaminated by higher, altered sections in the hole suggests the danger of missing ore deposits at Rosebud by not analyzing unaltered rocks is minimal.

Although the data tabulated above include drill holes from above the East Zone, they may not be representative of all styles of gold mineralization in the Rosebud area. A more rigorous test of the hypothesis that unaltered rocks at Rosebud do not host ore-grade concentrations of gold would be to seek out unaltered rocks in the vicinity of the mine workings and see if these too have only background levels of gold and to review the data for pre-Newmont drill holes. In the meantime, the data above should allow you to sleep well if you do choose not to assay unaltered intervals in some drill holes.

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** March 22, 1998

From: George Langstaff

Subj: **Comments on Sample Composites**

My recent consideration of the effects of coarse gold on sample precision ("Grain-size and dilution effects in Rosebud mineralization", 3/18/98) has led me to disbelieve the utility of compositing samples to save money. Compositing has two effects: diluting the anomalous material with non-anomalous material and decreasing the precision. In cases where the anomalous material occurs as coarse grains, the precision may decrease to the point where an anomalous result is unlikely even if sample dilution alone is not sufficient to make the anomalous appear normal.

For gold, Rosebud samples are composited where the rock appears to be unmineralized due to lack of alteration. It seems to me if the rock is not altered, the possibility of significant, very fine grained, disseminated gold is negligible (see memo of 2/3/98). There may still be a possibility that the rock contains inconspicuous gold-bearing veins. To detect gold in veins, sample sizes should be reduced, not increased by compositing.

For elements other than gold, absolute concentrations are higher and the effects of nuggets, or micronuggets, are less likely and precision less of a concern. However, depending on the questions that the geochemical data are meant to address, compositing may still be a bad idea.

If the geochemical data will be used to characterize rock types or alteration, compositing is a bad idea. If the composite samples happen to include different rocks or different alteration types, the data will not be useable and could be misleading. Samples should be selective for individual rock or alteration types.

If the geochemical data will be used to target gold mineralization, compositing is a bad idea. Compositing will make any geochemical enrichments (or depletions) surrounding gold mineralization appear broader (longer along the drill hole) and of lower magnitude than they really are. Magnitudes may be lowered to the point where they are not distinguishable from background or enrichments (or depletions) not related to ore-grade gold. Widths of ore-related anomalies may be broadened to the point where they no longer aid target recognition.

Three specific types of distortions due to compositing could impede exploration at Rosebud.

1. Sharp element zoning may be smoothed to the point where it is not recognized or is recognized only as a broad and therefore not prospective halo. If, for example, small stibnite pockets in the South Ridge Fault indicate proximity to gold ore below, compositing could give a broad Sb halo indistinguishable from barren, anomalous Sb zones (if there are any) or the Sb

anomaly could appear to envelop ore where, in fact, antimony is enriched only above the gold zone.

2. Narrow structures with strongly anomalous element concentrations might not be distinguishable from broader, weakly anomalous zones in which they occur. For example, could one recognize ore-controlling structures within the broad, shallow anomalous zone at Dreamland with 20-foot composites?

3. Narrow structures with strongly anomalous element concentrations might be confused with broader weakly anomalous zones unrelated to ore. For example, is the shallow anomalous zone in your Dreamland to Dozer Hill cross-section a broad zone of subeconomic mineralization or is it an artifact of smoothing the anomalies along ore-related structures such as the Mother Lode fault?

There is a lot of geochemical data for Rosebud. Bob Kastelic's down-hole histograms for various elements using composited data suggest there is potential for the method. However, to my knowledge, geochemical data for elements other than gold have not made any positive contributions to exploration for gold deposits. If the purpose of compositing is to save money, we could save a lot more money by not doing any ICP analyses.

Nonetheless, if gold deposits are surrounded by wide zones of progressively decreasing element concentrations, such as may be the case on the Carlin trend, then the gold signal may still be recognizable through the averaging effects of compositing. If element zoning around the Rosebud deposits or the types of deposits you are targeting were known, then we could estimate the deleterious effects of compositing and adjust compositing intervals accordingly. Our current compositing policy appears to be based on standard practice for Carlin deposits rather than on knowledge of our targets.

Compositing samples for analysis by ICP spectroscopy is also a bad idea because of the small analytical sample size used in the digestion. AAL uses .5 g. It may be unrealistic to believe that .5 g is truly representative of 20 feet of drill hole. Repeat and duplicate analyses could be used to determine how precise composite results are. Analyzing both a 20-foot composite and the four individual 5-foot samples for a few samples would give us a better idea of how reliable the composite results are.

<u>Recommendations</u>

1. To save money on gold analyses, do not analyze unaltered rock. Dark color, hematite-staining, and lack of any veins other than calcite, among other(?) criteria, may be indicative of lack of gold-related hydrothermal alteration. There is probably little to be gained from compositing to avoid missing possible low-grade resources, particularly given our focus on 1+ million-ounce deposits and the high-grade nature of known deposits at Rosebud.

2. To save money on analyses other than gold, there are several possible cost-cutting measures. First, identify those elements which really provide useful information. (AAL1/0 would give us

the same elements as AAL1/2 at 76% of the cost but with higher detection limits for Hg. As+Sb+Cu would be cheaper still.) Second, select those samples which will contribute that information. Core samples should be selected after logging and r.c. samples should be selected after at least a cursory examination. If available data suggest compositing is a viable option, then samples should be composited as much as possible. Unless we need information on background values or there is evidence to suggest unaltered rocks have ore-related geochemical anomalies, do not analyze unaltered rock.

- If the purpose of the geochemical data is to characterize rock types, individual samples should be selected to be representative of specific rock types. It is not necessary to analyze all samples. Analyzing 25% would be even cheaper than compositing every four consecutive samples.

- If the purpose of the geochemical data is to characterize alteration types, individual samples should be selected to be representative of specific alteration types. It is not necessary to analyze all samples.

- If the purpose of the geochemical data is to target gold, compositing should take into account the expected zoning patterns. It is not necessary to analyze all samples. For instance, it may be possible to use data from the gold assays (e.g., >50 ppb gold) to select samples for analysis of pathfinder elements.