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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	Results of logging RC chips from East Zone delineation holes, January 20, 1998
AUTHOR	Vance R; Allen K; Langstaff G
DATE OF DOC(S)	1998
MULTI_DIST Y / (N?) Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Newmont Exploration Ltd; Rosebud Joint Venture
COMMODITY If not obvious	gold; silver
NOTES	Petrographic report; geology; handwritten notes; schematic drill hole logs 6 p. 2 oversized plate

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
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Drill Logging Results, Observations

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Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance
Kurt Allen

Date: January 20, 1998

From: George Langstaff

Subj: **Results of Logging RC Chips from East Zone Delineation Holes**

Drill Log Results & Observations

Introduction

I have completed logging the rc samples for the eleven East Zone delineation holes drilled October-November 1997. The rc precollars varied in depth from 500 ft to 600 ft and samples were collected every 5 ft. The chips are stored in the warehouse against the southeast wall. My drill logs are kept in the filing cabinet in the exploration trailer and I gave Kurt copies of the logs this morning. I have prepared 2 figures summarizing my observations: "East Zone RC Samples - Lithology" and "East Zone RC Samples - Alteration" and copies were given to Randy and Kurt on the 15th.

Stratigraphy

1. In keeping with Kurt's memo on the geologic units to be penetrated by the East Zone holes, I have recognized the following units:

- **C** - colluvium and regolith

  <u>Chocolate Formation</u>
- **FG** - massive flow or sill with 1-2%, generally acicular, hornblende microphenocrysts up to 1 mm long in a grey aphanitic matrix; has sparse, 1-4 mm clots of vitreous pale grey to white zeolite(?) minerals and calcite and rarely quartz which I interpret as amygdales; has <1% sparse, irregular, rounded, or chunky, dark clots which may be clots of mafic minerals or some kind of iron oxide alteration; locally has <1%, subhedral, vitreous, pale grey to white, feldspar phenocrysts .5-2 mm long; locally is aphyric, lacking even the hornblende microphenocrysts; I observed one occurrence of biotite and one occurrence of possible quartz phenocrysts and several occurrences of dark grey, aphanitic, aphyric xenoliths
- **LLT** - generally monomict but questionably polymict in places, clast- and matrix-supported breccia with angular to subrounded, clay- to pebble-size (max. chip size) volcanic clasts, which could be derived from FG; where unaltered, some clasts have hornblende microphenocrysts and others are aphyric
- **Vc** - clay-rich (usually greenish) rock which could be derived from vitrophyre as proposed by Kurt; it may be impossible to recognize Kurt's clay-altered vitrophyre in rc samples and what I recognize as Vc doesn't occur in the locations expected for the clay vitrophyre
- **Pp** - "pink porphyry"; massive flow or sill with rare (<1%), white, clay-altered, subhedral, feldspar phenocrysts 1-2 mm long in a "pink" aphanitic matrix; the unusual, pink matrix makes this a relatively easily identified unit; there appears to be an aphyric phase (Pa) above the porphyritic phase which has the same distinctive color

2. The "pink porphyry" may be intrusive as it apparently occurs at 475-480 ft in RS-416 bounded by clay-rich vitrophyre(?) and within LLT.

3. LLT may have gradational contacts with both FG and Pa or FG and Pa may be brecciated adjacent to the contact. Clast-supported textures in LLT suggest a flow-breccia origin but matrix-supported textures (necessarily on a small scale in chips) could be interpreted as suggestive of a debris-flow origin. I found no evidence of a pyroclastic origin. The thickness of LLT is greater than one would expect for a tectonic breccia.

Recognition of LLT is problematic but clastic textures usually persist despite alteration. Ironically, clastic textures may be harder to see in dark unaltered chips. However, unaltered LLT usually gives some red-brown chips of soft clayey material in addition to the clast-bearing chips.

Alteration

Understanding the relation of the shallow alteration and weak gold mineralization in the East Zone delineation holes to ore-grade East Zone mineralization could be important to exploration concepts. The observations below are a small step toward that goal.

1. It now appears that all the pale rocks in the East Zone delineation holes are just altered versions of FG, LLT, and Pa/Pp. What I referred to as weak argillic alteration in the logs is actually a texturally destructive alteration. Although the chips are hard, the thick, pale grey slurry produced during rc drilling is evidence for alteration stronger than what appears in the chips. Contacts between altered and unaltered rocks are generally sharp but transitions can be seen in a few chips. Several changes occur during alteration:

i) the medium to dark grey matrix is bleached to a pale or very pale (±green or olive tints) grey,

ii) hornblende microphenocrysts and dark clots disappear,

iii) the matrix develops a very fine grained, granular texture,

iv) clear, vitreous, spermatozoa-like specks appear with no apparent precursors,

v) in some rocks, grey vitreous, prismatic to irregular, pseudophenocrysts up to 1 mm long appear with no apparent precursors.

Realization that the pseudophenocrysts may not be primary features came with logging of RS-417, where none of the unaltered rocks have feldspar phenocrysts but adjacent altered rocks have pseudophenocrysts.

The net result of this "argillic" alteration is a pale, very fine grained, aphyric rock without any mafic phenocrysts, characteristics similar to those of the "Dozer", "rhyolite", or "sage green tuff". Although I have not yet logged Dozer or observed it with the binocular microscope, it now seems possible that altered Chocolate could be indistinguishable from pale Dozer or Dozer-like rocks. Casual observation of core from the Dreamland area and of medium grey "Dozer" in the lower part of RS-410 (e.g., at 1041 ft) support this possibility.

Clastic textures are usually(?) preserved during this "argillic" alteration. The volcanic clasts become pale grey to white, aphanitic or very finely granular rocks but the matrix develops a granular, more vitreous appearance and preserves more of a brown tint in its color.

3. The degree of alteration in the "pink porphyry" is uncertain because it is not known for certain what unaltered "pink porphyry" looks like. The pale color alone, if the "pink porphyry" is originally dark like the Chocolate, Brady Andesite and others, suggests some degree of alteration but the chips do not have any other obvious evidence of alteration.

Gold Occurrence

1. Gold persists in the oxidized zone with at least one sample (55-60' in RS-411) containing 940 ppb. There is no apparent concentration of gold near the boundary between oxidized and unoxidized rocks or increase in gold concentration in unoxidized rocks but it is possible some gold has been leached from the oxidized zone.

2. The rc samples offer little encouragement for soil surveys although they do not cover the full areal extent of the East Zone mineralization. Only 2 samples of colluvium have >50 ppb gold (in RS-415 and RS-416). These samples are not supported by similarly anomalous bedrock and could be float from the Sharkfin or from now buried anomalous subcrops up slope. Only one hole, RS-411, has consistently anomalous gold in the upper 50 ft of bedrock although one other, RS-413, has sporadic anomalous gold. The possibility that anomalous gold in the rc samples is not related to ore-grade mineralization in the East Zone must also be considered when siting drill holes for deep targets based on anomalous soil samples.

3. Argillic alteration is a necessary but not sufficient condition for gold mineralization. A possible exception is the 400+ ppb in RS-415 (520-525') in "pink porphyry", which may lack significant argillic alteration. Argillic alteration is much more extensive than gold mineralization but no anomalous samples lack argillic alteration (except, again, for the possible exception of the "pink porphyry").

4. Disseminated pyrite is a favorable and possibly necessary but not sufficient condition for gold mineralization. Disseminated pyrite occurs in various habits and grain sizes and commonly occurs in siliceous patches of rock. There may be several paragenetic stages of pyrite and it was beyond the scope of this work to determine which may be related to gold mineralization. Nonetheless, samples which lack disseminated pyrite only rarely have >50 ppb gold and never have more than 300 ppb. A correlation between disseminated pyrite and anomalous gold is also suggested by a 10-ft interval (275-285') in RS-410 which has disseminated pyrite and 300+ ppb gold whereas samples above and below have neither pyrite nor anomalous gold. Also an increase in the abundance of disseminated pyrite at 185-190' in RS-416 is accompanied by an increase to 110 pbb gold.

5. Silicification is neither a necessary nor sufficient condition for gold mineralization but the proportion of silicified rocks which have gold mineralization is probably greater than the proportion of all rocks which have gold mineralization. All silicified zones recognized in this work have at least one sample with >50 ppb gold but only one has >300 ppb gold and many silicified samples are not anomalous. 5 ft of silicified breccia in RS-411 (70-75') have 995 ppb gold but other samples above and below the breccia are also strongly anomalous. Bladed marcasite occurs in or near essentially all of the silicified zones.

6. Calcite alteration is unfavorable but not necessarily exclusive for gold mineralization. Calcite altered rocks are less likely to have anomalous gold than rocks which are not calcite altered. RS-417, RS-418, and RS-419 have calcite almost throughout their depths but have only a few samples with >50 ppb gold. Calcite alteration and disseminated pyrite rarely occur together. A sample with 540 ppb gold at 280-285' in RS-410 is within a zone of calcite alteration but also has disseminated pyrite. A calcite altered rock at 410-415' in RS-416 has 320 ppb gold but is also silicified and has disseminated and vein marcasite. The apparent late occurrence (see below) and lack of associated gold and pyrite in calcite altered rocks suggest gold and pyrite may have been removed from previously mineralized rocks during this alteration.

7. The most common veins in the East Zone rc samples are (not in order of abundance) calcite, calcite + pyrite, calcite + bladed marcasite ± pyrite, quartz, quartz + pyrite, quartz + bladed marcasite ± pyrite, quartz + pyrite + calcite, white clay, white clay + quartz ± pyrite ± marcasite, and waxy pale green clay. Barite is rare and probably occurs in veins with quartz, as observed in the core tails for the East Zone holes. The association of white clay-bearing veins with gold was not considered because it is unlikely that a complete vein assemblage would be preserved in chips due to the friable nature of clay and because clay in a sample may or may not be derived from veins. Chips of vein clay are relatively rare in any case.

a. Quartz-pyrite veins are a necessary but not sufficient condition for gold mineralization. The quartz is clear and vitreous and may be drusy or massive but not chalcedonic. The pyrite has various habits. All rocks with disseminated pyrite (except 310-340' in RS-409) also have quartz-pyrite veins but the veins are more extensive, possibly because they are less easily destroyed than disseminated pyrite during calcite alteration. Hence, the effects of quartz-pyrite veins and disseminated pyrite may not be separable.

However, there are several instances where an increase in the abundance of vein pyrite coincides with an increase in gold concentrations to >100 ppb (e.g., 290-295' in RS-409 and 255-265' in RS-412) . Vein pyrite increases at 175' in RS-409 and decreases at 195'. Samples with 600+, 900+, and 2000+ ppb gold occur in this interval. Quartz-pyrite veins appear at 60' and disappear at 90' in RS-413; this interval contains a 900+ ppb sample and several 100+ ppb samples. Unusually large chips of quartz-pyrite veins at 210-215' in RS-410 coincide with an increase in gold to 200+ ppb. A decrease in vein pyrite at 190' in RS-410 coincides with a decrease in gold from 100+ ppb levels. Vein quartz, including drusy quartz, increases at 190' and decreases at 195' in RS-411 coinciding with an increase from 300+ ppb to 600+ ppb at 190-200' followed by a decrease to <200 ppb gold at 200-205'.

b. Bladed marcasite in veins is a favorable but neither necessary nor sufficient condition for gold mineralization. Most occurrences are in or near samples with >50 ppb gold. A quartz-marcasite vein at 175-180' in RS-413 coincides with 1200 ppb gold. Quartz-marcasite veins are relatively common in RS-418 at 300-600 ft and almost the entire section has anomalous gold.

Calcite-marcasite veins are less strongly associated with gold mineralization. Those at 430-460' in RS-418 are in samples with 100-200 ppb gold. One at 410-415' in RS-416 has 320 ppb gold but anomalous gold is not associated with those deeper in the same hole. Quartz-marcasite-calcite veins at 175-190' in RS-417 are in samples with less than 50 ppb gold but a 210 ppb sample occurs at 190-195' where calcite apparently disappears from the vein assemblage.

The correlation between gold and marcasite might improve if marcasite and pyrite could be more reliably distinguished. In my work, only a mineral with a bladed habit is considered marcasite. Some very fine grained, disseminated sulfide grains which appear to be flaky are also presumed to be marcasite (e.g., at 400-450' in RS-416).

c. Barite is also a favorable but neither necessary not sufficient condition for gold mineralization. Barite occurrences at 440-490' in RS-415 are in a longer anomalous section with gold consistently >50 ppb. That at 135-140' in RS-414 is at the bottom of a string of samples with 50-100 ppb gold. There is no anomalous gold associated with the barite in the oxidized zone of RS-415.

d. Calcite, calcite-quartz-pyrite, and uncommon calcite-pyrite veins, like calcite alteration, are unfavorable for gold mineralization. Many calcite veins occur in unaltered rocks, which lack any gold mineralization. A few samples with quartz-pyrite-calcite veins also have anomalous gold but the only sample with simple calcite veins and anomalous gold has quartz-pyrite veins above and below and the samples below also have anomalous gold.

Other Observations

1. The depth of oxidation in the East Zone delineation holes is 60-100 ft.

2. Hematite staining or alteration, which is recognized by reddish brown colors, commonly along fractures, is widespread even to depths of 550 ft (in RS-418). Core from holes in the Dreamland area indicate it extends even deeper.

3. Calcite alteration, in the form of finely disseminated (invisible under the binocular microscope) calcite, is widespread, occurs from the surface to depths of 550 ft, is as vigorous in argillically altered as in unaltered rocks, and continues without significant change across contacts between argillically altered and unaltered rocks. The latter characteristics and the occurrence of at least one chip of vein calcite cutting a pyrite veinlet suggests at least some calcite alteration is younger than argillic alteration and pyritization.

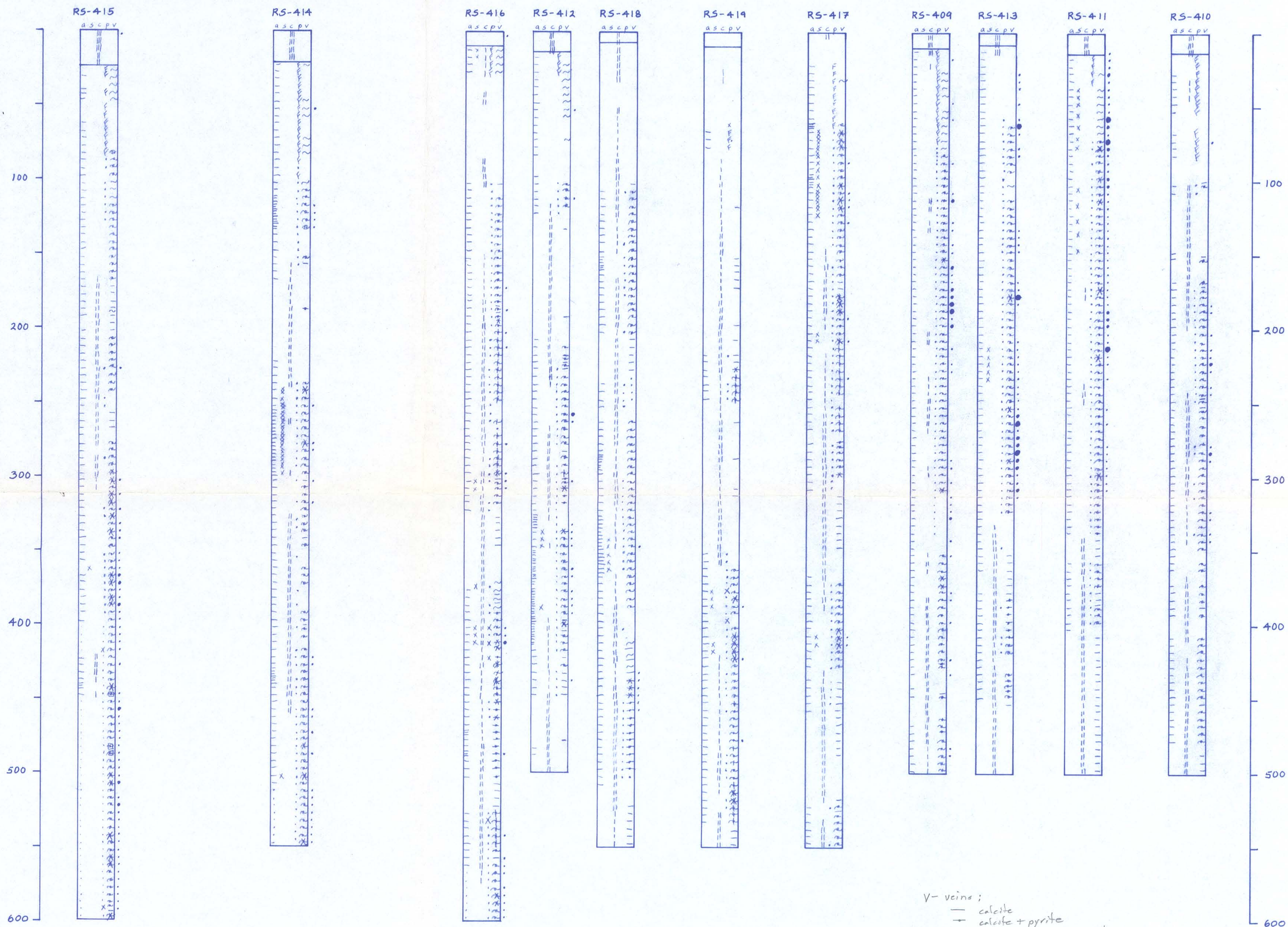
4. Two occurrences of magnetic minerals have been recognized. Rarely, small chips of unaltered FG can be picked up with a magnet. This is probably due to magnetite even though no crystals of magnetite are evident.

There is also a rare magnetic sulfide mineral in altered rocks. Under the binocular microscope, it cannot be distinguished from massive pyrite. It is locally intergrown with vein quartz or vein calcite. The mineral is probably pyrrhotite. High-temperature (>250^{o}C) pyrrhotite forms hexagonal, tabular crystals similar to those of bladed marcasite. However, no magnetic bladed minerals have yet been found and the angles on some of the bladed sulfides indicate they do not have hexagonal symmetry. I am not aware of other reports of pyrrhotite and even the low temperature form could have important implications for the paragenetic relations at Rosebud. The magnetic mineral could possibly be greigite, a diagenetic iron sulfide, but I haven't been able to find descriptions of greigite.

5. A green mineral which I suggested is chlorite replacement of hornblende in some of my early logs is not. It occurs as tabular to irregular crystals 1-3 mm long. It has the same appearance in altered and unaltered rocks but is more obvious in the pale altered rocks. In unaltered rocks, it occurs as individual crystals and is intergrown with white zeolite(?) minerals or calcite in what are probably amygdales. It is locally replaced by pyrite or altered to a waxy, pale green color in argillically altered rocks.

6. Lithologic control on shallow gold mineralization is the East Zone delineation holes is minimal. Samples with >300 ppb gold occur in all three of the principal rock types. There are too few samples with >900 ppb gold to allow meaningful comparisons. Five of the nine samples with >900 ppb gold are in brecciated FG. The best example of lithologic control is the consistently anomalous "pink porphyry". Almost all samples have >50 ppb gold and a few have >300 ppb even though disseminated pyrite is rare and argillic alteration may be minimal or absent. Quartz-pyrite veins, however, occur throughout the "pink porphyry" and some also have marcasite.

East Zone R.C. Samples - Alteration



a- argillic alteration:
— weak
≡ moderate
≣ strong
· uncertain degree of alteration in "pink porphyry"

s- silicification:
x weak
x moderate

c - calcite (disseminated):
| slightly calcareous
|| weakly calcareous
||| calcareous

p- pyritization (disseminated):
· disseminated pyrite present
X disseminated marcasite? (bladed) present
F iron-oxide staining and limonite

V- veins;
— calcite
calcite + pyrite
calcite + bladed marcasite
~ quartz
quartz + pyrite
quartz + bladed marcasite ± pyrite
quartz + pyrite + calcite
quartz + barite

Gold Concentrations in 5' Samples:
· > 50 ppb
• > 300 ppb
● > 900 ppb

East Zone R.C. Samples – Lithology

C – colluvium and regolith

FG – massive flow or sill with up to 1% hornblende microphenocrysts (<1mm) in aphanitic grey matrix; may have sparse amygdales; locally aphyric (FGa) lacking even hornblende phenocrysts; locally with <1%, .5-2mm long feldspar phenocrysts

LLT – generally monomict, clast- and matrix-supported breccia with angular to subrounded, clay to pebble-size (max. chip size) volcanic clasts, which could be derived from FG

Vc – clay-rich rock (often greenish-white) which could be derived from vitrophyre

Pp – "pink porphyry"; massive flow or sill with rare, clay-altered feldspar phenocrysts 1-2mm long in "pink", aphanitic matrix; locally aphyric (Pa)