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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	Suggestions for dblog units for Rosebud, January 20, 1998
AUTHOR	Vance R; 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
COMMODITY If not obvious	gold; silver
NOTES	Correspondence; comments on nomenclature; geology NOTE: Last 3 pages copyrighted - do not scan Sp.

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

Drill Log Database

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Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** January 20, 1998

From: George Langstaff

Drill Log Data Base

Subj: **Suggestions for dblog Units for Rosebud**

In case I have not been clear in our discussions of choosing rock names and attributes to use for dblog, I would like to emphasize the following points:

1. Formation names at Rosebud have not been adequately defined. It is easy enough to call all hornblende-phyric rocks "Chocolate" but if "Oscar Andesite" and "Brady Andesite" also have hornblende, we will have problems. We can't assume we will always know approximately where we are stratigraphically. Although the Oscar and Brady andesites are above and below the Dozer, what happens if the Dozer pinches out or if a Dozer-like unit occurs in the Chocolate?

Bob Bennett's six epiclastic units are of no help if we don't know their lateral continuity or the differences between them. Are the two epiclastic units on South Ridge 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6, 1 and 3, 2 and 5, or 1 and 6, etc.?

Shouldn't we also make allowance for new formation names? Some of the units north of the Rosebud shear zone may not correlate with anything on South Ridge. Because the basement-volcanic contact may be everywhere a fault, how do we know the Oscar is really the base of the volcanic pile? What if the "Chocolate" with the four intercalated epiclastic units near School Bus Canyon is actually the Oscar and the units to the west are pre-Oscar?

I agree that it would be a good idea to enter the principal formation names in the database now but only with the understanding that it may be months before we can assign them reliably to rocks.

2. It would be unwise to use compositional terms, such as rhyolite and andesite, before we have whole-rock data. If everything is rhyolite, nomenclature will be simple. In the worst case, we may need a whole-rock analysis of every unit we log in each drill hole and we may never be able to apply such terms to some of the altered rocks.

Again, include the terms in the database and hope that some day we will be able to use them. Based on Bob B.'s comments, it would be a good idea to include terms for alkalic or very potassic volcanics and possibly for high-silica volcanics. The volcanic rock with big sanidine phenocrysts I found last fall could be a strange one.

3. It would be unwise to use terminology for pyroclastic rocks until we have thin sections of unaltered samples of a substantial number of rock units. As in the case of the whole rock data, the result may lead to relatively easy or to very difficult classification schemes.

4. Cas and Wright (1988, "Volcanic Successions: Ancient and Modern") have a good discussion of descriptive vs. genetic classifications and I have attached three pages from their book to this memo. The most practical rock classification scheme will be one based on macroscopically observable features such as grain size and texture. It would be worth including genetic terms in dblog should the refinement of our work ever reach that point but the quality of previous work does not allow us to say now what those genetic units are. If you run short of ideas, Table 12.8 lists **41** genetic volcaniclastic units. In addition, you should make allowance for massive, flow-banded, brecciated, etc. flows and sills and their various phenocryst compositions. Some of the genetic units listed by Cas and Wright won't be applicable to Rosebud but who knows what we may find once we start looking at the rocks.

and again these should be treated with the same caution.

Constituent fragments

A summary of the dominant components in a pyroclastic deposit provides a qualitative lithological description as well as information on the genesis (Table 12.6).

Welding

We have already discussed the process of welding and the lithological variations it can produce in Chapters 6 and 8.

12.3 Classification of lithified, indurated and metamorphosed volcaniclastic rocks

The foregoing review of the classification of *modern* pyroclastics is an essential prelude to the consideration of ancient volcanic successions because it gives an appreciation of the great range of products produced by a diversity of *observed* (or confidently inferred) processes in, around and stemming from modern volcanic vents and centres. Such an awareness of the possible range of origins is critical for the geologist working in ancient successions because, in most instances, the definitive context and spatial relationship to vent or volcanic centre, that are often (but not always) observable or inferable for modern successions, are lacking. The approach therefore initially has to be more objective and less genetic, with the overall context, extent and characteristics of the lithological unit(s) having to be established.

Other factors which complicate the genetic interpretation and classification of lithified volcaniclastics include: devitrification, recrystallisation, new mineral growth during diagenesis and low grade metamorphism, and deformation, all of which lead to modification of original textures and mineralogy to varying degrees (Ch. 14). Add to this that epiclastic volcaniclastics can also be exceedingly abundant, and equally modified, and that modern weathering also takes its toll in producing confusion. It is then a brave person who walks up to an outcrop and applies a genetic classification or terminology. For example, devitrification of an originally glassy lava can produce an equigranular mosaic or spherulitic texture, so giving a pseudogranularity in hand specimen. Metamorphism and weathering can further accentuate this, so producing a granular texture which may be very difficult to distinguish from a truly fragmental texture. Thin section examination may be no more helpful than the hand specimen, because the original glassy character of the rock may have been overprinted, with the distinction between a coherent glassy groundmass and vitriclastic (e.g. shards) or epiclastic textures being difficult to identify.

Application of genetic terminology to lithified volcaniclastics should therefore be avoided until thorough evaluation of the *complete* set of characteristics of the lithology (or lithologies) has been made, including:

(a) hand specimen characteristics (textural, compositional),
(b) outcrop characteristics (bedded as opposed to massive; structures and fabrics that are essentially contemporaneous with emplacement),
(c) contact relationships (sharp or continuous, gradational),
(d) geometry (three-dimensional form and thickness),
(e) associated facies and
(f) context and palaeogeographic setting.

Rarely will any one of these, or any single outcrop, be definitive enough to allow an unequivocal interpretation of the genesis. Furthermore, it cannot be assumed, as is commonly done, that because a rock is volcaniclastic it had a pyroclastic origin. Even having demonstrated that a rock is of probable pyroclastic origin, it cannot be assumed that it was deposited close to the vent, as is also often done.

Finally, it cannot be assumed that the imprint and character produced by a particular mode of eruption will reflect the final transportational and depositional mode. For example, pyroclastically fragmented detritus (crystals, pumice, shards) can be transported and deposited by means other than pyroclastic ones (e.g. surface reworking, lahars,

Table 12.7 Non-genetic classification of volcaniclastic rocks (modified from R. V. Fisher 1961).

Volcanic breccia	
closed framework	
open framework	
non-cohesive, granular matrix	
cohesive mud-sized matrix	
Volcanic conglomerate	
closed framework	
open framework	
non-cohesive, granular matrix	
cohesive mud-sized matrix	
2 mm––––––––––––––––––––––––––2 mm	
Volcanic sandstone	
0.0625 mm–––––––––––––––––––0.0625 mm	
Volcanic mudstone	
volcanic siltstone	if sufficiently well sorted and volcanic origin is clear
volcanic claystone	

subaqueous mass flows; Ch. 10) and in environments away from the near vent area. *Consideration of genesis therefore involves consideration of both the fragmentation mode and final depositional mode.*

A useful starting place with ancient volcaniclastic rocks before attempting any kind of genetic classification, as presented in Section 12.2, is Fisher's (1961) suggested non-genetic nomenclature. Following Fisher's lead, a suggested initial non-genetic terminology is given in Table 12.7. If a wholly pyroclastic, rather than epiclastic, origin can be established, then the nomenclature of Table 12.5 can be used, and if beyond that the pyroclastic transportation and depositional origins can be established, then the appropriate nomenclature of Tables 12.1–12.4 can be used.

12.4 Descriptive lithological aspects of ancient volcaniclastic rocks relevant to determining their genesis

Few of the textural or compositional characteristics of volcaniclastics are by themselves indicative of one particular mode of fragmentation or deposition. For example, the term 'agglomerate' (which has distinct genetic connotations, see Section 12.5), is frequently used for any volcanic breccia but, as seen in Table 12.8, there are over twenty ways of producing volcanic breccias!

Another example is accretionary lapilli, which are generally assumed to be diagnostic of air-fall deposits, formed by rainfall through a downwind ash cloud or from a moisture-laden eruption column, especially a phreatomagmatic column. It is now known that accretionary lapilli are perhaps more commonly generated within the explosive eruption column, particularly within those of phreatomagmatic eruptions (Ch. 5). They are therefore common in base surge deposits and some ignimbrites, as well as surtseyan and phreatoplinian ash-fall deposits (Fig. 5.24). They have also been noted in fossil fumarole pipes in ignimbrites, and could form in the secondary explosion columns of rootless vents formed where pyroclastic flows or lavas interact explosively with a body of water (Ch. 3) or ice.

The following is a brief listing of important descriptive properties of volcaniclastics and some qualifying comments on their usefulness or limitations. The assemblage of properties should be used together with the larger-scaled outcrop and field properties and relationships to evaluate the genesis. The majority of the listed properties are sedimentological in origin, and we feel that such an approach is a useful one.

Textural:
- *coherent crystalline igneous texture versus fragmental texture*
- *welding*
- *grainsize*
- *sorting*
- *shape*
- *angularity or rounding*, and
- *framework type*

Compositional:
- *compositional affinities*
- *compositional homogeneity*, and
- *clastic components.*

Table 12.8 Grainsize-
characteristics).

Grainsize–te
A conglomerate – c (rounded clasts e
B conglomerate – c (rounded clasts e
C breccia – closed (angular clasts e
D breccia – open (angular clasts
E sandstone (sand-sized fr essential)
F mudstone (mud-sized g

Table 12.8 Grainsize–textural classes of volcaniclastic rocks and some possible origins (see App. II for suggested diagnostic characteristics).

Grainsize–textural class	Origin
A conglomerate – closed framework (rounded clasts essential)	1 epiclastic reworking (fluvial, shoreline) 2 mass-flow redeposition (subaqueous) 3 pumice and scoria concentration zones in ignimbrites and scoria-flow deposits 4 fines-depleted ignimbrite
B conglomerate – open framework (rounded clasts essential)	5 epiclastic reworking and mass-flow redeposition (deposits with granular matrix) 6 cohesive pebbly mudflows and lahars 7 non-welded (uncollapsed pumice) ignimbrite and scoria-flow deposits
C breccia – closed framework (angular clasts essential)	8 epiclastic redeposition and mass-wastage (includes gravitational collapse, including caldera margin collapse breccias) 9 aa lavas 10 block lavas 11 lava dome and flow-front talus deposits 12 agglutinates 13 agglomerates 14 quench-fragmented lavas, cryptodomes and shallow intrusives (hyaloclastites) 15 hydrothermal explosion breccias 16 hydraulic fracture breccias 17 pumice-fall deposits 18 scoria-fall deposits 19 lithic concentration zones (base of *layer 2b*) and ground layers of violent ignimbrites 20 co-ignimbrite breccias (lag breccias and ground breccias) 21 fines-depleted ignimbrite
D breccia – open framework (angular clasts essential)	22 glacial till and moraines (diamictites) 23 glacial dropstone deposits 24 epiclastic reworking and mass-flow redeposition with granular matrix 25 cohesive debris flows and lahars 26 ignimbrite (*layer 2b*) and other (denser clast) pyroclastic flow deposits (block and ash flows, scoria flows) 27 co-ignimbrite breccias and proximal ignimbrites 28 near-vent base surges 29 ground or ash-cloud surge 30 giant pumice beds
E sandstone (sand-sized framework grains essential)	31 epiclastic reworking 32 epiclastic mass-flow redeposition 33 weathered and/or devitrified lavas or dykes 34 fine-grained ignimbrite 35 air-fall ashes or tuffs 36 base surge deposits 37 ground or ash-cloud surges
F mudstone (mud-sized grade predominant)	38 epiclastic 39 fine-grained ignimbrite 40 air-fall ashes or tuffs 41 surge deposits