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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 Structural Study; Rosebud Project, report prepared for LAC Minerals (USA) Inc.; August 20, 1991
AUTHOR	Beaty R; Kuhl, T; Trodden A; Moore S; Dixon R; Kortemeier C
DATE OF DOC(S)	1991-1992, 1996
MULTI_DIST Y / N? Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Rosebud Project; LAC Minerals (USA) Inc Santa Fe Pacific Gold; SFPG Rosebud Joint Venture Wildrose Prospect; Wildrose Canyon Mouth target; Oscar; Badger Basin target; Southeast Dreamland; Shaft Fault target; Chance Prospect
COMMODITY If not obvious	gold; silver
NOTES	Geologic report; geology; geologic map; cross sections; handwritten notes; correspondence stratigraphic columns 46 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)

	Initials	Date
SS:	DP	9/10/08
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ROSEBUD GEOLOGY -
STRATIGRAPHY GENERAL

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LAC MINERALS (USA), INC.

MAR 1 2 1992

March 6, 1992

Ross Beaty
Equinox Resources, Ltd.
625 Howe Street, Suite 900
Vancouver, B.C. V6C 2T6

• Plates to follow later

Dear Mr. Beaty,

Tim Kuhl asked me to send you the enclosed Rosebud Structural Study completed by Steve Moore last August. Enjoy!

Sincerely,

Aina K. Trodden

Aina K. Trodden
Office Assistant

enc: Rosebud Structural Study

205 - reports

ROSEBUD STRUCTURAL STUDY

ROSEBUD PROJECT
Pershing County, Nevada

Report Prepared for LAC Minerals (USA) Inc.

Stephen C. Moore
Consulting Geologist

August 20, 1991

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INTRODUCTION

A structural investigation of the Kamma Range in the vicinity of the Lac Rosebud property, embracing the Dozer Hill gold deposit and several additional prospect areas, was conducted from June 10, 1991 to August 20, 1991.

This study emphasized the examination of field exposures of the volcanic section and of major and minor faults. Excellent field exposures permit the collection of a great deal of structural data on all scales that pertain both to local and regional structural analysis. A total of 23 days were spent in the field, together with about 20 days in the office for orientation, interpretation, and the preparation of reports and illustrations.

The procedures emphasized during field study have been for the following objectives:

1. To synthesize the volcanic stratigraphy among the various sub-areas that have had detailed (1"=200') mapping, in order to provide a stratigraphic scheme that can be referred to project-wide.

2. To use marker units in the volcanic stratigraphy, where possible, to determine structural offsets of the stratigraphic section.

3. To use structural models of faulting to predict previously unrecognized faults that are geometrically required by exposures of dipping strata.

4. Combining the past in-house mapping, together with current field observations, to characterize the known structures and recognize a general pattern of faulting and structural development.

5. To present a scheme of structural development that would define distinct structural environments and a relative chronology of faulting that can be related to the localization and timing of epithermal gold mineralization.

6. To detect areas which appear prospective for further mineralization from the standpoint of structural preparation.

Results of the study are presented on various illustrations with this report. Geologic and structural maps and cross sections at a scale of 1" = 500 ft, covering areas of interest on the Lac property in the Kamma Range, are appended.

ACKNOWLEDGMENT

The foundation for the ideas presented with this report has been the detailed mapping and reconnaissance experience of many individuals in the LAC organization. My interpretations are extensions of the ideas and maps generated by B. Bennett, G. Massengill, S. Maynard, K. Tullar, and C. Walck. I thank these persons, T. Kuhl, and others in the Reno LAC office for assistance during orientation, for stimulating conversations, and for help in the preparation of this report.

VOLCANIC STRATIGRAPHY

The stratigraphic section of the Kamma Mtn. Volcanics has been summarized, from reconnaissance study, on a Longitudinal Stratigraphic Section at a scale of 1"=1000'. Unit thicknesses have been determined from structure cross-sections in compiling this chart. In addition, thicknesses of rock units are tabulated on Table 1.

The Longitudinal Stratigraphic Section illustrates some new conclusions about the volcanic stratigraphy. The sub-Bud stratigraphy has been subdivided, and the stratigraphic units mapped on the Chance prospect and observed at the Wildrose prospect have been incorporated into the overall scheme. The horizon occupied by the Bud Volcanics has been traced along the length of the property. Some additional and locally distinctive lithologies have been recognized in the Chocolate Rhyolite. The Badger formation has been redefined.

During the study, a number of new names have been introduced and some units have been redefined:

1. New names have been introduced for the Goblin Gulch Dacite and the Knob Gulch Breccia, which are exposed on the Chance prospect, and can be extended northward along the western slope of the range.

2. Some previous names have been modified. In particular, the designation of"Tuff" applied to the Dozer, Wildrose, LBT, and Chocolate units is not recommended, as these units now appear to be largely rhyolite lava flow rocks. Consequently, these units are now referred to as the Dozer Rhyolite, the Bud Volcanics, etc.

3. The Bud Volcanics is recognized as a separate unit from the Chocolate Volcanics, rather than a member of it.

To date, the Bud Volcanics appears to be a distinctive unit with a unique stratigraphic horizon underlain by Dozer or Wild Rose and overlain by the Chocolate. The alternative scenario of multiple horizons of a recurring sedimentary environment, yielding a repeated lithology in several of the units, is not necessary to explain the observed distribution.

Definition of the Bud becomes difficult where the epiclastic members thin, and volcanic flows interfinger with the overlying and underlying units.

Table 1

Thickness of Rock Units, Kamma Mtns. Volcanics

Location	X-Sec	Tt	Tkg	Tgg	Td	Twr	Tbv Total	Bud Volcanics Lower Tbe	Bud Volcanics Tbc or Tbw	Bud Volcanics Upper Tbe	Tct	Tb
Juniper Creek	A	-	>3000 (1)	0	0	800	400	100	300	0	1900	>1000
Wildrose Canyon	-	-	~1500 (1)	~1000	0	1700	0		- 0 -		700 - 1500 (2)	>2000
Chance-Rosebud Peak	B	-	~2000 (1)	> 900	500	2200	350		-		1150 (2)	>1000
Knob Hill-Schoolbus	C	-	> 600	1300	500	2400	600	<100	300	200	2500	-
Lower Schoolbus	E	-	0	0	>1500	≤ 200	1250	450	600	200	Partial Section	-
Dozer Hill	H	50	0	0	1000	0 ? (3)	~800	lenses ?	"LBT" ~600	300-400 (4)	1700	> 600
South Ridge	D,G	?	0	0	2700	0	0	220	400-550	300	2000	> 600
South Kamma	F	800	0	0	900	0	0	0-100	600-1000	lenses	1600	-

Notes:
1) Section is intertongued with Tgg and Twr.
2) Tct thinned by onlap of Tb below unconformity.
3) LBT problem: LBT could be sub-Bud Twr, or, could be interbedded within Bud as Tbw.
4) "Upper Tbe" includes entire mine section of upper Bud, TMB, and lower Bud.

4. The Badger Formation as redefined incorporates the Gator Breccia of earlier maps. The Badger unit is the uppermost unit of the Kamma Volcanics and its base is an unconformity with significant local relief.

5. The Dozer Rhyolite section, below the Bud Volcanics, has been subdivided and redefined from reconnaissance examination. The Wildrose Rhyolite is now recognized as a distinctive unit which overlies it, and the Goblin Gulch and Knob Gulch units are lateral equivalents of the Dozer.

6. The LBT unit, which hosts ore at Dozer Hill and underlies the mine section of the Bud Volcanics, is provisionally correlated with the Wildrose Rhyolite, which underlies the Bud further north. An alternative interpretation is that the LBT lies within a thicker section of Bud Volcanics,occurring as a rhyolite lens sandwiched between epiclastic strata.

Two alternative scenarios of the LBT correlation problem are offered on two versions, I and II, of the Longitudinal Stratigraphic Section.

The difficulty of defining the Bud Volcanics as a mappable unit, in areas where the epiclastics interfinger with volcanics of the overlying and underlying units, remains a stratigraphic problem, and is the crux of item 6 above. This "problem", however, is an arbitrary one, as complex interfingering relationships are to be expected among volcanic and alluvial units, and the results are not easily fit into conventional stratigraphic "boxes".

A type of stratigraphic problem that is not arbitrary, however, is that exemplified by the thickness of the Dozer Rhyolite at Dozer Hill vs. that on South Ridge. The problem is illustrated on the Longitudinal Stratigraphic chart and on Cross-Sections G and H. The rapid variation in thickness of the Dozer Rhyolite are unexplained for the time being, but could suggest that an unrecognized structure is causing the discrepancy between the two nearby locations. I think that there are instances where such stratigraphic problems can point to structural solutions. This is the potential value of the stratigraphic information reported here.

KAMMA MOUNTAINS VOLCANICS

Basal Kamma Unit (Tt)

Volcanic and sedimentary strata that overlie the Mesozoic basement are known from drillholes beneath Dozer Hill, and are exposed above Jurassic-Triassic metasedimentary outcrops east of the Oscar Fault along the western front of the Range at Oscar. These two occurrences are quite different in lithology and thickness.

The outcropping section at Oscar is dominated by basalt flows, interbedded with dark-weathering pebble conglomerates containing Mesozoic clasts, and fine grained, laminated siltstone. The basalt flows locally form a pile several hundred feet thick, as at the base of the ridge directly south of the west end of South Ridge. The entire unit is about 800 ft thick (Cross Section F).

It is important to distinguish the conglomerates exposed here from the younger Sulfur group conglomerates, which occur on the other side of the Oscar fault. Where altered, the younger beds are strongly lithified. Both conglomerates contain rounded Mesozoic pebbles. If the position of the Oscar fault is uncertain, the two units can be confused, but they are separated in time by the deposition of the entire Kamma volcanic section.

The basal conglomeratic strata are part of what was called tne Pansy Lee Conglomerate in earlier mapping on the property, but this term took in other conglomerates that have Mesozoic clasts, and so erroneously included some of the younger strata.

The clastic "transitional" beds which overlie the basement in Dozer Hill drillholes are generally thinner than 50 ft thick. These strata are sandstones and laminated siltstones which probably overlie Mesozoic basement depositionally. Structural offsets along faults in the footwall of the South Ridge fault may have considerably modified the apparent thickness of this unit, however.

<u>Knob Gulch Breccia (Tkg)</u>

This unit is the principal lateral equivalent to the Dozer Rhyolite in the northern part of the range, northward of Knob Gulch. In the Chance area, it underlies, overlies, and interfingers with the Goblin Gulch Dacite, and it is composed principally of clasts of the dacite and of flow-laminated rhyolite. As it apparently completely envelopes the dacite, it is locally quite thick. It is exposed on both sides of Wildrose Creek and Juniper Creek, beneath the Wildrose Rhyolite.

North of Juniper Creek, rhyolite clasts become dominant over dacite. In this area, a possible extrusive dome of Wildrose Rhyolite intrudes the breccia and has probably contributed rhyolite clasts to it.

The unit consists of pyroclastic and epiclastic breccias with local conglomerate. The breccias are probably debris-flow breccias in large part. Breccia beds in Wildrose Canyon have planar tops and bases and are perceptibly stratified. Near Wildrose Spring, stratified conglomerates occur immediately below the Wildrose Rhyolite contact.

Outcrops of unaltered Knob Gulch breccia, in particular where there is a large component of dacite in the breccia, are dark, blocky, and dark brown weathering. Where bleached, the breccia looks very different, as along the range front near Knob Hill. Bleached and unbleached breccia are juxtaposed on either side of the Juniper Canyon fault.

The Knob Gulch Breccia is intruded by rhyolite domes correlated with the Wildrose Rhyolite along Wildrose and Juniper Creeks.

Sediments near the base of the Kamma Mtn. Volcanics have been mapped by Wallace and others east of the Sulfur deposits. I will venture a guess (sight unseen) that these epiclastic strata are part of, or interfinger with, this unit. Other possibilities are Tt, or Bud.

Goblin Gulch Dacite (Tgg)

Dacite flows are exposed from Guzzler Gulch to Wildrose Canyon. This unit is equivalent to part of the Dozer rhyolite and interfingers with it near Guzzler Gulch. It interfingers with the Knob Gulch Breccia, and is entirely enveloped by it, between Goblin Gulch and Wildrose Canyon.

The dacite forms dark brown, blocky to jointed outcrops. Fresh, it is a dense, aphyric rock with a medium gray, unweathered interior containing fine grained magnetite.

North of Chance, in Goblin Gulch and Wildrose Canyon, the dacite forms an oval exposure in map view that is entirely surrounded by Knob Gulch breccia. The dacite can be interpreted as a pile of lava flows that interfinger laterally with, and contribute clasts to, the breccias. Alternatively, the dacite exposure could be dome-like, and partly intrusive into, the breccia section.

Dozer Rhyolite (Td)

Td underlies the Bud Volcanics in Schoolbus Canyon, Dozer Hill, South Ridge and Rosebud Canyon. Further north, it underlies the Wildrose Rhyolite, which in turn underlies but in part interfingers with the Bud Volcanics. The Dozer interfingers laterally with the Goblin Gulch dacite at Guzzler Gulch.

The Dozer is composed of olive green to sage green rhyolite flows. It is generally aphyric. It is distinguished from the Wildrose Rhylite mainly on the basis of color. The upper contact is fairly sharp and definable between Schoolbus Canyon and Short Shot, where the Wildrose begins to attain a significant thickness above it.

In areas where the Dozer is thick, such as South Ridge, its foliation attitudes appear to be highly variable, whereas foliation attitudes of the Wildrose Rhyolite, even where it is thick, are more uniformly moderately dipping to the east. It has been suggested therefore that the Dozer represents a viscous extrusive dome in these areas, whereas the Wildrose is composed more of stratiform flows with horizontal flow layering.

South of Chance, felsite flows that overlie the Goblin Gulch dacite have properties transitional to typical Dozer rhyolites, i.e. a more fissile foliation and olive green interior. Discrimination between the Goblin Gulch and Dozer is not always possible. The flows that overlie the dacite and grade upward into the Wildrose Rhyolite are tentatively identified as Dozer on maps and sections. These flows are associated with discontinuous occurrences of pyroclastic breccia and lapilli tuff.

Wildrose Rhyolite (Twr)

Wildrose rhyolite is a thin layer at the top of the Dozer in Schoolbus Canyon. It thickens northward to greater than 2000 ft in Wildrose Canyon, and then thins somewhat further north. The unit overlies the Dozer and the Knob Gulch Breccia.

It principally underlies the Bud Volcanics, but is apparently in an interfingering relationship with it along its length. Some rhyolite flow exposures that may correlate with the Wildrose are interbedded with Bud epiclastics north of Juniper Creek, on South Ridge, and in the south Kamma Range.

The LBT unit of the mine section may correlate with the Wildrose Rhyolite. Alternatively, it may lie between Bud epiclastic horizons, as do the somewhat similar rhyolite flows exposed on South Ridge (Little Chocolate hill).

Visualized as an evolving volcanic system, it appears that rhyolites classed as Wildrose-like were extruded throughout a period that preceded and spanned the Bud epiclastic interval. The Wildrose lavas are largely aphyric, but those that are interbedded with the Bud horizons may contain trace biotite phenocrysts. Concurrently, lavas that contain more abundant phenocrysts, of feldspar as well as biotite, began to extrude during this interval, and then became dominant in the Chocolate Volcanic interval.

The Wildrose rhyolite forms red-brown to purplish-gray, conspicuously flow-foliated outcrops. It is generally aphyric. The unit contains very few pyroclastic breccia interbeds.

As many as three rhyolite domes that are exposed at Wildrose and Juniper Canyons are correlated with the Wildrose Rhyolite. Two of the domes that intrude Knob Gulch Breccia were probably intrusive and did not vent to the surface. The glassy vitrophyric margin of one of these is well exposed at the mouth of Wildrose Canyon. Stratification in the surrounding Knob Gulch Breccia is arched upward and outward from the dome, suggesting forceful intrusion.

The two intrusive domes can't be related to the Wildrose with certainty, but are correlated with it because of the relationships surrounding the third dome. The dome interpreted at the Wildrose prospect appears to pass upward into stratiform Wildrose lavas. The dome also feeds clastic detritus to the intruded Knob Gulch Breccia, and overlies the latter along an inward-dipping, foliated margin. In the interior of the interpreted dome, the rhyolite is blocky and dense. This exposure is interpreted therefore as an extrusive dome complex that fed Wildrose lavas onto the paleosurface. Domes, country rock and flows were subsequently tilted eastward (Cross Section A).

Bud Volcanics (Tbv)

The Bud Volcanics is the most distinctive unit in the volcanic section and occupies a stratigraphic interval between largely aphyric rhyolite lavas and phenocryst-bearing lavas of the overlying Chocolate Volcanics. It records a period of subsidence, alluvial sedimentation and relative quiescence of volcanism.

The unit extends most of the length of the range, but is thickest and best exposed on either side of Rosebud Canyon. Where the epiclastic members of the unit thin and pinch out, the horizon can sometimes be recognized with fair certainty as the contact between aphyric and porphyric volcanics. This horizon may also be marked by celadonite in the enclosing volcanic units, and variable and distinctive lithologies such as basalt flows. At times the entire Bud interval is filled with rhyolite lavas resembling either the Wildrose or the Chocolate units.

The Bud Volcanics pinch out completely north of North Equinox and Wildrose Pass. However, the contact between aphyric Wildrose Rhyolite and porphyritic Chocolate pyroclastic breccias, the Bud horizon, is clearly definable. The underlying Wildrose is particularly thick at this location. It is likely that it was a positive topographic feature during Bud time, and that therefore no Bud was deposited over it.

The distinguishing lithologies of the formation are gray-green and purple sandstone, pebble conglomerate, and cobble conglomerate that show aqueous sorting. Interbedded with the clearly sedimentary beds are mudflow and debris-flow breccias, colored green, purple or tan. The breccias are either clast or matrix supported, and contain rounded cobbles to boulders as well as angular material. Matrix supported breccias show crude grading, with boulders near the bottom of the flow. True pyroclastic breccias may also be present but are probably much less common than the mudflows, which could be largely epiclastic.

The thick Bud section on the west end of South Ridge contains a very well exposed, tilted, paleocanyon 400 ft deep that has been filled with numerous mudflows. Alluvial sediments are present mainly above the filled canyon, and record a period where there was more subdued topography and alluvial fan sedimentation.

Rhyolite flows resembling either the Wildrose Rhyolite (Tbw) or the Chocolate Volcanics rhyolite (Tbc) are interbedded with the epiclastics, and are often sandwiched between two or more epiclastic members. The Chocolate-like rhyolites are typically pink, gray and purple, devitrified rhyolites with a few % phenocrysts and often with a well developed flow lamination. Flows of green glassy rhyolite and vitrophyric bases of devitrified flows are more common in the Bud than in the Chocolate formation (Cross Section E).

Wildrose-like flows are either aphyric or contain sparse fine biotite or rare feldspar phenocrysts. These flows are typically purple-gray, or darker purple-brown, and are foliated to jointed. Such flows intertongue with epiclastics near the Wildrose prospect and on either side of Rosebud Canyon, and include the "Little Chocolate Hill" flows, or sills, as previously mapped. Flows correlative with the Little Chocolate exposures are thickened south of Rosebud Canyon, and are possibly sourced from plugs just east of the Oscar prospect (Cross Section F).

Chocolate Volcanics (Tct)

The Chocolate Volcanics are porphyritic rhyolite flows and interbedded pyroclastic breccias, attaining a thickness of 2000 or more ft near Rosebud Canyon. Further north and south in the range, other lithologies comprise much of this thickness. Typical rhyolite flows are red-brown where fresh; however this unit exhibits more alteration at the surface than any other unit, and altered colors are light gray, tan, or bleached white. Pyroclastic breccias are relatively common and make up perhaps 20% of the formation in the central area.

A couple of distinctive units have been noted. One is a crystal rich rhyolite (Tcl) with a well developed flow lamination, 5-15% phenocrysts, and 1-2% dark lithics which may be basement fragments. This unit occupies the north ridge of Kamma Peak, south of Rosebud Canyon, and is present again on either side of the Rosebud Shear near the Oscar prospect (the outcrops being startlingly close to each other, considering that a major shear zone divides them). In some outcrops, patches resembling pumice are present. This unit is possibly an ash-flow tuff, although if it is, flowage has modified the tuffaceous character. Ashflow tuffs are noted elsewhere, uncommonly and locally, both in the Chocolate and among the Bud rhyolite units.

North of Juniper Creek, dacite and andesite (Tci) with 5-10% fine feldspar phenocrysts occupies much of the thickness of the Chocolate unit. In this area, too, rhyolites resembling the Wildrose rhyolite are present, in some cases relatively high in the Chocolate section.

The top of the Chocolate Volcanics is an unconformity, and its thickness is therefore quite variable (Table 1). There may be on the order of 1000 ft of relief on the sub-Badger unconformity. Some of this relief is probably due to faulting synchronously with sedimentation and doesn't necessarily represent pre-existing paleotopography.

Badger Formation

The Badger Formation is a volcanic and epiclastic unit that occurs all along the eastern margin of the Kamma Range. Its base is an unconformity that suggests a significant hiatus, with erosion and incipient eastward tilting of the underlying Chocolate Volcanics. This is seen at locations such as east of Rosebud Peak, where the Badger strata lap over the Chocolate unit such that only the bottom half of that unit is exposed. Badger strata downdropped by graben-forming faults along the Rosebud shear may be another instance where the Badger laps far down into the Chocolate section.

The unconformity is further illustrated by the map pattern of Chocolate subunits north of Wildrose Pass, where parallel strata disappear obliquely northward beneath the Badger. Also, at the east end of Rosebud Canyon, individual flows in the Chocolate Formation are truncated along an angular conformity below the Badger. At this location and again, north of Dozer Hill, a peculiar vesicular, glassy latite(?) lava (previously mapped as QTb basalt) appears to mark the base of the Badger Formation.

Lithologies are principally cobble and boulder-bearing beds of debris-flow breccias and fanglomerate, with crude stratification. Fanglomerate with finer stratification and interbeds of pebble conglomerate are present, as well as pumiceous tuff and rhyolite flows. The stratification can be seen on air photos as east dipping linears on reddish hillslopes.

South of Rosebud Canyon, the unit becomes more volcanic in character, with rhyolite flows and associated pyroclastic breccias becoming dominant. The rhyolite flows are aphyric and finely laminated. More centrally, rhyolites also occur within the Badger south of Dreamland, and east and northeast of the Dozer Hill area.

A red-brown, hematitic matrix, which weathers to soft red-brown soil, is typical of the formation which is typically very poorly exposed, as it weathers easily. The oxidized matrix may be primary and possibly reflects dry paleoclimatic conditions and an oxidized alluvial environment, in contrast to the wet conditions suggested by the reduced iron colors and celadonite of the Bud Volcanics and various green intervals in the Chocolate.

YOUNGER SEDIMENTARY UNITS

Sulfur Group

The Sulfur Group was defined by A. Wallace in the Sulfur area for the principally alluvial units that host the ore at the Sulfur gold deposits. The Sulfur group consists of a conglomeratic and lacustrine sequence that grades upward into latest Tertiary alluvial gravels.

The Sulfur Group is pre-mineral, and therefore probably older than about 2 m.y. Its age could span the late Miocene to Pliocene interval. It is at least 1500 ft thick in the Sulfur area, and its lowest units, intercepted in a single deep drillhole, are described as red in color and rich in volcanic clasts. These beds could be gradational with, or could in fact be part of, the Badger Formation.

The youngest strata are poorly consolidated gravels, but still reflect the regional alteration associated with the Sulfur mineralizing event; yellow, green, and reddish hues color the beds from Sulfur southward down the western pediment of the Kamma Range. Sulfur group beds are also nearly everywhere tilted into listric faults which were active prior to mineralization at Sulfur.

Sulfur Group beds occur west, south and east of the Kamma Range. The gravels commonly are dominated by Mesozoic clasts, mixed with a variable minority of volcanic clasts of more local provenance. The Mesozoic source could be fault bounded ranges uplifted to the east and south. Volcanic flows are locally interbedded with these sediments, especially evident to the south of the Kamma Range, west of Placerites.

As well as the Hycroft gold deposits, the Sulfur Group hosts the alteration at Oscar, which is structurally analogous to Hycroft but is a much smaller occurrence. The unit hosts the quartz boulders of the Gold Zone on the Lantern property, and the alteration on Silver Ridge there. Sulfur Group sediments are probably the basement beneath the gold-bearing Quaternary gravels of the Double-0 and other placer occurrences near the mouth of Rosebud Canyon.

Sulfur Group clastic sediments were deposited on top of the Kamma Mtn. Volcanics, and at least partially if not completely buried the Kamma Range. A small patch of consolidated conglomerate with Mesozoic pebbles is preserved along the South Ridge Fault next to the easternmost "shark fin" outcrops on the fault. This exposure strongly resembles the Sulfur group conglomerates exposed at the Oscar prospect.

The tilting of the beds of this formation on all sides of the Kamma Range attests to the widespread occurrence of listric faults in this region. Tilted beds on the Lantern property, east of the Kamma Range, dip east into exposures of Mesozoic phyllite. This geometry requires that a listric fault must truncate the Sulfur Group exposures at their eastern contact, located approximately where the Silver Ridge and SP Hill alteration and mineralization occur. (Here is an example of where a stratigraphic geometry implies the presence of a listric fault, which has apparently acted as a conduit for repeated mineralization and alteration.)

<u>Older Quaternary Gravels (Qog)</u>

Prior to latest uplift of the Kamma Range, older gravels were deposited along the western front of the range, and partly over the top of it. The gravels on the west are now uplifted, relative to the subsident base level in the Black Rock desert basin, and are being dissected. These gravels include the auriferous placers near Rosebud Canyon, and the gravels that cap the mineralized rocks, but are partially offset by faults, at the Hycroft mine. Relative to the older Sulfur Group sediments, the gravels are unconsolidated, unaltered and drab in color, and untilted.

Clasts in these gravels indicate Mesozoic provenance. It is reasonable to suppose that the Kamma Range was partially buried, and that paleodrainages sourced Mesozoic clasts from eastern highlands like the Antelope Range. These drainages flowed over and through the present site of the Kamma Range.

Remnants of a gravel sheet that overlay the Kamma Range, or at least, the eastern slope of the range, are preserved along faults that underwent limited reactivation during the Quaternary. The Kamma fault is marked by linear patches of gravels along the entire eastern margin of the range. In previous mapping, these outcrops have been mapped as Mesozoic bedrock. Bedrock outcrops are present, but most of the green veined quartzite and phyllite along the Kamma fault is cobbles in Qog.

Small amounts of normal displacement along the fault, or along a splay of the fault, downdrop and "trap" a 50-100 ft thickness of gravel, which is then preserved from immediate erosional stripping during later uplift (Figure 1).

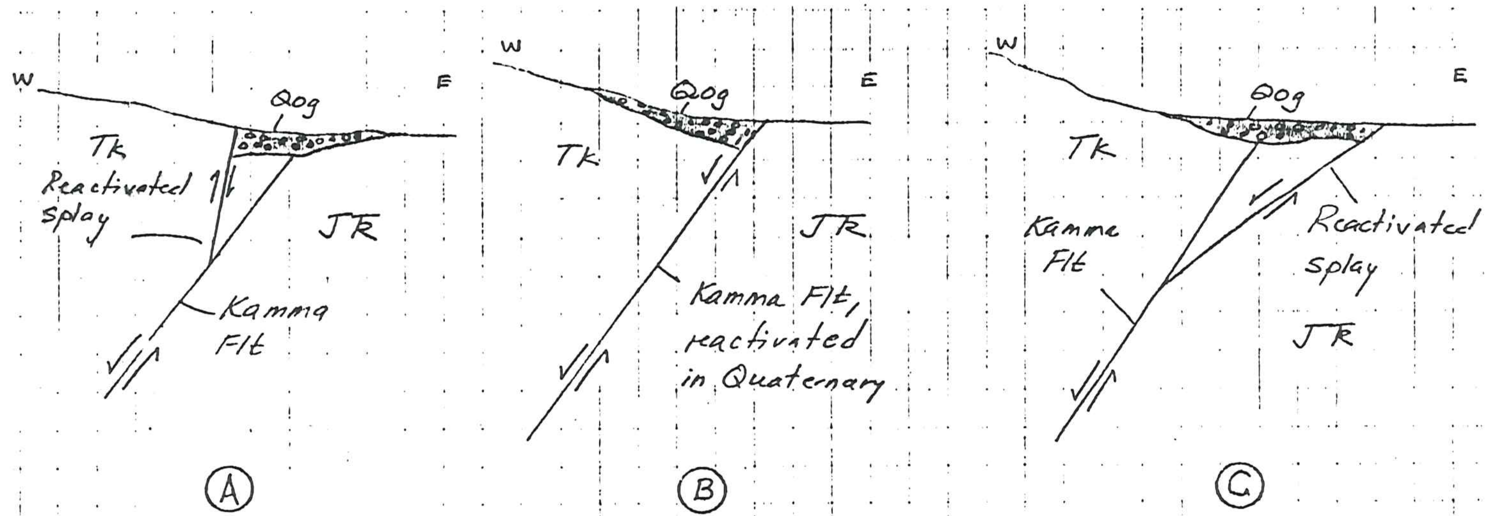
These gravel patches are noted in a few other places. One is the patch of unconsolidated Mesozoic cobbles, with a few volcanic cobbles, that has been preserved along the Shaft fault, just northeast of Dozer Hill. This outcrop was originally mapped as Mesozoic bedrock, but drillhole RL-143, angled beneath it, intercepted Tb and Tct (Cross Section B). This occurrence is exactly analogous to the Kamma fault gravels. Another possible example is unconsolidated gravels along the Elbow fault near the Oscar prospect.

The conglomerate preserved along the South Ridge fault is trapped in a similar manner, but as these exposures are of consolidated conglomerate, correlation with the Sulfur Group is suggested.

Figure 1

Linear Gravel Outcrops "Trapped" Along Major Faults

Observed on Kamma, South Ridge, Shaft and Elbow Faults



A Reverse movement on hanging wall splay: Apparent fault trace is a sharp linear bordering gravels on west.

B Normal movement on main fault: Apparent fault trace is a sharp linear bordering gravels on east.

C Normal movement on footwall splay: Apparent fault trace is a sharp linear bordering gravels on east

Examples: A: Qog outcrops on Kamma Fault north of Wildrose lineament

B or C: Qog outcrops on Kamma south of Rosebud Canyon

STRUCTURAL DEVELOPMENT

Figure 2 shows a model for structural history of the Kamma Range, based on the stratigraphic history above and the observed structures.

The range, and the entire region it is part of, is characterized by listric faulting, down to the west, that have tilted the volcanic section and some younger strata. In brief, crustal extension causes faults that flatten in a zone of uncoupling in the middle crust. Downdropping of blocks along the curving fault surfaces tilt sections of rock that dip into the fault and are truncated. In the Kamma Range, extension began in the middle to late Miocene and continues now.

The area of greatest subsidence, and therefore extension, in the region is the Black Rock desert. The listric faults dip toward this region, and much of the drainage in the late Tertiary has also been westward into it.

Unlike many Basin ranges, the Kamma Range and its pediments have external drainage into the Black Rock desert, indicating recurrent depression of sediment base level. Previous basin fills, Ts and Qog, are now relatively uplifted and dissected.

Regions in the Basin and Range which underwent extreme Tertiary age extension are characterized by various distinctive faulting styles. One is detachment low-angle faulting, which accompanies isostatic uplift of the middle crust to an upper crustal position. This process is accompanied by low angle faulting that structurally strips away the upper layers of rock along shallow surfaces that don't necessary root deeply in the crust. Another is Yerington style faulting, in which multiple sets of more deeply rooted listric faults tilt thick blocks of upper crust, and in the process, tilt earlier generations of faults that were originally high angle structures.

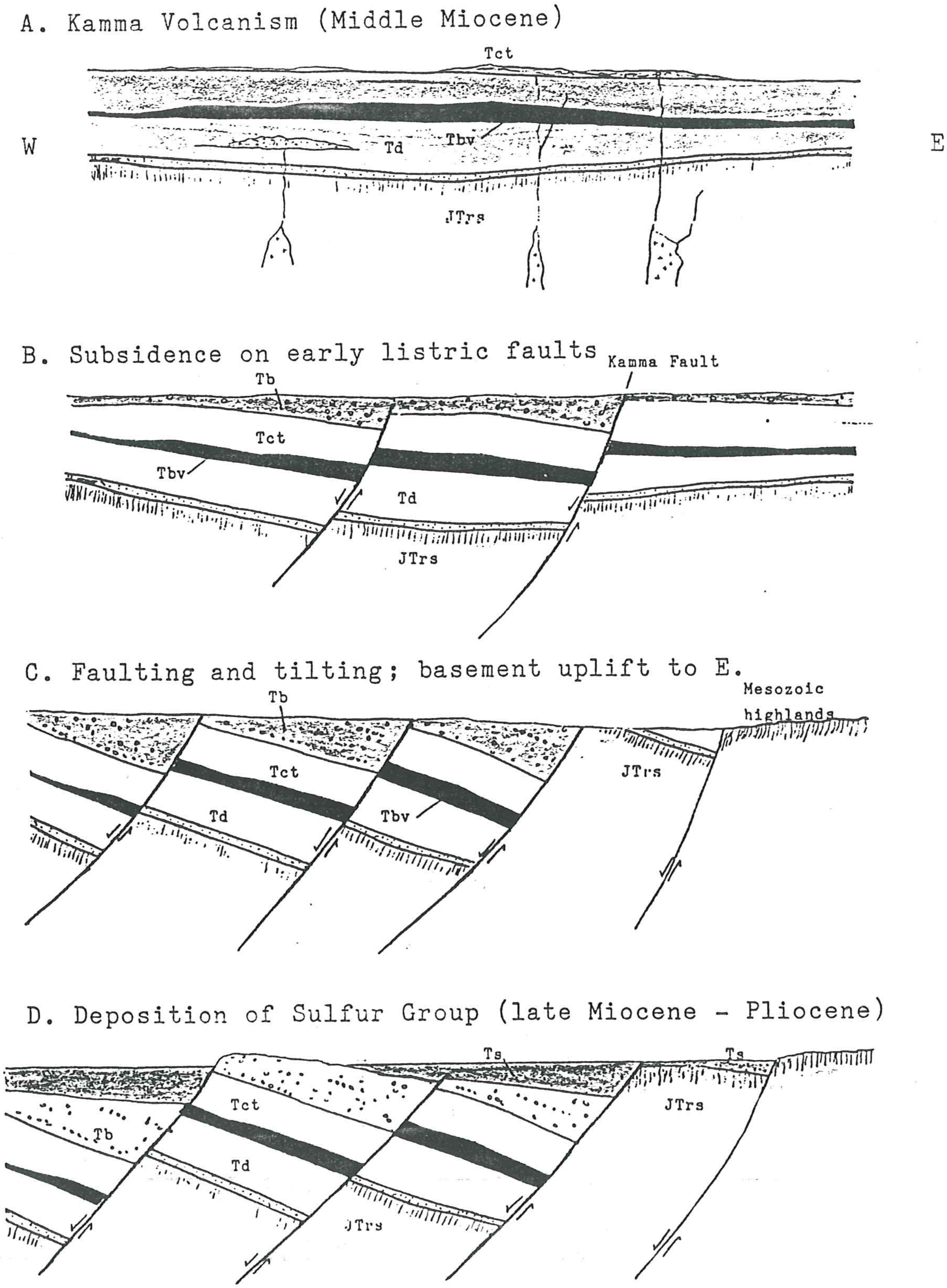
Neither of these styles is typical of the Kamma Range. The listric faults which are present do not cut the section with particular abundance, and the amounts of tilt are moderate. Some of these faults have moderate west dips, and others are steep. The region is characterized by moderate rather than severe extension.

LISTRIC AND STRIKE SLIP FAULTS IN THE KAMMA RANGE

Listric faults develop normal to the axis of extension. In the Kamma Range, most strike north-south to north-northeast. The older faults, like the Kamma fault, are more N-S, whereas current range-front faults, some of which have moderate west dips, like the Oscar fault, trend NNE to NE. All dip westerly.

Figure 2

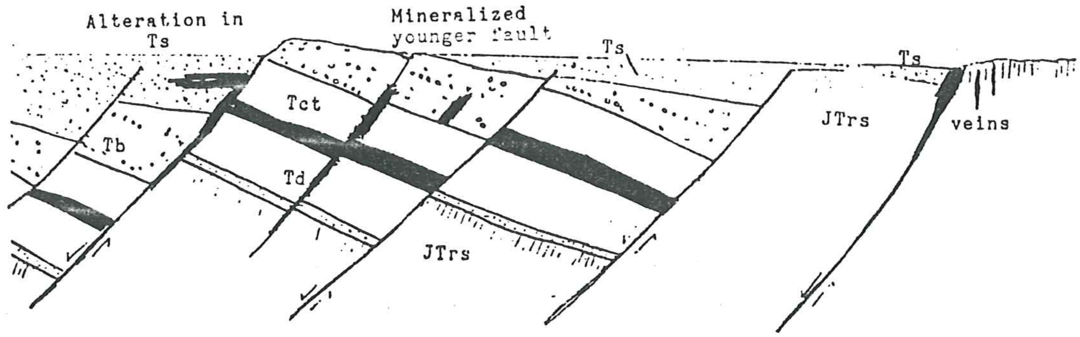
STRUCTURAL DEVELOPMENT OF KAMMA RANGE



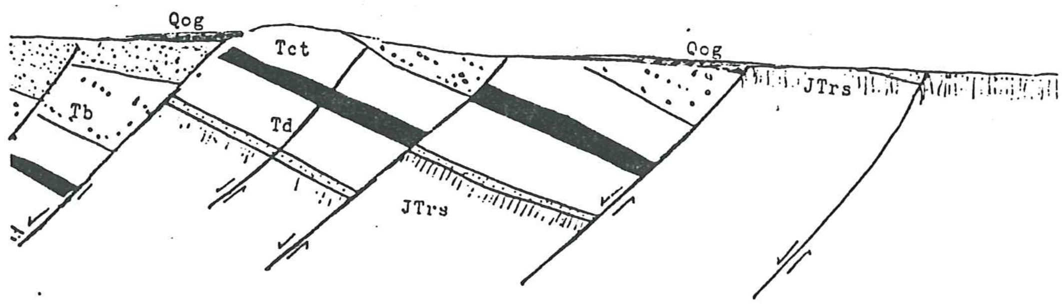
Scale: 1" ~ 5000 ft

Figure 2 (cont.)

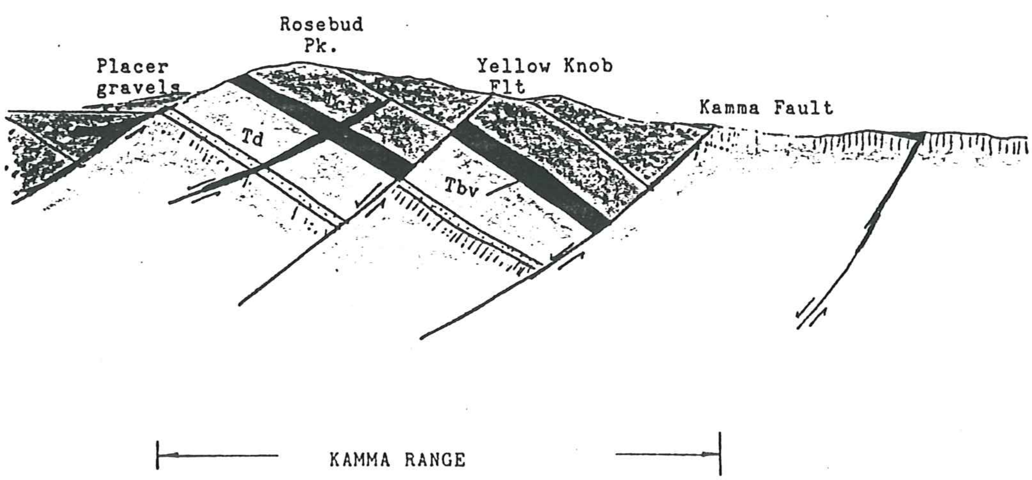
E. Mineralization (~ 2 m.y.)



F. Quaternary Uplift; Older gravels (1-2 m.y.)



G. Present



Scale: 1" ~ 5000 ft

Listric faults duplicate and thicken stratigraphy in east-west cross-section. Consequently, a stratigraphic unit containing a listric fault that is unrecognized will appear thicker than it is in an east-west traverse across it.

Strata that dip into older strata and are truncated lie in the hanging wall of a listric fault. Thus, for example, the Sulfur group beds that dip east on the Lantern property into Mesozoic phyllites must be truncated by a fault that dips west beneath them.

Listric faults terminate along strike either by progressively decreasing normal displacement, or by curved, cuspate terminations that have lateral displacement (Figure 3). Because lateral displacement can take up a large part of the normal vector on the fault, a listric fault and an intersecting a lateral-slip fault will facilitate displacement as a single structural unit (Figure 3C). Therefore, lateral slip shear zones and deep crustal zones that are transcurrent to the axis of listric faulting will facilitate listric breakaways.

In the Kamma Range, two such structures are present: the Rosebud Shear and the Wildrose Lineament. In a general way, the listric structures are grouped around these cross-structures, and many terminate at or into them. The Saddle, Yellow Knob, Dreamland and Degerstrom low angle structures are all associated spatially with the Rosebud Shear. Similarly, the Chance and Wildrose structures straddle the Wildrose Lineament.

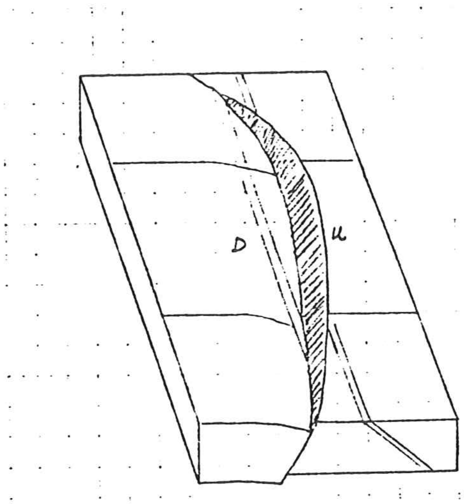
The Rosebud Shear is a left-lateral structure. Left-lateral, oblique displacement can be observed directly on the striated outcrops of the South Ridge Fault, which is a splay of the Rosebud. Left-lateral offset on a northeast-trending structure is part of a super-regional pattern that extends over much of the western Great Basin. The Walker Lane offset pattern is for right lateral offset on northwest structures, a reflection of the shear sense at the North American plate boundary. Northeast Walker Lane structures from Las Vegas to the Truckee River have a left-lateral sense of displacement, conjugate to the northwest structures.

On a small scale in the Kamma Range, a similar pattern can be noted. Many faults which lie in the east-west quadrants exhibit oblique offset with a lateral component, as preserved by post-mineral striations on chalcedonic surfaces. Those that trend WNW tend to be right-lateral, whereas those that are ENE, left-lateral.

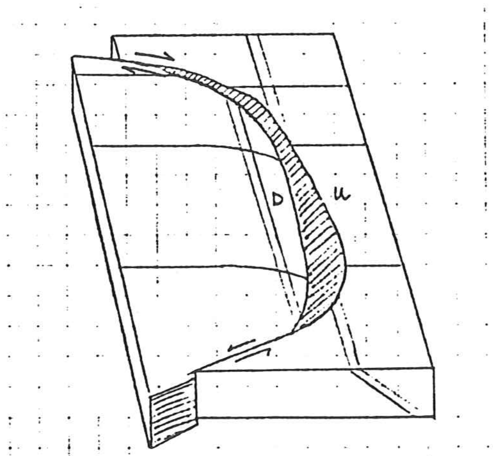
This could reflect a regional stress pattern, as it does in the Walker Lane. Alternatively, approximately east-west structures in many instances are cuspate terminations of north-striking listric faults. The listrics form cusps, trending northwest at their north ends, and southwest at their south ends (Figure 3). Dip-slip movement will result in right lateral offset at the north ends of these faults and left lateral offsets at the south ends.

Figure 3

Listric Fault Offset and Termination



3A. Slip decrease along strike



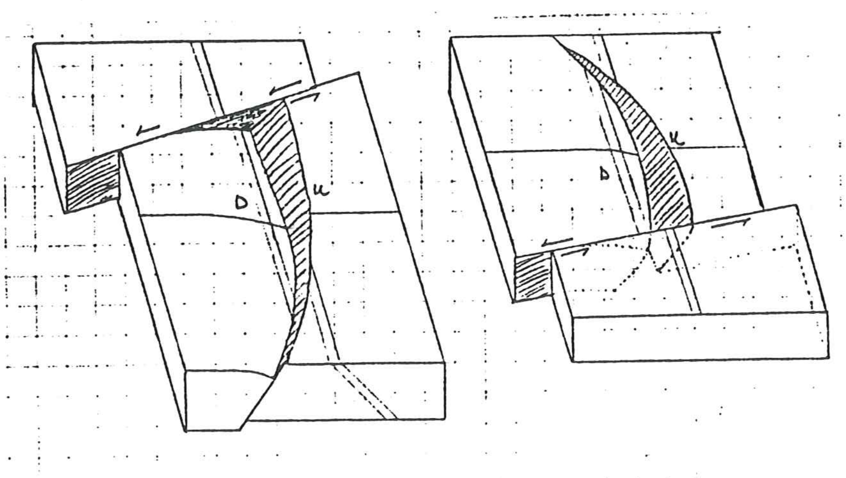
3B. Lateral-slip, cuspate termination

Note: opposite sense of slip on cusps

"spoon-shaped" fault surface

Kamma Range examples:

Degerstrom fault
Rosebud-Great Wall system
Juniper Canyon fault and listric Badger offset



3C. Differential slip on cross-structural shear zone

Kamma Range Examples:

Saddle fault, north end
Degerstrom fault, south end

Kamma Fault

The Kamma fault, trending north to NNE, borders the Kamma Range on the east. The Kamma Volcanics are absent east of it. It is an early listric fault which downdropped the Kamma volcanic field west of it, while the terrain to east was subsequently uplifted, stripping the volcanics and exposing the Mesozoic basement (Figure 2). That paleotopography is now reversed.

Because the entire Kamma section lies on its hanging wall, the displacement on the Kamma fault exceeds 6000 ft.

Faulting on the Kamma fault began perhaps as early as Badger time, as the Badger formation appears to overlap incipiently tilted Chocolate Volcanics.

The fault was apparently not well dilated or active during the mineralizing episode. The Kamma and other early listric faults characteristically exhibit weak or little alteration, as they were not apparently open during this event. There is some alteration, bleaching and Fe-staining along the Kamma fault at the east end of South Ridge. At some other points along the Kamma fault, however, the Fe-staining noted on photos is in the matrix of the Quaternary gravels that lie near the fault, and is not alteration.

Minor reactivation of the Kamma fault took place in the Quaternary, as linear patches of older gravels were downdropped into the fault zone. The gravel patches are marked by a sharp linear contact that marks the reactivated fault trace during the Quaternary. This linear occurs at various places either on the east side or the west side of the gravel outcrop. Reactivation and normal movement of the original Kamma fault would produce a linear on the east side. Linears on the west side of the gravel outcrops could be produced by reverse movement on the Kamma (Figure 1).

There was no significant movement on the Kamma fault during late Quaternary uplift of the Kamma Range. This uplift took place on western range front faults, with gentle eastward tilting of the range block (10-15 degrees), exposing the site of the Kamma fault to erosional stripping. The topographic expression of the fault is erosional.

The Kamma Fault is offset by the splays of the Rosebud Shear zone, illustrating the left-lateral displacement of the Rosebud.

The Kamma fault is exposed in outcrop about 4500 ft southwest of Rosebud Canyon. The fault zone is weakly iron stained and contains calcite veinlets; nearby structures in the Mesozoic phyllite have been prospected. The fault dips 70 degrees west here.

Rosebud Shear

The Rosebud shear zone appears to offset the western front of the range left-laterally about 5000 ft. On the east side of the range, the shear zone divides into at least three splays, the South Ridge, the Shaft and the Northeast faults. Each offsets the Kamma fault left-laterally. The South Ridge accounts for about half of the total with about 2500 ft of horizontal component of offset of the Kamma.

The Rosebud shear zone west of the Dozer Hill area is poorly exposed but has been intersected in a few drillholes. Where cored in hole RL-111, a 70 degree north dip can be estimated. In this area, at the West Valley prospect, an IP linear anomaly exactly corresponds with the trace of the shear zone.

Relation to Mineralization. The Rosebud shear and its splays were open during mineralization. It is not clear how much earlier than mineralization the Rosebud might have existed, but since some of the older listric faults like the Saddle and Yellow Knob faults appear to end at the Rosebud, it may have been a structural zone quite early in the structural history of the range. Movement has continued into post-mineral time also, as seen in the striated, slick faced South Ridge "shark fin" outcrops.

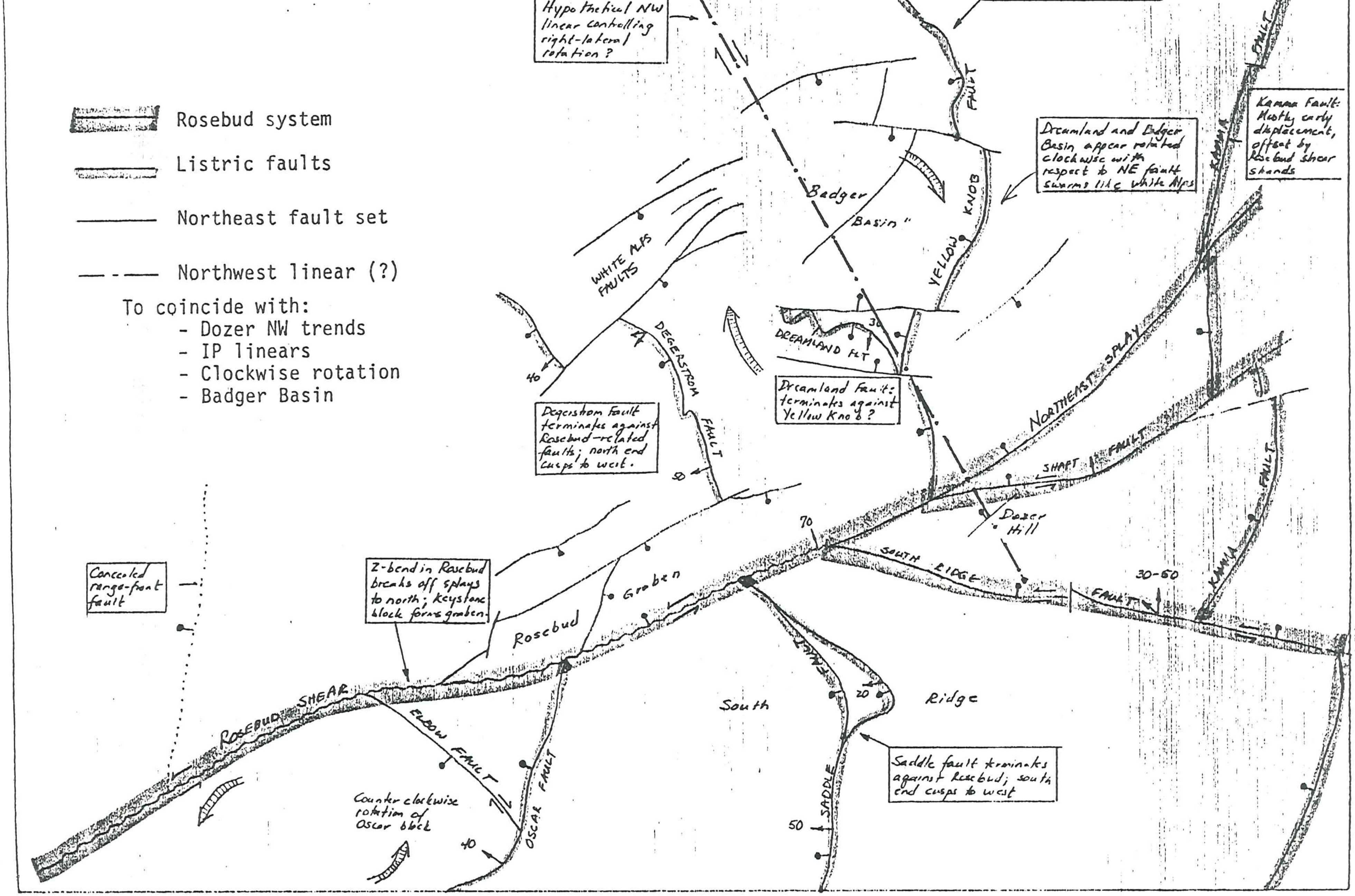
The stress orientation predicted along an ENE, left-lateral zone implies that a NNE trend is the most favored orientation for structural dilation. This is the trend of several of the listric structures. It is also the trend of some of the chalcedony-barite veins on Dozer Hill and generally, the ore beneath it. This same trend is parallel to the strike of the stratigraphy, suggesting that stratification surfaces might be opened up during structural preparation. North to NE trends are also approximately the orientations of ore-bearing or mineralized structures at Sulfur, Lantern, Scossa and Oscar.

Rosebud Shear and Listric Faults. In general, many of the listric faults in the central Kamma Range, both the early listrics and later mineralized faults, can be related spatially and probably genetically to the Rosebud shear zone. Figure 4 shows the importance of the Rosebud shear to this grouping of listric structures. As suggested above, the presence of a major trans-structural zone was probably a factor in facilitating listric normal faulting in this area.

In contrast to the generally north-trending listric faults, two faults, the South Ridge and Dreamland faults, are east-west striking low angle faults. If the left-lateral movement on the Rosebud is restored, these two faults face each other across the shear zone, and dip into it. Their origin is a puzzle, but their spatial relation to the Rosebud is obvious and suggests that they were caused by shear along it.

Figure 4

ROSEBUD SHEAR AND RELATED STRUCTURES



Northeast Fault Set. A set of numerous faults with a northeast to ENE orientation is associated with the Rosebud Shear, and occupies a large domain between the shear zone and Rosebud Peak. This is illustrated on the Structural Overlay map. This style of faulting is largely restricted, asymmetrically, to the north side of the Rosebud shear.

Weak to moderate alteration and bleaching is characteristically associated with these faults. Mineralization and interesting alteration, such as that at the Mother Lode fault and on the White Alps prospect, seem to be narrow and structurally confined. The proper cross structures, or wrenching stress orientation, that might better structurally prepare the rock in this domain to allow for greater dilation and ore trapping has not yet been encountered.

Rosebud Graben. Northeast-trending faults parallel to the Rosebud downdrop a graben block containing Badger strata. These faults are splays from the Rosebud fault that originate where the shear zone undergoes a subtle Z-shaped bend. Compression at the inflection point has generated splays that branch off northward, and then parallel to the main structure. The intermediate block has been downdropped into the fault zone.

West of the graben, strata of the Sulfur group have been dragged into the shear zone at the Oscar prospect. They strike parallel to the zone and dip steeply south. South of the shear zone in this area, the strike of Sulfur Group beds has been bent into a sigmoid pattern, apparently caused by counterclockwise rotation, generated by the left-lateral sense of shear along the zone. Dilated north-south structures exhibit silicification of the conglomeratic beds.

South Ridge Fault

A central problem surrounding the Rosebud shear zone is the origin of the South Ridge fault. It is an unusual splay of the Rosebud shear zone for two reasons. First, many lateral-slip faults develop splays, but a left-lateral fault would be expected to produce horsetail splays that would branch off northward and tend to bend into a north-south orientation, which is the axis of maximum tension. The South Ridge branches eastward.

Second, splays are usually steeper features, with a dip comparable to the parent structure. The 30 to 45 degree average northward dip of the South Ridge fault is anomalous. The east-west strike is also difficult to explain as a member of the listric fault population that was "captured" and modified by the Rosebud shear zone, as it is difficult to imagine a listric fault with that attitude, given the pattern of north-south faulting that is present elsewhere.

One scenario that can be proposed involves a shifting of displacement from one splay of the Rosebud to others. The Northeast splay of the Rosebud is the one that is most directly on line with the main structure. It is visible on photos as a pronounced linear with a color contrast across breccias and rhyolite flows of the Badger Formation. The Northeast splay has been penetrated by at least two drillholes, RL-138 and RL-139 , which intersected a wide silicified zone rather than the thick fault gouge penetrated by RL-111.

The Northeast splay was apparently therefore altered and healed with silica during the mineralizing event. When the shear zone again broke open, the block to the north of it captured a triangular prism of rock, the hanging wall of the South Ridge fault, now welded across the original Rosebud zone, and began to translate it in a westward direction. The South Ridge hanging wall effectively became part of the north block of the Rosebud shear.

This seems possible only if a low angle surface were already present that could be reactivated as the South Ridge fault. Figure 5 suggests that perhaps an early splay of the Kamma fault might have been captured as the hanging wall of the South Ridge.

Saddle Fault

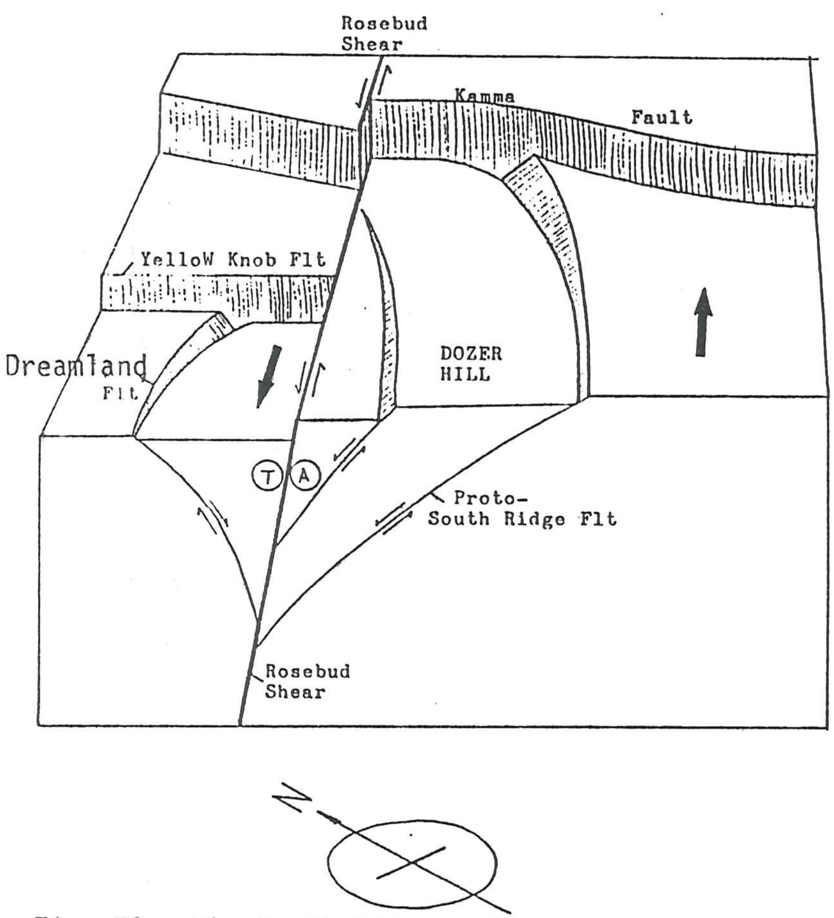
The Saddle fault duplicates the Dozer and Bud sections on South Ridge. The fault is fairly well exposed on the south side of South Ridge, where Bud strata clearly dip into a truncating surface above Dozer Rhyolite exposures. Recognition of this fault is entirely dependent on the presence of the Bud, which is both a distinctive, and a dipping, stratified unit.

The Saddle fault appears to terminate at the Rosebud shear. Southward, it can be traced, somewhat hypothetically, up Rosebud Spring canyon, where the thinning epiclastic member of the Bud is again duplicated. Other than the duplication of the Bud, the only outcrop evidence which I found is west-dipping slick surfaces in dense Ti rhyolite (in the footwall of the interpreted fault), just above Rosebud Spring. The fault loses displacement southward, and seems to form a westward cusp as it terminates.

Regarding the problem of the Dozer thickness on South Ridge (Cross Sections G and H), it is possible that other listric faults are present in the South Ridge area, creating a false, apparent large thickness of the Dozer section.

Figure 5

South Ridge and Dreamland Faults



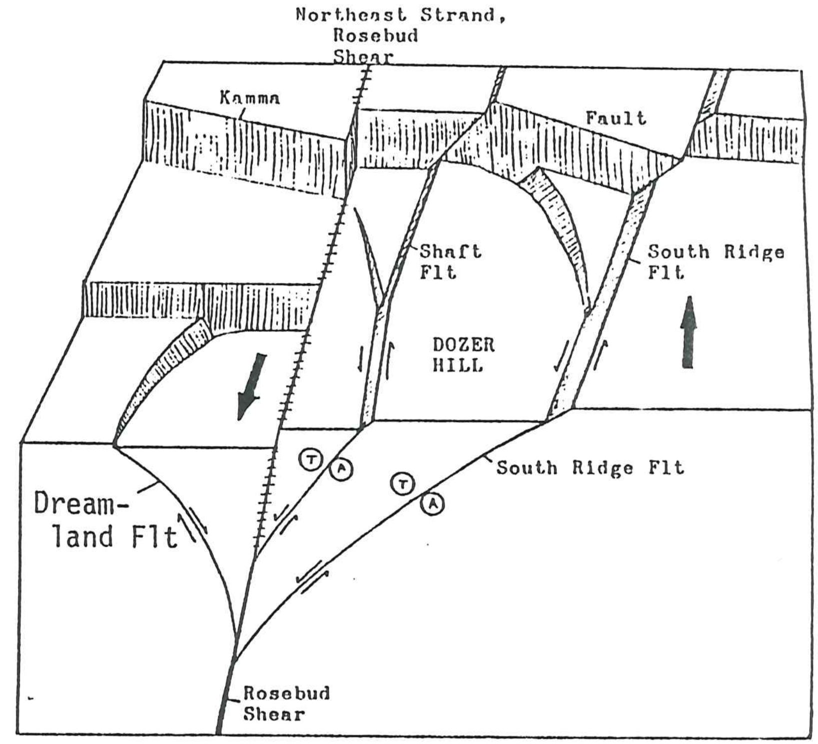


Fig. 5A: The South Ridge and Dreamland faults might have developed as splays of the early listric faults, within the shear stress environment of the Rosebud structure. The low angle faults are cuspate outward from the listrics, and dip into the Rosebud Shear.

Fig. 5B: As the Northeast strand of the Rosebud Shear becomes inactive, lateral slip is transferred to the low angle faults, which become modified as splays of the Rosebud. All Rosebud splays are open to mineral-izing fluids; the listric faults are no longer active.

Yellow Knob Fault and Badger Basin

This is a new fault recognized by the truncation of dipping Badger strata, south of Dreamland and east of Badger Ridge, against Chocolate Rhyolite exposures. An early listric fault, it is segmented by later E-W structures of the Dreamland area.

This fault appears to terminate southward against the Rosebud shear. Northward, it is traced to the North Equinox area, where a low angle surface has been recognized beneath Badger beds and above Chocolate breccias. Here, it is possible that the fault may be linked with lateral movement on the silicified, northwest-trending North Equinox structure, which would serve as a left-lateral cuspate termination of the Yellow Knob.

The Yellow Knob fault bounds on the east a fault-bounded block referred to as Badger Basin. An approximately square patch of downdropped Badger formation is bounded on most sides by faults. Strata at the west edge dip east at 45 degrees, an inclination that would suggest a thickness of 1000 ft or greater at the Yellow Knob fault. But since the Yellow Knob fault dies out, and probably just a thin slab of Badger overlies Chocolate in the North Equinox area, a section this thick does not appear likely on the east side (Cross Section C).

Several alternatives are possible. One possibility is that the east dip flattens eastward, either synclinally, or due to a hinging fault that flattens the dip toward the Yellow Knob fault. A second explanation is that the Badger thins eastward due to paleotopography. This is consistent with the fact that the Badger beds to the west are well down in the Chocolate Volcanics section, and may have been deposited in a paleotopographic low.

While not fully understood, the Badger Basin appears to be structurally anomalous, and unusually subsident for this area. Since the southern margin conceals possibly mineralized rock of the Dreamland area, a potential target area is suggested beneath it.

Mineralized Listric Faults: Dreamland and Degerstrom

A younger generation of listric faults that were conduits for epithermal silicification and mineralization during the regional mineralizing event extends north from the Rosebud shear zone to Rosebud Peak, and then along the west front of the range northward to the Wildrose Prospect. These faults strike mostly N-S and dip west; Dreamland is an exception. Offsets on these faults is mostly small compared to older listric faults like the Saddle Fault.

Characteristic chalcedonic silicification of the fault zone, from a few feet thick to thicker zones of at least 50 ft, occur on these structures. Post-mineral displacement along the fault is indicated by striations on chalcedonic slick faces.

Displacements are mostly normal on north-striking portions of these faults. Where the faults turn westward as cusps, oblique slip with a component of lateral displacement is present.

This is illustrated by the **Degerstrom low angle fault**, which strikes north and then turns northwest, and can be traced for 2500 ft. This fault displaces rocks of the Chocolate Volcanics an unknown amount. The Degerstrom terminates southward at the Rosebud shear. It dips 45 to 50 degrees west and has dip-slip striae where it is closest to the Rosebud. Progressively northward, a right lateral component of oblique slip increases.

A possible extension to the Degerstrom fault exists on the north side of the Schoolbus fault. Silicified outcrops striking northwest truncate the Bud Volcanics outcrops in Schoolbus Canyon. These outcrops have the same sense of displacement as the silicified outcrops along the Degerstrom on the ridge to the east: right lateral oblique. This exposure of the Degerstrom, if it is, represents a downdip portion of it, as the fault displaces Bud against Wildrose Rhyolite rather than Chocolate. Northwestward, alteration decreases along this fault.

The **Dreamland low angle fault** strikes east west and is part of a structural domain south of the Badger Basin where the principal structures are east-west. The origin of this orientation is uncertain, but it appears that the E-W structures are basically similar to and part of the NE structural domain. Possibly a block encompassing Dreamland has been rotated clockwise. Southward bending of the northeast structures at White Alps gives this impression.

Figure 5 shows a possible scenario in which the Dreamland fault is torn open as a splay to the earlier Yellow Knob fault. The stresses that are driving the younger listric fault in this sketch are generated along the Rosebud shear zone.

The **North Rosebud low angle structure** is truncated on the south by a swarm of northeast faults. These faults do not seem to have lateral displacement, so they do not represent a lateral-slip termination zone, and in any case, there seems to be very little displacement of the Bud Volcanics across the Rosebud structure. The North Rosebud zone of alteration is a confusing intersection between northeast and north trending fracture sets, some of which dip gently west.

The North Rosebud structure may link to the silicified fault exposed as the Great Wall, above the Chance prospect. The Great

Wall is a right-lateral oblique-slip fault, which could represent the northern cuspate termination of the North Rosebud. Amounts of displacement are unknown but small.

Wildrose Lineament

The Wildrose lineament is a prominent linear feature visible on small scale aerial photos and satellite images. It encompasses several drainages, including Wildrose Canyon and the drainage east of Wildrose Pass, and it appears to mark the southern end of the Sulfur mineral district. Where it crosses the western front of the Kamma Range, it seems to be a zone of basement faulting that is expressed on the surface as a 5000 ft wide zone with E-W and WNW faults. The principal fault expression within the zone at this location is the Juniper Creek fault, which has left-lateral displacement and is a conduit for alteration (Figure 6).

The Wildrose lineament disrupts the fault pattern along the west front of the range. The Chance fault terminates in the zone, and the front of the range gives the impression of having been offset northwestward.

Several E-W faults are mappable from the Chance area to the Wildrose prospect. Some of them are mineralized, and these tend to have a component of oblique slip. Northeast faults are present north of the Juniper Creek fault, but not to the south, an asymmetrical distribution similar to that along the Rosebud Shear zone.

Listric faults that border the zone terminate into it. Examples are the North Rosebud-Great Wall system, extensions of the Dipslope Breccia structure at Chance, and the low angle structures of the Wildrose prospect.

Range-front faults in the Sulfur area, including the East, Albert and Central Faults, bend eastward into the Wildrose zone and may terminate within it.

Hydrothermal alteration is largely lacking within the main part of the zone. However, alteration cells at the Wildrose prospect and Chance occur immediately outside of it on either side.

Juniper Canyon Fault

The left-lateral Juniper Canyon is responsible for large displacements of several stratigraphic contacts. The Wildrose - Chocolate contact (spanning the stratigraphic horizon where the Bud Volcanics have pinched out) is offset westward some 2800 ft (horizontal component). It also displaces westward the contact between the Knob Gulch Breccia and the overlying Wildrose Rhyolite.

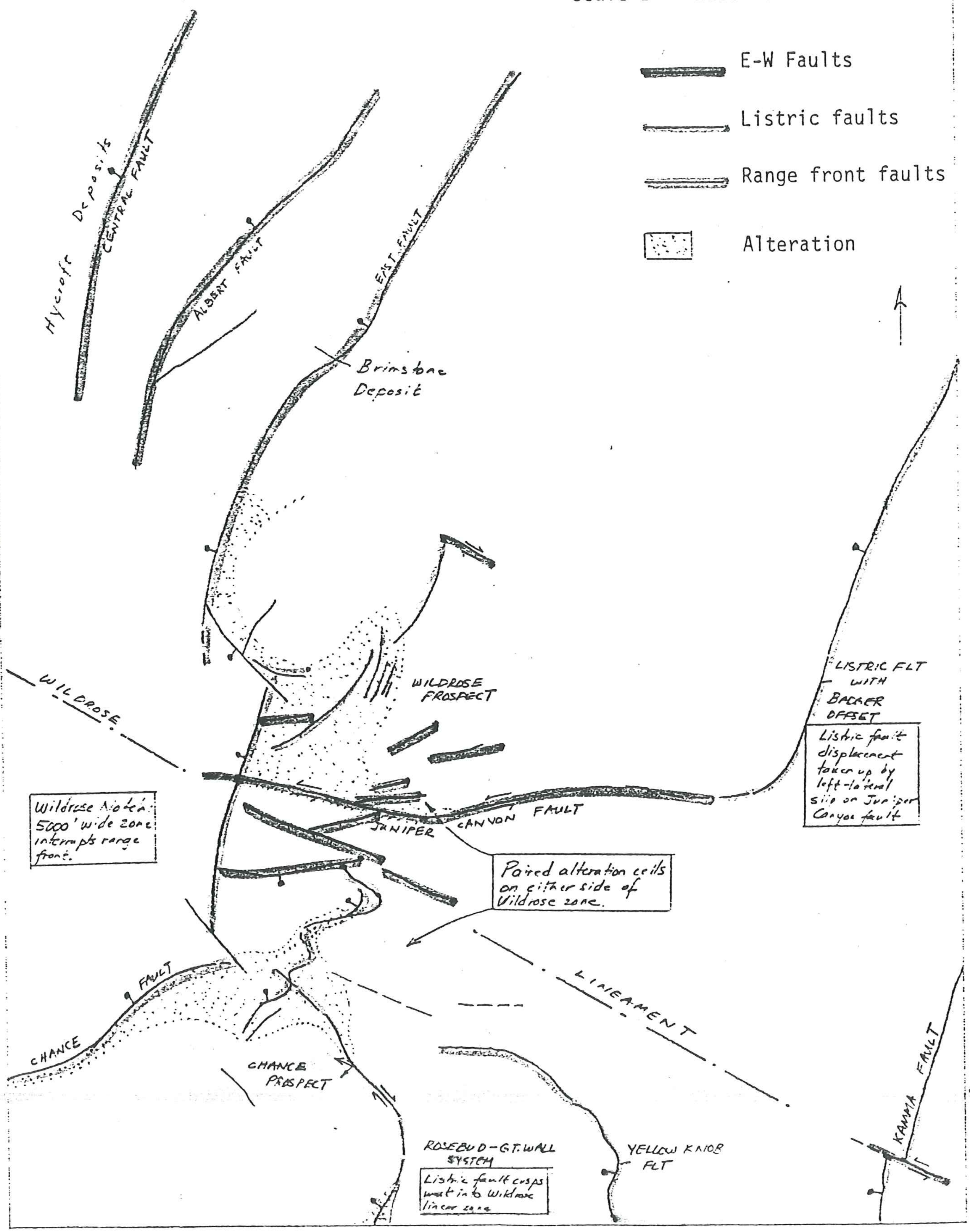
The Juniper Canyon fault acts as the limit to the alteration associated with the Wildrose prospect, as only rocks north of the fault display bleaching over wide areas. The fault is itself silicified along short segments and along splays that bend northward from it.

An eastward extension of the Juniper fault offsets the Badger formation north of Wildrose Pass. The horizontal offset here is 1800 ft or so. An apparent duplication of the basal part of the Badger formation is very clearly seen on air photos in this area. A likely possibility is that a listric fault trending north duplicates the Badger formation. Its listric offset is linked with the lateral movement on the Juniper Canyon fault. The combined structural unit is equivalent to a listric fault with a southern cuspate termination having left-lateral slip.

Figure 6

WILDROSE LINEAMENT AND RELATED STRUCTURES

Scale 1" = 2000 ft



Wildrose Prospect Structure

Several west-dipping, low angle surfaces at the Wildrose prospect have been silicified during mineralization. Previous mapping has depicted a flat fault between Gnarly Hill and the ridge to its west (spanning Gnarly Canyon). Probably, however, there are several structures that are present here, some dipping moderately west and some at a steeper angle (Cross Section A). In any case, the zone of significant structuring and alteration along these structures is quite thick, approaching 500 ft on Gnarly Hill alone. The alteration is typical of a high level system, and might generate interesting geochemical values below the level of exposure.

Of the untested areas on the Rosebud land block, the Wildrose prospect is structurally the most interesting for the breadth and complexity of the listric-faulted zone, and its localization of alteration. Detailed mapping of this area and subsequent drilling are encouraged.

RELATIVE CHRONOLOGY OF FAULTING

Structural Overlays at 1"=500 ft depict a suggested relative chronology of types or orientations of faults, and their relation to the mineralizing episode.

Early listric faults, such as the Kamma and Saddle faults, are unmineralized. Weak alteration, such as that along the Yellow Knob fault south of Dreamland and west of the Mother Lode, are locally present. In general, these structures are not permissive for mineralization.

The Rosebud Shear system is long-lived and perhaps spans a period from early listric faulting to the present. The system was active during mineralization, and critical to the development of the Dozer Hill mineralization along and in the hanging wall of the South Ridge Fault.

Mineralized listrics form a linear pattern from south to north along the western part of the range from the Rosebud shear to Wildrose.

Faults with a young record of large movement are the range-front faults along the west margin of the range. These faults were in existence during mineralization, and controlled the ore localization at Hycroft. Subsequent displacement has been large on such faults as the East Fault and the Oscar Fault.

It is interesting to note the possibility that a progression of listric faulting from east to west took place sequentially.

The Kamma and other early faults, like the Saddle and Yellow Knob, are on the eastern edge of the range; the mineralized listrics shift the locus of faulting to the central or western parts of the range, and the range front faults are yet further west.

Northeast faults were synchronous with the Rosebud shear during mineralization, but, excepting the White Alps occurrence, their orientation was apparently less favorable for extensive alteration and than was the north-south orientation of the mineralized listric structures.

SUGGESTED TARGET AREAS

Areas that are of interest because of structural complexity, combined with localization of alteration and known favorably geochemistry are suggested as areas in which drill targets can be considered. In some cases these are blind target areas without much encouragement at the surface, but which are of interest from the point of view of structural anomaly, and which might be worth investigation by drilling to assess the subsurface geochemistry. Geophysical and geochemical work could make these areas more attractive to the point of justifying a drilling program.

Wildrose Prospect

Cross Section F shows an interpretation of the Wildrose Prospect area. More detailed mapping is recommended to confirm or improve this version of the prospect geology.

Abundant west-dipping structures cut two interpreted domes of Wildrose Rhyolite, which intrude the Knob Gulch Breccia, and are overlain by Wildrose flow units. The domes, a smaller one, which was probably intrusive only, and a larger one, which may have vented extrusive flows, have been tilted to the east. The cross section shows a hypothetical feeder column beneath the surface exposures which has been tilted and dips west, and therefore is approximately parallel to the west-dipping structures which cut the complex. Such a volcanic neck or feeder, if it exists, would enhance conduction of the hydrothermal fluids during mineralization.

The listric faults resemble the mineralized listrics further south in the range, except for their greater abundance. They have been flooded by chalcedonic silica, mostly without very significant geochemistry. Late movement is recorded on striated slick faces. The structures dip west at varying angles, from 20 to 60 degrees. Significant groups of altered fractures are concentrated on the west side of Gnarly hill, and also on the west slope of the hill further west, on the front of the range. The offsets are small.

The abundance of the structures is remarkable, and the fact that they have acted as conduits for high level silicification over an area approximately 2000 ft in diameter, suggest that a fairly large plumbing network has been invaded by the mineralizing system.

The alteration would be worth some further study. Outward from the silicified ribs along faults, various kinds of argillic alteration and bleaching occur. Rhyolites on the west side of

Gnarly Hill appear to be porphyritic, but I think they are just peppered with spots of kaolinite, perhaps after a devitrification texture. West of Gnarly Canyon, lithophysal blebs in the rhyolite contain pyrite.

The best grades seem to be to the north, as the structure becomes more confined along just one or two west-dipping listric structures, in particular, the fault exposed in the saddle at the north end of the prospect area. Fluids were restricted to a smaller number of structures northward, and geochemistry was consequently upgraded by this confinement. The presence of .0X Au values in outcrop suggests that significant Au values are probably present at depth beneath the area of more widespread alteration.

The area has abundant structure, a wide area of alteration, local favorable geochem, a choice of two rock types for a host, and a possible volcanic structure to enhance the listric structure: an attractive package for exploration. Geophysics, IP and magnetics, could help define targets. The area is too rugged for VLF.

Wildrose Canyon Mouth

The Structural Overlay, North Sheet, shows an area at the mouth of Wildrose Canyon that is the focus for a number of different structural trends. The area is range-front pediment, and would be a blind target, with gravels concealing the volcanic bedrock.

This prospect area is within the Wildrose Notch, the point at which the Wildrose lineament crosses the range front and disrupts the pattern of northeast faulting. Range front faults intersect the western extension of the Juniper Canyon fault in this area. Listric faults striking southward from the Wildrose prospect pass into it. The range front faults that host mineralization on the Hycroft property also bend inward, southeastward, toward this area.

This is a blind conceptual target of intersecting faults in an important structural zone. The gravels are probably not too deep, as a drillhole next to the Juniper Canyon road has bedrock cuttings. Geophysics would be recommended to define a drilling target.

Shaft Fault

The Shaft fault is analogous to the South Ridge Fault, but on a smaller scale, and within the hanging wall of the South Ridge fault. Its hanging wall block is higher in the stratigraphic section, with Chocolate and Badger exposed at the surface, and Bud at greater depth.

Like the South Ridge, its hanging wall is a triangular prism that increases in dimensions eastward, like the prow of a boat. The hanging wall block of the Shaft fault could be prospective from a structural standpoint, by analogy with the South Ridge, especially if one is willing to entertain other possible host rocks besides the LBT, like the Chocolate.

The IP grid of the Dozer area partly covers the eastern extension of the fault. A linear IP anomaly running east from Little Dozer saddle suggests a location for the Shaft fault, trending into the drainage below and east of the saddle. A significant offset of the Kamma fault is present in this drainage, so this is the probable location of the Shaft fault. Its hanging wall eastward is occupied by aphyric rhyolite of the Badger formation, bleached and autobrecciated.

A few holes already explore the western portion of the Shaft fault hanging wall. I recommend that the remainder of this structural block be tested at some point.

Southeast Dreamland

A northwest topographic linear, which is accompanied by linear IP trends, extends from Dozer Hill to the area just south of the East Dreamland prospect. Structurally, this area contains the Yellow Knob fault, trending north-south, the eastward to southeastward downdip extension of the Dreamland low angle fault, and the western extension of the Mother Lode fault.

Poorly defined northwest trends influence the mineralization at Dozer Hill, both in limiting and in controlling the geometry of ore. These trends strike into the area of consideration, and although Southeast Dreamland is to the north of the Rosebud shear, there may be a connection, as the IP linears cross the shear zone.

There is some alteration along this zone. The bleaching which is present in the Badger Formation beds, which dip moderately east into the drainage, could be localized by the Yellow Knob fault. Alternatively, later, more syn-mineral faults, trending north to northwest, might have controlled this alteration. In addition, a low angle silicified structure, dipping 30 degrees south, is exposed in an adit on the east side of the drainage. This attitude is reminiscent of, and directly downdip from, the Dreamland fault.

Without clearcut geochemical or geophysical targets, the area is nevertheless suggestive of interesting structural intersections.

Badger Basin

The southern end of Badger Basin conceals alteration localized by the east-west fracture system of Dreamland. The basin itself is anomalously subsident, and delimited by faults. Bleaching and alteration spottily affect the red sediments of the block.

An IP anomaly located 500 ft north of Dreamland is remarkable in that it is about the only over-background response detected in the Badger Formation on the IP grid. The Badger Formation is so homogeneous (and perhaps opaque?) in geophysical response that its map distribution can be accurately mapped by reference to one of the contours (the purple one) on the contoured IP phase data mapsheet.

The anomaly is on line with northeast trending anomalies in the White Alps area, and occurs on a hypothetical "hinge fault" that flattens bedding eastward in the Badger.

I suggest that the areas between Dreamland and this anomaly might be worth testing, further even than this year's program, which will test the southern margin of the basin. The anomaly is small but curious, and begs an explanation.

Oscar

The Oscar prospect displays a number of interesting and intriguing features which aren't understood yet. There is ample evidence of a hydrothermal system localized by the Oscar range-front fault, which dips west at 40 degrees. Sulfur group conglomerates are silicified, locally very intensely, along the Oscar fault, along northeast-trending bedding, and along dilated north-south structures. The style of mineralization is like the Sulfur deposits in miniature.

The Elbow fault, which trends northwest, appears to be the main range-front fault segment connecting the north and south halves of the range which have been offset by the Rosebud shear. The Elbow fault ought to have significant displacement, with the Sulfur group substantially downdropped to the west, above a southwest-dipping surface, overlying Chocolate Volcanics in the footwall. The Elbow and Manganese faults might also have right lateral displacement, conjugate to the shear sense of the Rosebud shear.

If this scenario is correct, the hanging wall of the Elbow fault is prospective. The general target area, which has been tested by only two St. Joe drillholes, is the northwest-trending block of rock between the Elbow and the Manganese faults. This area corresponds with much of the siliceous alteration in the Sulfur conglomerates.

This assessment requires confirmation by careful mapping. There are a couple of outcrops on the ridge northwest of the silica-calcite knob which could suggest that the Elbow fault does not exist, and that a relatively thin sheet of sediments overlies the Chocolate rhyolite. If this is true, the range-front fault of the triangular block between the Oscar Fault and the Rosebud shear lies further basinward, beneath and within the conglomerates: a hidden structural target.

The southern Oscar target is probably too small to be significant, but it offers its own puzzles. Bleaching and veining occur along a west-dipping fault that is in the footwall of the Oscar Fault. The bleached fault cuts phyllites and apparent sandstones and conglomerates of the Mesozoic basement. The basement rocks are overlain by basal Kamma sediments: siltstones and conglomerates of Tertiary age.

Two questions are unresolved in my mind. First, the lithology is confusing. The conglomerates in the Mesozoic outcrops look as though they ought to be Tertiary, i.e. part of the basal Kamma sequence, yet they also appear to be interleaved with unquestionably Mesozoic phyllite, and metasandstone (bleached) containing metamorphic minerals.

Second, smoky quartz veinlets with some sulfides cut this sequence. Since quartz veins are rather rare among the mostly high level occurrences of epithermal chalcedonic replacement in the Kamma Range, it would be nice to know how these veins fit into the model, zonally and chronologically., and whether their presence here has significance for the downdip extent of mineralization on the Oscar fault system.

NWMA

DISCOVERY AND GEOLOGY OF GOLD MINERALIZATION

AT THE ROSEBUD PROJECT PERSHING Co., NV

WARCK

BENNETT

KUHL

KENNER

12/92

STRATIGRAPHY

OSCAR: CONGLOMERATES ^[& TUFFACEOUS SEDIMENTS] OVERLAIN BY ANDESITES

DOZER FM.: RHYOLITIC FLOW DOME COMPLEX WITH FLOW DOME BRECCIAS

LOCAL POSITIVE RELIEF.

KAMMA FM.

WILDROSE: 1300' DENSE DARK GREEN FLOWS, TUFFS & VOLCANIC BXA'S

W LOCAL GREEN CLASTIC UNITS. MAIN HOST !? TRANS TO

BUD: WATER LAIN PYROCLASTICS & EPICLASTICS CONTACT BUD TO

CHOCOLATE TRANSITIONAL ~~PORPHYRITIC LAVAS, VOLCANIC BXA'S & TUFFS~~

CHOCOLATE: PORPHYRITIC QTZ LATITE LAVAS, TUFFS, VOLCANIC

BRECCIAS.

BADGER: UNCONFORMABLY OVERLAYING BADGER SILT MATRIX

VOLCANICLASTIC SEDIMENTS

MINERALIZATION

WILDROSE: BRITTLE HARD HIGH FRACTURE PERMEABILITY

BUD IS SOFT (AQUACLUDE) AND MAY

DEFORM DUCTILEY

DOZER: DENSE WEAKLY ALTERED FINE GRAINED FLOWS IN

FOOTWALL OF S. Ridge Fault.

Reconnaissance Exam Rosebud Thin sections

RB-1 Oscar Andesite: Lava Flow

Good porphyritic Andesite 15-20% Porphyritic Phenos

85-80% Fine Grained G-mass

Pheno

2:1 Hornblende : Plag.

G-mass

5:1 Felted intermediate Plag : MAFICS

Particular rock is mod prop. altd.

RB-2. Mapped as Dozer very strongly argillized

g-mass completely re-xln.

Ghosty FeOx rich seen macroscopically

match RB-1

Probable protolith Oscar andesite? Problematic

due to alteration

RB-3 Mapped as DOZER :

highly altered fg fine grained rock:

1 pheno zone intermediate plag noted. Euhedral

G-mass extensively argillized & weakly silicified

No tuffaceous textures noted

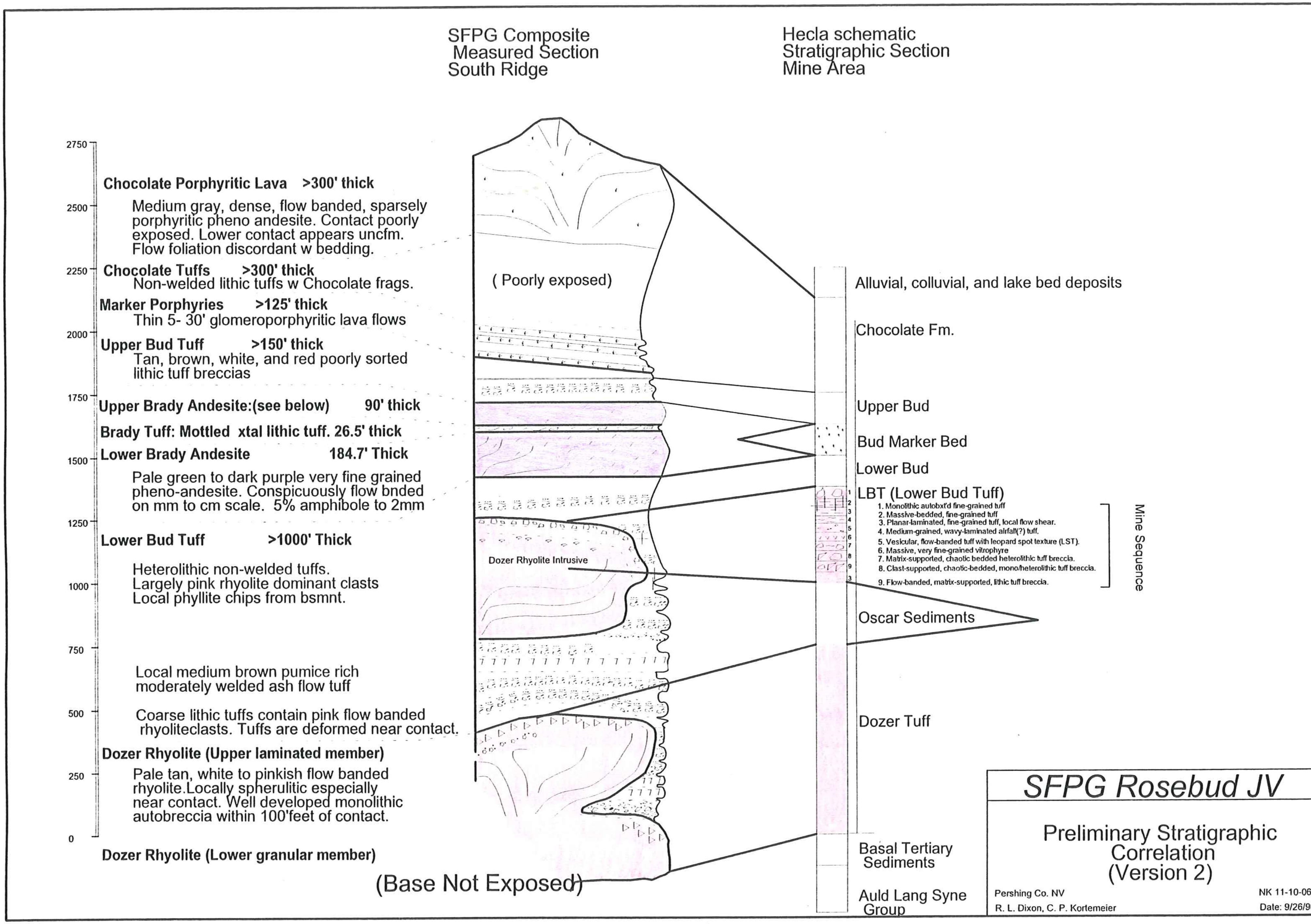
rexln g-mass has relict Flow foliation under X-pol.

No pressure shadows around phenos

No lithics: consistent with non-tuffaceous origin

RB-4 Iron rich auto breccia of similar rock to

RB-3: slightly coarser grained



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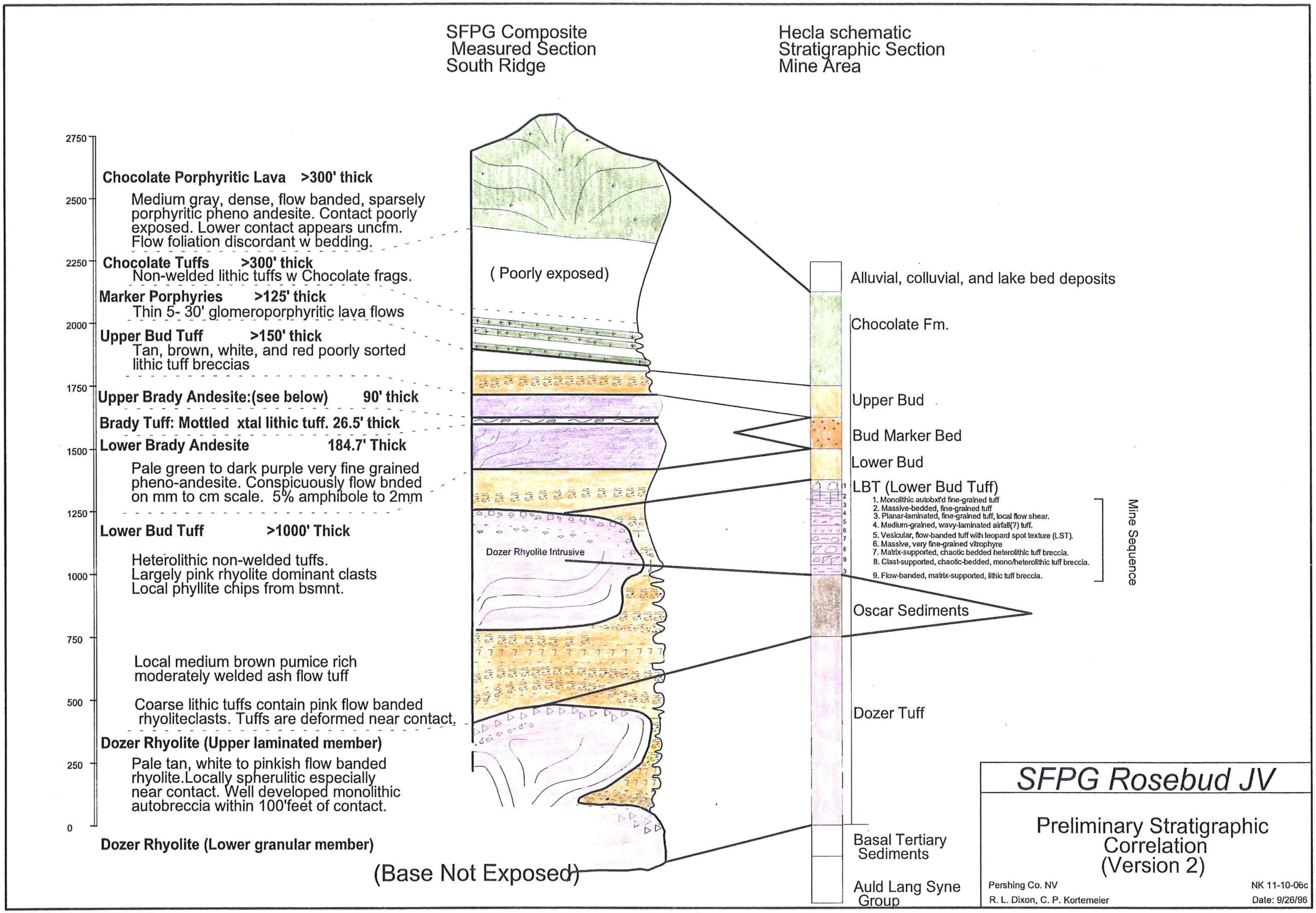
SFPG Composite
Measured Section
South Ridge
Hecla schematic
Stratigraphic Section
Mine Area
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
Chocolate Porphyritic Lava >300' thick
Medium gray, dense, flow banded, sparsely porphyritic pheno andesite. Contact poorly exposed. Lower contact appears uncfm. Flow foliation discordant w bedding.
Chocolate Tuffs >300' thick
Non-welded lithic tuffs w Chocolate frags.
Marker Porphyries >125' thick
Thin 5- 30' glomeroporphyritic lava flows
Upper Bud Tuff >150' thick
Tan, brown, white, and red poorly sorted lithic tuff breccias
Upper Brady Andesite:(see below) 90' thick
Brady Tuff: Mottled xtal lithic tuff. 26.5' thick
Lower Brady Andesite 184.7' Thick
Pale green to dark purple very fine grained pheno-andesite. Conspicuously flow bnded on mm to cm scale. 5% amphibole to 2mm
Lower Bud Tuff >1000' Thick
Heterolithic non-welded tuffs. Largely pink rhyolite dominant clasts Local phyllite chips from bsmnt.
Local medium brown pumice rich moderately welded ash flow tuff
Coarse lithic tuffs contain pink flow banded rhyoliteclasts. Tuffs are deformed near contact.
Dozer Rhyolite (Upper laminated member)
Pale tan, white to pinkish flow banded rhyolite.Locally spherulitic especially near contact. Well developed monolithic autobreccia within 100'feet of contact.
Dozer Rhyolite (Lower granular member)
(Poorly exposed)
Dozer Rhyolite Intrusive
(Base Not Exposed)
Alluvial, colluvial, and lake bed deposits
Chocolate Fm.
Upper Bud
Bud Marker Bed
Lower Bud
LBT (Lower Bud Tuff)
1. Monolithic autobxt'd fine-grained tuff
2. Massive-bedded, fine-grained tuff
3. Planar-laminated, fine-grained tuff, local flow shear.
4. Medium-grained, wavy-laminated airfall(?) tuff.
5. Vesicular, flow-banded tuff with leopard spot texture (LST).
6. Massive, very fine-grained vitrophyre
7. Matrix-supported, chaotic bedded heterolithic tuff breccia.
8. Clast-supported, chaotic-bedded, mono/heterolithic tuff breccia.
9. Flow-banded, matrix-supported, lithic tuff breccia.
Mine Sequence
Oscar Sediments
Dozer Tuff
Basal Tertiary Sediments
Auld Lang Syne Group
SFPG Rosebud JV
Preliminary Stratigraphic Correlation
(Version 2)
Pershing Co. NV
R. L. Dixon, C. P. Kortemeier
NK 11-10-06c
Date: 9/26/96