60001814

Mining District File Summary Sheet

DISTRICT	Rosebud
DIST_NO	4010
COUNTY If different from written on document	Pershing
TITLE If not obvious	Rosebud; Stratigraphy and Lithology
AUTHOR	Mahood, G.; Langstaff, G; Mitchell, P; Dow J; Allen K; Muerhoff C; McLachlan H; Westerveld, T; Vance R.; Maynard S; Mueller J; Christenson O
DATE OF DOC(S)	1999
MULTI_DIST Y / N? Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Rosebud Mining Co LLC; Newmont Exploration Ltd; Hecla Mine Dream Land; Newmont GoldCo.; Mother Lode; White Alps; Lac Minerals USA Inc.
COMMODITY If not obvious	gold; silver
NOTES	Miscellaneous papers; geology; petrography; handwritten notes; field notes; correspondence; sample location maps; sample tags 160 p. 2 oversized plates

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 7/31/08
Initials Date

DB:
Initials Date

SCANNED:
Initials Date

Revised: 1/22/08

STRATIGRAPHY AND LITHOLOGY

60001814 4010

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From: Gail Mahood <gail@pangea.Stanford.EDU>
To: VA_WINN.Winnemucca(PMIT1)
Date: Fri, Apr 23, 1999 5:55 PM
Subject: Rosebud petrography

Hi Peter:

I've sent some petrographic observations by snail mail and am sending them as an attachment to this e-mail. Forgot to mention in that letter that I looked over the chemistry you sent. It's a little hard to interpret because I'm not sure which samples are which, and the petrography shows many of the rocks to be highly silicified or to contain lots of calcite, but the main point I take away from the data is that the rocks are a little on the alkalic side, but not likely to have been truly peralkaline. Maybe the best comparison to unaltered rocks would be to the Yellowstone silicic rocks.

Give me a call if you have any questions after reading it.

Regards,
Gail

-3. Sulfur Group

Kamma Mountains Volcanic Group

-2. Kamma Andesite

-1. Rosebud trachydacite

0. Badger Fm

1. Chocolate Fm = sequence of trachydacite lavas = effusive volcanism

2. Bud Fm = intercalated sequence of volcaniclastic, tephra fall and ignimbrite units; contains rhyolite crystal lapilli tuff, trachydacite lava

2.3 LBT

? 2.5 Wildrose Fm = alkali rhyolite lava

3. Dozer Fm = alkali rhyolite flow-dome complex

4. Oscar Fm

5. Barrel Springs Fm =

6. Auld Lang Syne Group

4/23/99

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SOUTH RIDGE TRAVERSE

3620A and **3621** look similar in that they both contain relatively large glomeroporphyritic clots of good plagioclase plus a population of smaller feldspar phenocrysts that are strongly zoned, show poorly developed twinning, and often show anomalous blue extinction colors, which lead me to conclude that they are more anorthoclase-like in composition (these latter could look like sanidine in hand specimen). The abundance of mafic microphenos (all totally shot, but look like amphibole) and the abundance of groundmass mafics indicate that these are too mafic to be rhyolitic. Also, phenos are fairly abundant, at which stage I'd expect to see quartz, which I don't see as a pheno in thin section (though I could believe that you run across them occasionally in hand specimen). So I'd call these two samples porphyritic hornblende trachydacite lavas. The samples aren't from the same lava, because 3621 has a much higher proportion of phenocrysts (about 15%), but they could be related units.

3622, 3623, and 3626 are very similar-looking lavas; 3623 and 3626 are more highly altered with the development of incipient "spots" in the groundmass typical of slightly alkalic lavas. All of these lavas have sparse plagioclase phenocrysts and plag microphenocrysts in a felted groundmass rich in feldspar and oxides. Because 3622 is less altered, I can identify sparse opx microphenocrysts, and what looks like one olivine microphenocryst. These are the kinds of rocks that commonly used to get called latites. Now they'd probably be called trachydacites.

3620B is a lava intermediate between 3620A and 3622/23/26 in crystal content, but if one wanted to lump it with something else, I'd be inclined to lump it with 3622/23/26 because the microphenocrysts are sparse and they appear to be plag, rather than the ternary-ish feldspar in 3620A. This sample is strongly silicified.

3625A is a massive aphyric lava. Forced to give this aphyric rock a name, I'd call it an alkali rhyolite, but I am not confident of that name. The groundmass has enough oxides in it that this clearly isn't a typical rhyolite; it's got to be a more Fe-rich alkali rhyolite if it is a rhyolite. It's got the light color of rhyolites, as opposed to trachydacites or trachytes, but that could be a function of silicification.

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3628 is listed as a massive to weakly flow-banded lava under "our name" and as Dozer under "old name", but the thin section and hand specimen of that number are rhyolitic crystal lapilli tuff. I think this must just be some sort of transposition of sample numbers. The majority of this tuff consists of ash-sized pumiceous clasts, but there are also fragments of dense perlitic glass and of other fragmental rocks (perhaps ignimbrites). The little reddish clasts look like trachytic volcanic rock with abundant oxides. Crystals are plagioclase and sanidine.

3624 is also a rhyolitic lapilli tuff. It differs from 3628 in consisting almost entirely of pumiceous clasts (though there are some dense perlitic clasts) that seem like they could have been derived from a single source. It also contains many fewer feldspar crystals. The sample is silicified.

3627 is a densely welded ignimbrite. It contains small phenocrysts of plagioclase, sanidine, and quartz, which makes it rhyolitic in composition. It contains volcanic lithics that have a felted groundmass texture like 3626. Contains abundant cc.

WILDROSE CANYON

3631 is a strongly flow-laminated, strongly silicified alkali rhyolite lava in Wildrose Canyon that contains sparse sanidine phenocrysts and microphenocrysts. I'd call it an alkali rhyolite based on the absence of plag phenos and the fact that I don't see ghosts of lots of mafics (though admitedly the rock is so far gone in silicification that this may have removed evidence for mafics). (Because it has obvious sanidine and no plag, I wouldn't lump it with **3622** and **3623**, which means it might be better to not call them Wildrose and to, instead, retain the name Chocolate.)

3632 is a perlitic alkali rhyolite vitrophyre that contains sparse phenocrysts of sanidine and plagioclase, as well as microphenocrysts of a green (Fe-rich?) amphibole. The glassy groundmass is strongly hydrated and perlitic. The texture looks a bit like the sort of densely welded vitriclastic texture characteristic of some of the high-temperature ignimbrites in NW Nevada, in which the glassy shards are blocky rather than tricuspate. On the other hand, I know that you can get psuedo-clastic textures in hydrated and altered rocks. So I'd want to walk out this feeder to see if it fed a lava or an ignimbrite.

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BARREL SPRINGS AREA

3615 is a rheomorphic porphyritic devitrified rhyodacitic ignimbrite.

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3617 is a tuffaceous siltstone. Probably a lake deposit.

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Barrel Springs

3615 rheomorphic porphyritic rhyodacitic ignimbrite
3616 rhyodacitic crystal vitric tuff
3617 lacustrine tuffaceous siltstone
3618 rhyolitic crystal vitric lapilli tuff

South Ridge

3620A porphyritic hornblende trachydacite lava (Rosebud Quartz latite)
3620B trachydacite lava (Chocolate Peak Alkali Rhyolite)
3621 porphyritic hornblende trachydacite lava
3622 trachydacite lava] single flow (LBT)
3623 trachydacite lava]
3624 rhyolitic lapilli tuff (pumiceous) (spherulitic flow)
3625A aphyric alkali rhyolite lava (Dozer III lava) top
3625B alkali rhyolite lava (Dozer III lava) middle or lower
3626 trachydacite lava (LBT = 3623)
3627 densely welded rhyolitic ignimbrite (ignimbrite)
3628 rhyolitic crystal lapilli tuff (bolby ignimbrite)

Wild Rose Canyon

3629
3630
3631 flow-banded alkali rhyolite lava (group w/ 3622 & 23)
3632 perlitic alkali rhyolite vitrophyre (lava or densely welded ignimbrite?)

White Alps

3633 rhyolitic crystal lapilli tuff (pumiceous quartz latite lapilli tuff)

KAMMA MOUNTAINS GROUP	BARREL SPRINGS FORMATION	BARREL SPRINGS MEMBER (> 2000'; 610m)	Tuffaceous mudstone, siltstone and sandstone, porcelinite and intercalated pumiceous, vitric crystal tuff
		RABBITHOLE CREEK MEMBER (~480'; 146m)	ALS Pebble Conglomerate (~250'; 76m)
			Tuffaceous siltstone and mudstone (~140'; 43m)
			White tuff (~90'; 27m)
		RABBITHOLE IGNIMBRITE MEMBER (> 700'; 213m)	Rheomorphic trachyte ignimbrite
AULD LANG SYNE GROUP			

700'

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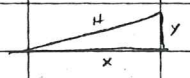
Unit starting at 134 = ~19m (= ft) thick & had
thin <10cm interbeds of volc pebble congl.
CT + ~35' @ 225° = b = 015, 42E
End of traverse = CT w/ overlying unit
@ flag.
on ridge line
to 2008N 4792E = 253½°
to 2012N 4800E = 098½°
to 2012N 4792E = 315°
} = CT + flag

b in overlying unit + CT = 007, 42E

actual CT = ~15' @ 085° from flag = ridge center
= Cobble (rounded) congl w/ exotics
up to 1.5m across

AZ	DIST	VA.	T. DIST.	ELEV
072	270'	+13	263	61
	178'	+18	169	55
	92-134	+11	41	8



cos = x/H
sin = y/H

778-2863 - DAVE GROVES (5TH STREET)

10-2-98
09374 = George Langstaff
5-5627

1506 = Randy Sunday 8 Am
625-5613

= GAIL MAHOOD =

3-10-98 - Gail Borrel Springs

Stop 1 184 steep dips (>2 to 3°) = structural
outlaws Bin-eruptive tuff

Rheomorphic tuff
↳ drumming exposure - began to flow
andesite(?) inclusions + ALS + lithophysae
↳ Holes = lithophysae (vugs) + spherulites
Hot = reverse circulation (if add air = no welding)
to weld must have magmatic gas -
degassed from base eruption column.
just too to be hot, not necessarily proximal
or big! biotite + px = high T 900°C
Densely welded + Rheomorphic
Hot Magma or proximal!

Caldera + intracaldera tuffs/environments

gum = welded at top
tuff at base

rx = sanidine + qtz + biotite

Vent + picked up
Gail + Wes = Bishop tuff! paper
Everything above was air tuff = from the vent

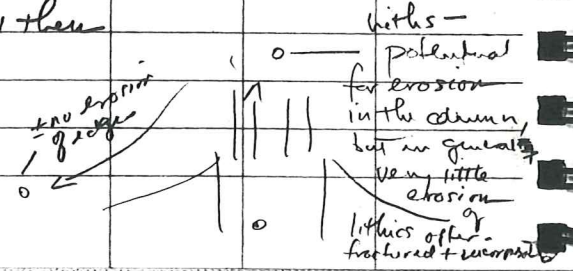
Mafic magma – look for flattening – not as flattened as the xln mix, crenulated margins

4 broken = lithic,

here = xenoliths (lithics) not mafic melt blobs
because not flattened enough + too angular look for evidence of flattening (i.e. fiamme-like edges) of edges

Andesite when fracture can give any shape – some lithics here have very odd shapes, but are probably lithics

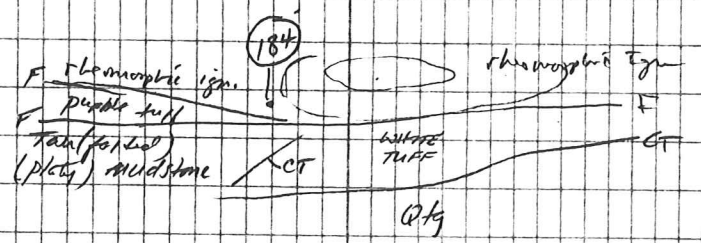
Here xenoliths/lithics = altered rinds around them

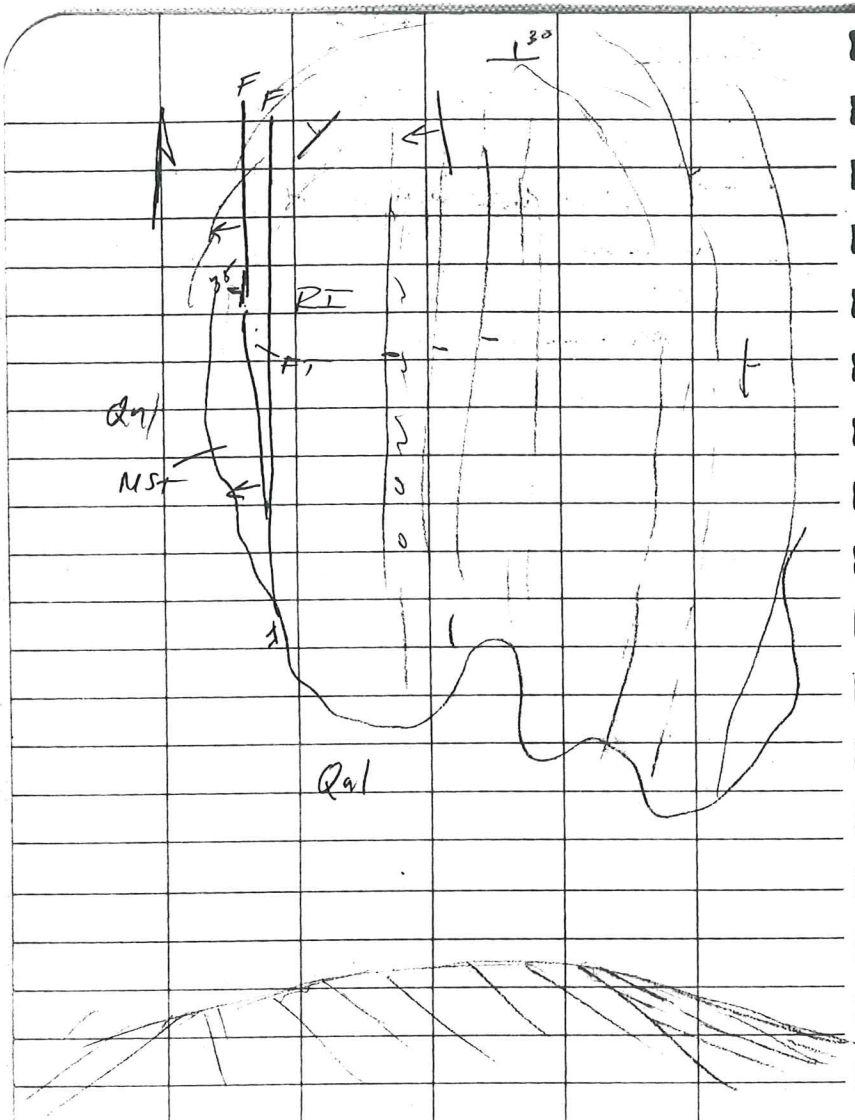


Stop 2 = rhyolite/dacite dike = back side of ridge near Qt, fr to <1%
Qtz phenos to 2mm across.

Rheomorphic fab – ash is not mixed and welding – not preserved in geologic record – this is a ignimbrite!

= Rheomorphic Ignimbrite





SAMPLES

184 = Rheomorphic Ignimbrite

NWRA-3615

185 = (A) Fallout tuff → ignimbrite } trachyte

(B) LAVA

NWRA-3616

186 = tuffaceous (?) mudstone / siltstone

NWRA-3617

* Ro look like trachyte = not enough quartz

(sed rx because anhedral xls) pumiceous (lapilli-size)

-3 (186) NWRA-3617

first = vitric crystal tuff (20%-25% xls)

NWRA-3618 1.5m (187) (4)

reverse graded = lake turbidite sandstone to granular size trans

sediment

1m thick

pumiceous (floats) resedimented so can get reverse grading.

lacustrine ± tuffaceous mst/slt/ss + porcelinite

conformable

Beach lag? → ALS pebble congl.

because of planar conformable CS for long distance + imbrication + lack of rounding of pebbles

fed by tanglewreck somewhere

Lacustrine ± tuffaceous slt/st/mst

(2) - (185) NWRA-3616

unconformity

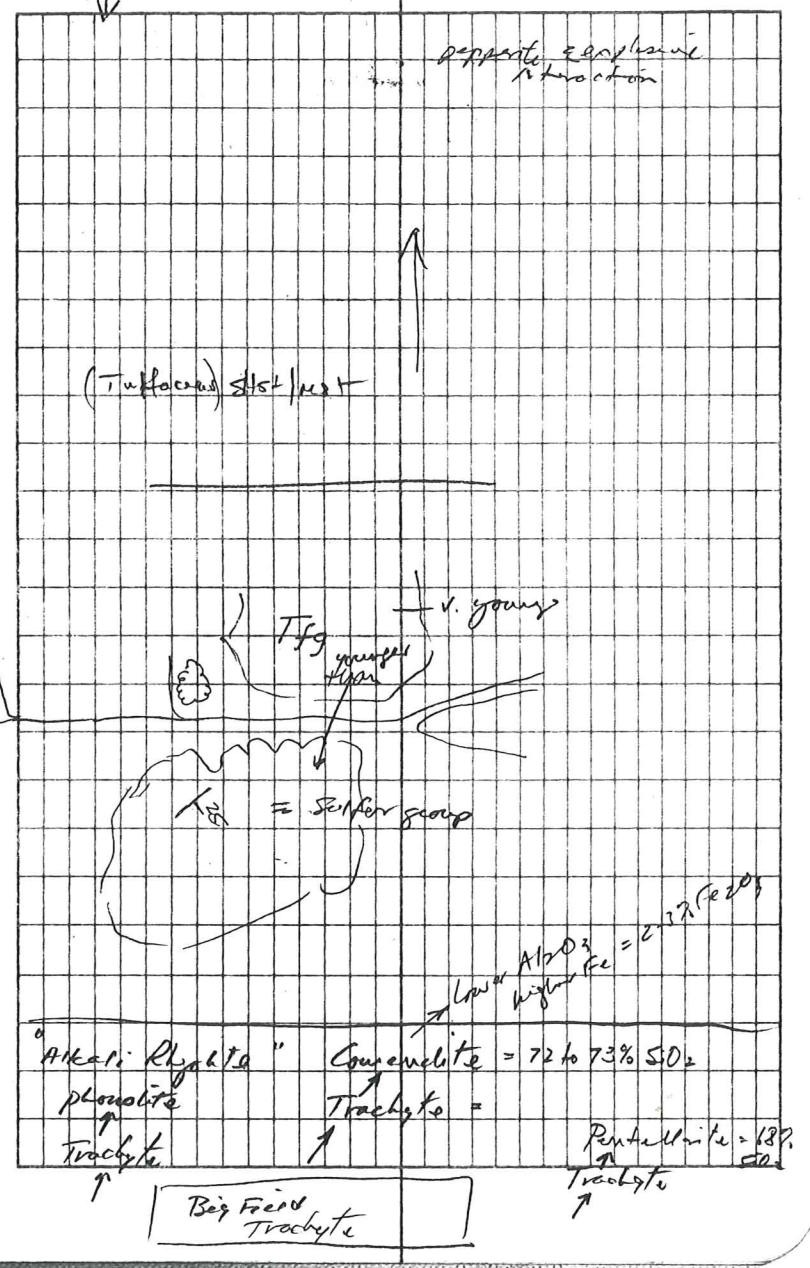
Rheomorphic Tgn.

(1) (184) NWRA-3615

F - less blobs + less rheomorphic F

BASE NOT EXPOSED

lava flows have broken xls



Dozer = flow-banded trachyte (comenditic)
= along road on N side South Ridge
→ + some local autobx zones = small + irregular

Strongly parallel banding (>5 m) = lava
discontinuous + pinch & swell = rheomorphic tuff
10's of cm.

* lava flow vesicular + vapor phase xln = flow laminations

Dozer trachyte / comenditic
autobx (1) lava dome ?
(2) slide blocks ?
tectonic transport

→ lava domes - brecciated along internal margins
no mix + no variation in fragment size
Definitely, not Hydrot or pyroclastic

Here Dozer = lava flow or lava domes
trachyte can go 3 to 5 km easily
flowage = Temp effect more than SiO2 content

Very Hot lava flows can flow easily -
Rhyodacite, not quite 76% SiO2

Vitrophyre in ignimbrite = 10 m or less
in lava flows vitrophyre can go for a long way.

* generally in ignimbrite of this composition should have lithic inclusions.

Ash flows + lava can have from 0 to 40% crystals

Gail M. = ± N Km³ ignimbrite flows in aphyric.

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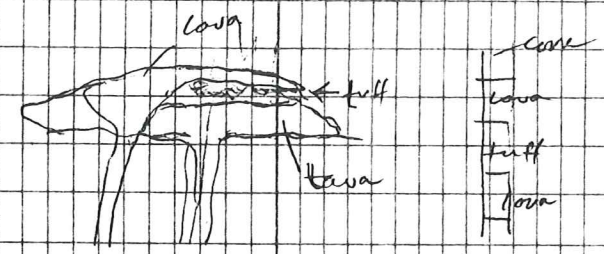
rhyolite domes have fall out units w/in them



SUNDAY 4-10-98

1. Notes on how to identify volcanic units, ie., lava flows, ash flows, tuffs, in the field.

2. Rock tape

= Pinnacle 2 from E.

Vertical flow foliation generally simply vent area; other places = on flow fronts = regional (can have local vertical flow foliation) Some vesiculation = evidence for lava flow or lava dome

NOTE! If flow-foliation is rotated to pre-tilt it is still vertical.

If vertical flow-foliation = continuous over the length of the s/c (all pinnacles) = probably a vent.

yesterday — flow lam = v.l. shallows = flowing "away": flow dome + lava flow.

Hot flow margin can rewield so clasts w/o real boundaries

highly vesiculated flow tops = not preserved in geological record

This bx @ the top of Td could be HT!

This is a talus pile = crude bedding poorly sorted. from different Hoover tuff!!

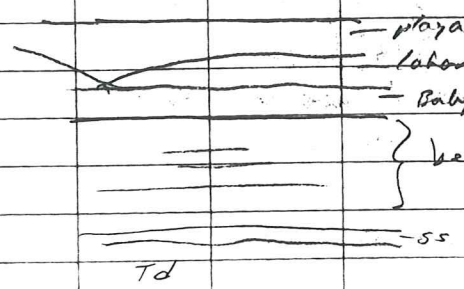
- less Hm, but down Td

more Hm = Hm probably = syneruptive

Evidence for lava dome complex = non-continuous units

*"Tos" above the bx maybe a pyroclastic deposit

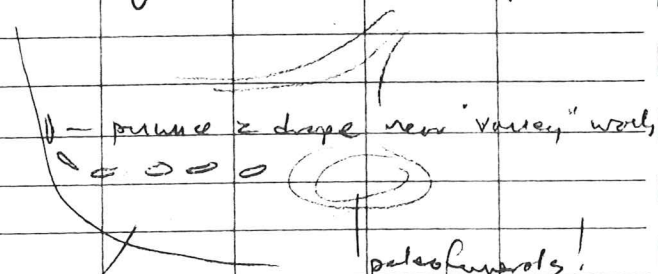
Lahar = unsolely mp, wide range of vesiculation some angular, wide clast size range some = v. large, massive



lahars = preserved = in valleys

Dike alti = possibly HT.

Weakly welded Ignimbrite = Valley of lapon sinks



filling paleo canyon 100,000's to millions

Ages
*→ few 10,? of thousands to few million

Erosion surface - lava dome = eroded

Note vert. lava (flow) on Td on west side of review

1. Sequence = going in and out of lacustrine deposits + ignimbrites or reworked + lahars
equivalents = "map the environment (facies) not the units"

lahars = doubly graded.

* platy jointing = classic intermediate composition lava flow = probably latite to trachyte lava! two joint sets => pencil tuffs

if biotite = not an andesite = a mafic trachyte.

Spots => alkalic intermediate compositions
Hawaiites and up - these may be icelandites!

also have flow bx!
→ near south side (may be a feeder dike - orange flow!

Dozer II = plagioclase phyric ($\pm 2\%$, $\bar{x} \simeq$ tr to 4%)
→ Name plagioclase phyric Dozer (?)

* to E = "Chocolate" precursor dike = Sanidine + hbn

⇒ * Vitrophyre = possibly associated w/ a densely welded tuff – they occur ~ 1 to 2m above the base – the bottom 1–two m's = cooled too quickly to form vitrophyre – this rock could be dated!!

Lunch

Badger (1) at prospect maybe lahar
(2) playa environments w/ flash flood deposits

Intermediate composition dikes can become bx near the surface where they breach and flow or form lahars

1. The gorilla = Sanidine, plagioclase ± biotite brecciated, locally vesicular
It is not! the Rosebud Quartz latite

The earlier tuff = lava flow = different than the gorilla rx.

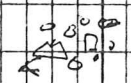
The gorilla = intrusive plug of trachyte

bx (1) if lateralithic = i.e. = Dozer + Chocolate ⇒ debris flow/fan = less likely syn eruptive
(2) if monolithic = syn-eruptive = hot and "spalling" off a lava dome = ± welded together i.e., all Chocolate

debris fans = relatively isolated individual lobes


= lava dome

Creek Exposure ⇒


= bx spalling off!

Gail – This does not look like a lava dome bx – proximal Debris fan coming off Chocolate lavas, but not hot

* White Alps Porphyry = feldspar trachyte

porphyritic (volcanic name) =

porphyry = fine-grained (aphanitic) gm > 2mm

Nomenclature

Monday 5-10-98 (Westend South Ridge)

Oscar Andesite - no plag, Amp (?) = ~ fresh (?) → same px?

relative felsic - possibly trachyte, but

Big Road not normal andesite.

Dozer = closer to plag phyric Dozer (?)

oops → plag ± sanidine (?) + Qtz phenos =

Rosebud Quartz latite dike (?) = flow banded

Stop 2 possibly Rosebud Qtz latite = Pete's TI (= latite) + glom. pl

2 dikes, 1 w/ Qtz-San-bio and

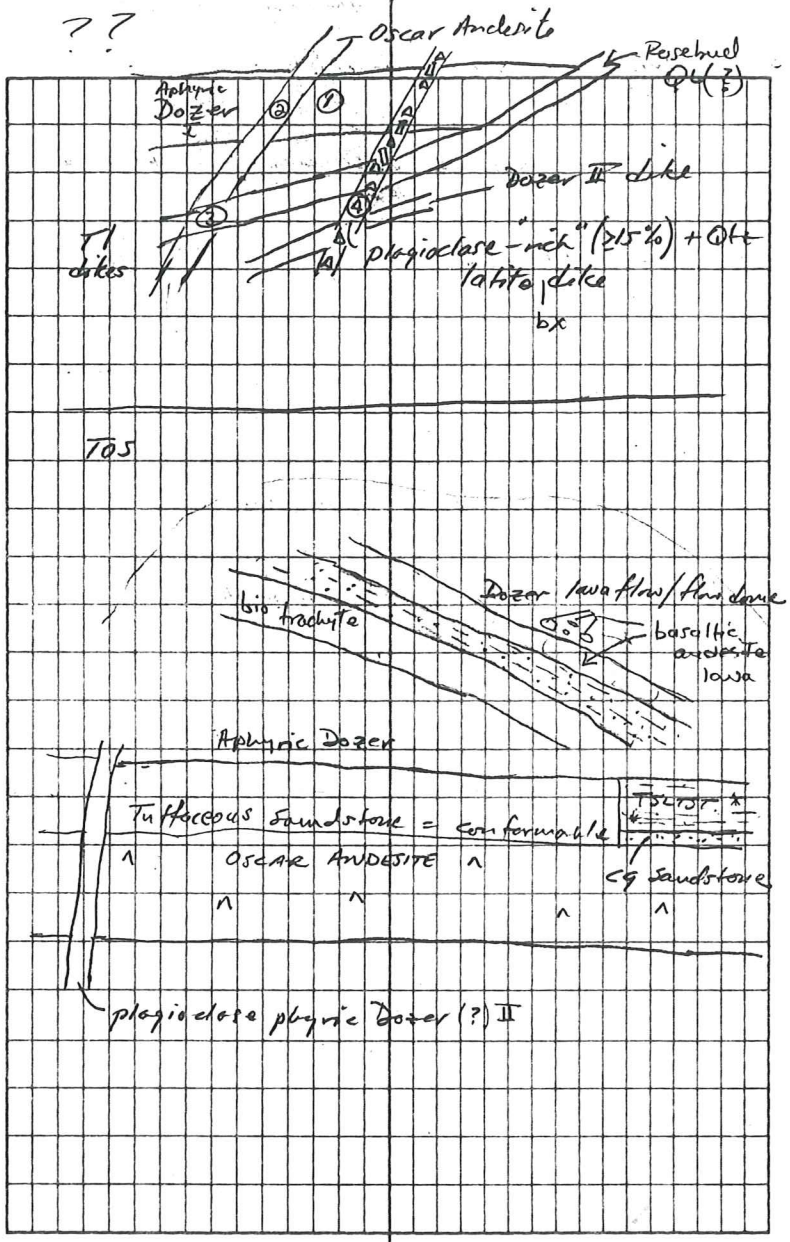
1 w/ Qtz ± ?

Stop 3 = xenolithic ? feldspar-rich (bx) dike

fragments = (1) Dozer II pl + coarser grained

cuts TI dikes + Oscar andesite

??



Age of "andesite" dikes

Note: The basaltic andesite (?) dikes are much fresher (±uralitic) and denser so these may be v. young = to Basin & Range Extension

Weakly alkaline Volcanic dikes = age to the volcanic center w/ v. late basin + range calc-alkaline dikes

---

6? Rosebud Quartz Latite (?), but cryptocrystalline qtz and possibly more plagioclase phenos.

7 = Sanidine-bearing latite w/ amphibole

Upper Bed Epiclastic beds = clastic w/ pumice eruptions occurring at the same time, possibly primary pyroclastic deposits

Lacustrine volcaniclastic sedimentary rx mudstones + siltstones, breccias, ash, flows + dikes, pepperite

maybe 80 to 100' thick.

pale green color = smectite (?) = typical of lacustrine deposits deserves.

5 = (188) = NWRA-3619

* Sills usually have diabasic textures - @ least cryptoslitic or coarser. This is v. fg to glassy & probably a flow

Big Chocolate PK

NWRA-3620 (189) 6 Rosebud Qtz Latite

NWRA-3621 (190) 7 Lacustrine Volcaniclastic Sediments + pyroclastic (?)

NWRA-3622 (191) 8 (Vitrophyre) lava flow

LBT = platy (+ some flows = vitrophyre) — rare large (~5mm) bio ± micro xln interior — devitrified

1 flow

9 (192) w/ sanidine (?)

NWRA-3623

? not exposed — usually thinner bottom layer

* Don't base calls on phenocrystals < 1%

Not - to platy unit just above dozer from Am of day 2 - missing mafic magma blotch + biotite

Note: Need to be sure numb's are ≈ in abundance

NWRA-3624 (193) 10 Epiclastic Lacustrine Volcaniclastic Section

10 = Spherulitic flow? — finer grained than above

Unconformity 025, 48E / 015, 52E

1m — med/thick bedded talus bx — lahar (multiple units)

Erosional surface — Dozer lava dome — Antoby dome margin

(194) 11

NWRA-3625 — Saddle

NWRA-3626

(195) 12 LBT = 9

Sodalite

only(?) difference = no marbs
± less sanidine, both have bio

Volcaniclastic lacustrine sediments
mass flow deposits ± pumice

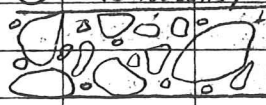
Note: should measure sections here
at silicified pebble conglom. +
Eastern and western locations = 3 sections

NWRA-3627

LBT?

probably trachytic?
Welding w/o
much pumice =
trachyte = ≈900°C
HOT! Lithic
rich

13 (196) lithic-rich, xl- ± pumice-poor trachytic
ignimbrite (?), columnar jointed
(both hills / oles



Caldera wall
Collapse bx
(possibly retained in the
ignimbrite)

tuffaceous mx w ign

one unit?

Stopped
mapping

(?)

(197) 14 Baby ignimbrite from below

NWRA-3628

Fault ?? Epiclastic/Volcaniclastic section

Welded Ignimbrite ≈ (14), maybe repeated
Section?? - Some big blocks = exotic
blocks = Spalling off topographic high -
less welding around blocks

~~Epiclastic/VOLCANICLASTIC SEDIMENTS~~

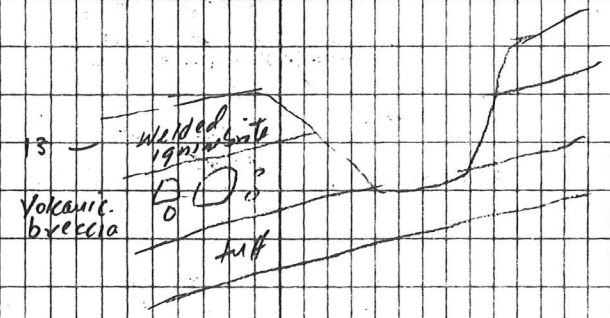
Spherulitic unit w/ zones of flow
lineation

LBT (thick)

TOS(?) few feet to few m

Dozer DIKES Dozer I

LAHAR



(1) ignimbrites give paleo-horizontal
(2) ignimbrites = planar surface = mappable over
(3) Caldera w/ multiple flow dome fields + Ash

Spherulites = near edge of lava flow or dome
= cool quickly — if cools slowly xln does
not radiate outward from points =
but more equal xln

Vapor phase alt mostly near the top of
the flow/dome

% phenos doesn't vary much in a

— General Eruptive Sequence — South Ridge

LBT = Lava Flow

~~Lacustrine Volcaniclastic rx~~

Lahars + ignimbrites

Erosional Surface

Domes

$317+

Tuesday 6-10-98

Field Traverse

1. Basal Badger
2. DDH-446 - Rosebud Quartz Latite
3. Short shot + Wild Rose + RQL dike
4. Wild Rose Canyon + Juniper Canyon — Wild Rose

Gail - Comments

1. Use Alkali Rhyolite for the Dozer rock name to denote alkalinity.

2. Rosebud Qtz Latite may be the causative intrusion

3. Vitrophyre = glass + >5% phenocrysts, <5% phenocrysts = obsidian

4. Dikes don't usually have well developed flow lineation

5 LBT should be renamed = Wild Rose Trachyte 68% + 8% Alkalis

Pete's Stop = LBT

* At short shot the Brown Flow / Wild Rose = LBT and to the south along the road to the west

(198) NWRA-3629

George's O/C = (15) on map

possibly trace sanidine

SiO_2 ~ 68%

$Na_2O + K_2O$ > 8.0 } trachyte

NWRA-3630

(199) (16) = possible Densely welded ignimbrite, lithic-rich + crystal- & pumice-poor, possibly = to yesterdays (13)!, but w/ biotite

(200) NWRA-3631

(17) = "South Ridge" LBT = identical!

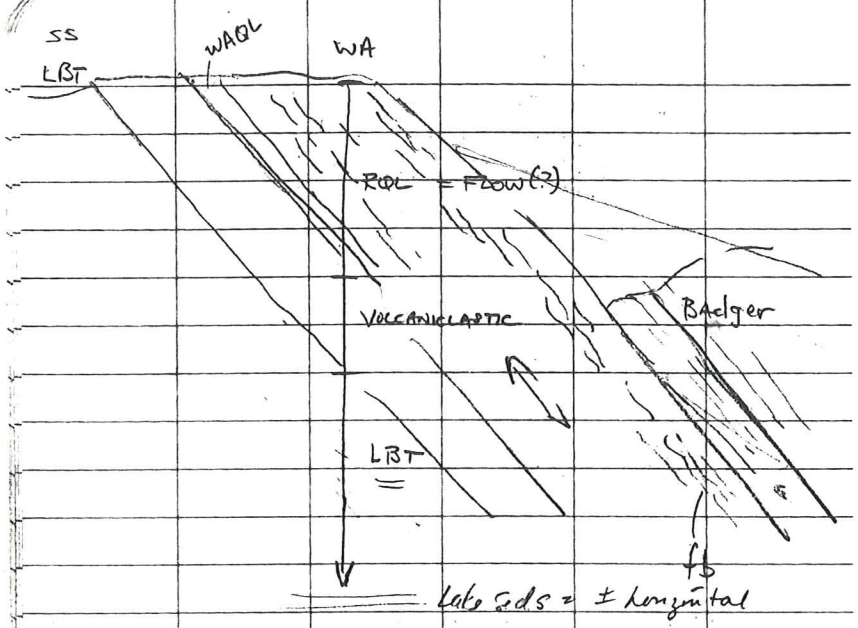
(201) NWRA-3632

(18) = sanidine-bearing (1-2%) obsidian possibly trachyte

6 Mass flows (debris flows) off domes = Lacustrine + Subaerial

7 RQL = sills, may breached surface, upflow =

DON
ALAN

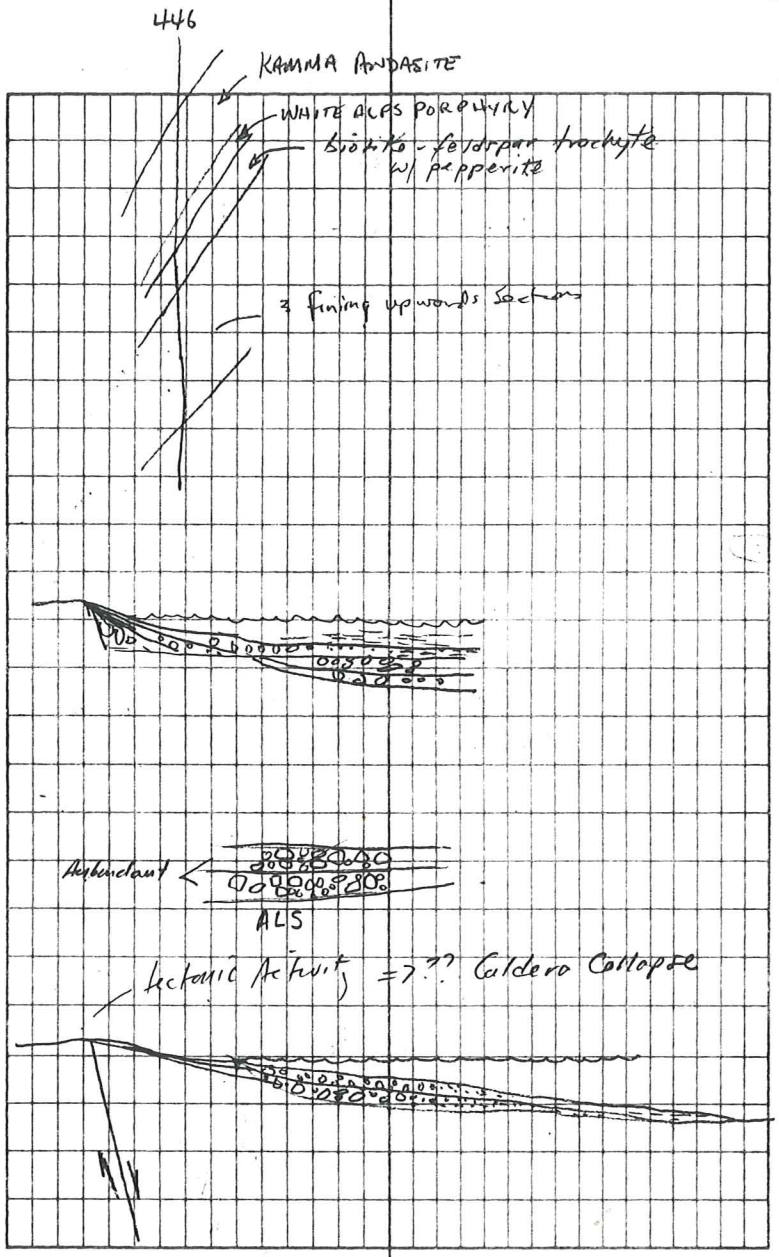


Dozer

Gail – only use feldspar-bearing or feldspar absent for the dozer – don't worry about plagioclase or sanidine which we probably can't tell.

(1) Megascopic Identification of volcanic rx

(2) Rock Nomenclature



Th = groundmass
west end SR LBT – correlation

Ask Randy
(1) what he wants Gail to address in her report – see Gail
(2) 50¢/mile? – see Gail

END FIELD TRIP

DEZO water lake – look up turbidites

SMst/SS bedding ∡'s? = potential structural problem!

COMMENTS –

RHEOMORPHIC IGNIMBRITE (Flow)
WILD ROSE TRACHYTE = LBT A, B, C etc. (DOME OR FLOW)
DOZER ALKALI RHYOLITE = DOZER TUFF (DOMES)
WILD ROSE obsidian (DIKE + FLOW

"Comendite" Dome field with interdome Volcaniclastic deposits intercalated w/ ignimbrite flows and lava flows. No caldera = ALS basement beneath Kamma Mtns

Domes (1) DOZER, (2) LBT,

Add Turbidite section in 446 + OTHER DIKES

Rosebud Quartz Latite = flow, sill, dike? + cryptodome

Randy Barron

	18.00		Basic Wrock Rock		18.00
	SiO_2		Extended Add on		16.00
	Al_2O_3				
	TiO_2				
9.00	FeO				
	Fe_2O_3				
	MnO				
	MgO				
	CaO				
	K_2O				
	Na_2O				
	P_2O_5				
	LOI				
			8.00		
6.50	S		Ba	La	
16.00	Cl		Nb	Ni	
18.00	F		Rb	Th	
			Sr		
	Se		Y		
			Zr		

Report
Mulloge

porphyritic hornblende trachydacite lava 303

6A = NWRA-3620 A

Phenos

Rosebud Quartz Latite (?) II

3% mafic magma blobs

~ 8% Feldspar

3% Sanidine

5% Plagioclase

≤1% Quartz

1% Smoky

0 Clear

4% Amphibole microphenocrysts

≤1% Magnetite

Rosebud Quartz Latite II

trachydacite lava 556J

6B = NWRA-3620 B

Phenos

Chocolate ! Alkali Rhyolite

1% mafic magma blobs

~ 4% Feldspar

1% Sanidine

3% Plagioclase

10% Quartz

Smoky

10% Clear

7% Amphibole

≤1% Magnetite

CHOCOLATE PEAK
ALKALI RHYOLITE

fine- medium grained gm of feldspar - quartz - Amphibole

2096N 4760E > scree = Volcaniclastic (≤ 20%, exclusive of fines)
Rosebud Quartz Latite (≤10%)
LBT (≤ 45%)
feldspar porphyry (≤10%)
breccia (≥15)

2096N 4764E > scree ± sfoc = ~~Rosebud Qtz latite~~ - some silicified, fsp porphyritic lava

NOTE = TS = ~ 200' N of 2096N, 4764E ~ 100' from ridge = Vesicular Rosebud Quartz Latite.
(202)

2104N 4760E > scree >95% LBT w/ Amph (≤2%), feldspar (plag and possibly sanidine, ≤3%), and possibly Quartz (tr)
* Possibly mafic magma blobs??

=18 = 201

NWRA - 3632 = obsidian w/ <1% feldspar microphenocrysts

=19 ≤10%

NWRA - 3633 = pumiceous quartz latite (lapilli tuff) ≤2% fsp phenocrysts pl:San ~1:1, trace clear quartz, ≤20% lapilli-size pumice fragments.

10 = 193 = NWRA-3624 = sandy, tuffaceous granule to pebble conglomerate (medium to coarse-grained sand, tr to 3% pumice*

11 = 194 = NWRA-3625 A = massive, aphyric, pumiceous (?) lava
3625 B = flow-banded, quartz-bearing (1-2%), ± fsp-bearing lava

12 = 195 = NWRA-3626 = Relatively aphyric, weakly banded lava w/ rare Amphibole and <1% feldspar phenocrysts.

13 = 196 = NWRA-3627 = Densely welded lithic-rich (<1 to ~8mm; $\bar{X}$ = 5mm) crystal (Sanidine?)-poor, pumice-poor ignimbrite.

granule = 2-4mm
pebble = 4-64mm

14 = 197 = NWRA-3628 = poorly welded, crystal-bearing (fsp = sanidine? ≈ 1-2%; biotite <1%), lithic-rich, pumiceous ignimbrite

15 = 198 = George's location

16 = 199 = NWRA-3630 =

17 = 200 = NWRA-3631 = Strongly flow-banded, crystal-poor (tr Amph, tr-1% sanidine?, trace ≤1% qtz) alkali rhyolite(?) lava

Badger	900-1000	Qal 0 to > 300'
chocolate flow	+300'	Conglomerate 40 to > 250
chocolate tuff	+300'	Ts late Seds 2000
Upper Bud Seg	+300	
Bradley Seg	90+26+185	
Lower Bud	+1000'	
Dozer	250-1800'	
TOS	0-50'?	
TCS	0-100'	

42½ = 1700' = 168.5

250' = 37.7

10.09

33.8

oscar seg

Rheomorphic Ignimbrite > 700' 213m

white tuff 90 27m

Tuffaceous siltst & mst 190 > ~230' 43m 70m

ALS pebble Congl ~250' (76m)

Tuffaceous siltst/mst/ss + tuff > 2000' (610m)

1" = 500'

1" = 400' = 1:4800

1" = 200' = 1:2400

> 2000'	(610m)	Tuffaceous siltst, mst, ss w/ intercalated pumiceous bx
~250'	(76m)	ALS pebble Conglomerate
~140'	(43m)	tuffaceous siltst & mst > ~230' (70m)
~90'	(27m)	white tuff
> 700'	(213m)	Rheomorphic Ignimbrite

~3180' (969m)

Fault — Fault

Barrel Springs

3615 rheomorphic porphyritic rhyodacitic ignimbrite
3616 rhyodacitic crystal vitric tuff
3617 lacustrine tuffaceous siltstone
3618 rhyolitic crystal vitric lapilli tuff

South Ridge

3620A porphyritic hornblende trachydacite lava (Rosebud Quartz latite)
3620B trachydacite lava (Chocolate Peak Alkali Rhyolite)
3621 porphyritic hornblende trachydacite lava
3622 trachydacite lava] single flow (LBT)
3623 trachydacite lava]
3624 rhyolitic lapilli tuff (pumiceous) (spherulitic flow)
3625A aphyric alkali rhyolite lava (Dozer III lava) top
3625B alkali rhyolite lava (Dozer III lava) middle or lower
3626 trachydacite lava (LBT = 3623)
3627 densely welded rhyolitic ignimbrite (ignimbrite)
3628 rhyolitic crystal lapilli tuff (bolny ignimbrite)

Wild Rose Canyon

3629
3630
3631 flow-banded alkali rhyolite lava (group w/ 3622 & 23)
3632 perlitic alkali rhyolite vitrophyre (densely welded ignimbrite?) lava or

White Alps

3633 rhyolitic crystal lapilli tuff (pumiceous quartz latite lapilli tuff)

KAMMA MOUNTAINS GROUP	BARREL SPRINGS FORMATION	BARREL SPRINGS MEMBER (> 2000'; 610m)	TUFFACEOUS MUDSTONE, SILTSTONE AND SANDSTONE, PORCELLANITE AND INTERCALATED PUMICEOUS, VITRIC CONTRA TUFF
		RABBITHOLE CREEK MEMBER (~480'; 146m)	ALS PEBBLE CONGLOMERATE (~250'; 76m)
			TUFFACEOUS SILTSTONE AND MUDSTONE (~140'; 43m)
			WHITE TUFF (~90'; 27m)
		RABBITHOLE IGNIMBRITE MEMBER (≥760'; 23m)	RHEOMORPHIC TRACHYTE IGNIMBRITE
AULD LANG SYNE GROUP			

700'

F

Unit starting at 134 = ~19m = ft thick & has
Thin <10cm interbeds of volc pebble congl.
CT + ~3.5' @ 225° = b = 015, 42E
End of traverse = CT w/ overlying unit
@ flag.
on ridge line

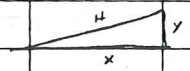
to 2008N 47925E = 253½°
to 2012N 48006 = 098½°
to 2012N 47926 = 315°

= CT + flag

b in overlying unit + CT = 007, 42E

actual CT = ~15' @ 085° from flag = ridge center
= Cobble (rounded) congl w/ exotics
up to 1.5m across

AZ	DIST	VA.	T. DIST.	ELEV
072	270'	+13	263	61
	178'	+18	169	55
	92-134	+11	41	8



$\cos = \frac{X}{H}$
$\sin = \frac{Y}{H}$

778-2863 - DAVE GROVES (5TH STREET)

10-2-98

09374 = George Langstaff
5-5627

1506 = Randy Sunday 8 Am
625-5813

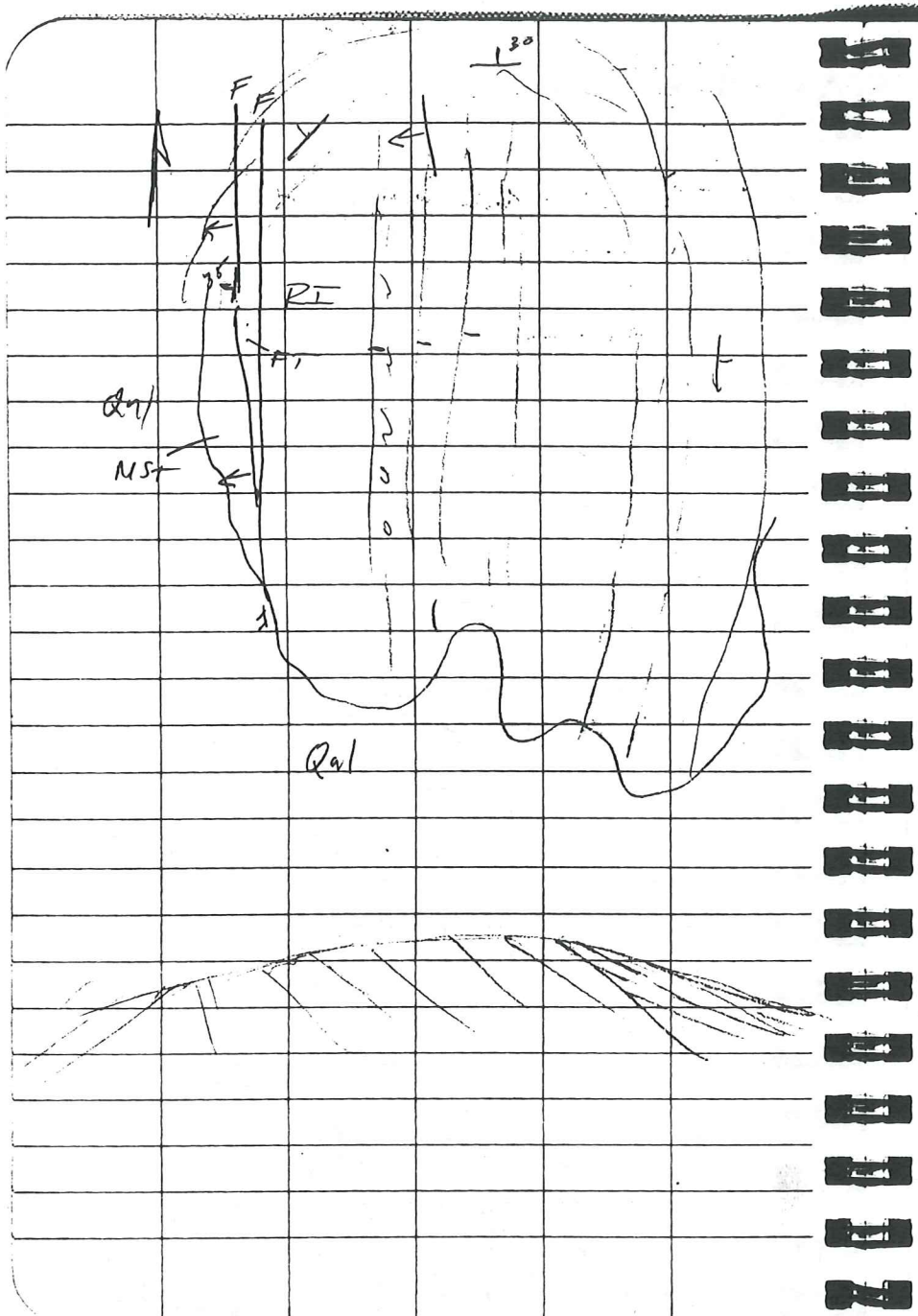
= GAIL MAHOOD =

3-10-98 - Gail Barrel Springs

Stop 1 184 Strong dips (>2 to 3°) = structural
uniform pyroclastic tuff

Rheomorphic tuff
→ drainage exposure - begin to flow
andesitic(?) inclusions + ALS + lithophysae
Lithics = lithophysae (stages) + spherulites
Hot = recirculation? (if add air = no welding)
to weld must have magmatic gas -
deposited from hot eruption
just too to be hot, not necessarily proximal
or big! biotite + px = high T 900°C
Densely welded + Rheomorphic
Hot Mega or proximal!

Caldera + intracaldera tuffs/environments
gum = welded at top
tuff at base



SAMPLES

(18A) = Rheomorphic Ignimbrite
NWRA-3615

(18E) = (A) Fallout tuff → silicified } trachyte
(B) LAVA
NWRA-3616

(18B) = tuffaceous (?) mudstone / siltstone
NWRA-3617

* R. look like trachyte = not enough quartz

Dozer = flow banded trachyte (comendite)

= along road on N side South Ridge

↳ + some local autobx zones = small + irregular

strongly parallel banding (>5m) = lava

discontinuous + pinch & swell = rheomorphic tuff

↳ 10's of cm.

* lava flow vesicular + vapor phase wld = flow laminations

Dozer trachyte / comendite

autobx (1) lava dome ?

(2) slide blocks ?

↳ tectonic transport

↳ lava domes - brecciated along internal margins

no mix + no variation in fragment size

Definitely not Hydrot or pyroclastic

Here Dozer = lava flow or lava dome

trachyte can go 3 to 5 km easily

flowage - Temp effect more than SiO_2 content

Very Hot lava flows can flow easily -

↳ Rhyodacite, not quite 76% SiO_2

Vitrophyre in ignimbrite = 10 m or less

in lava flows vitrophyre can go for a long way.

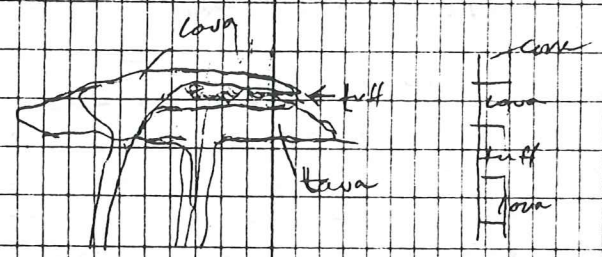
* generally in ignimbrite of this composition should have lithic inclusions.

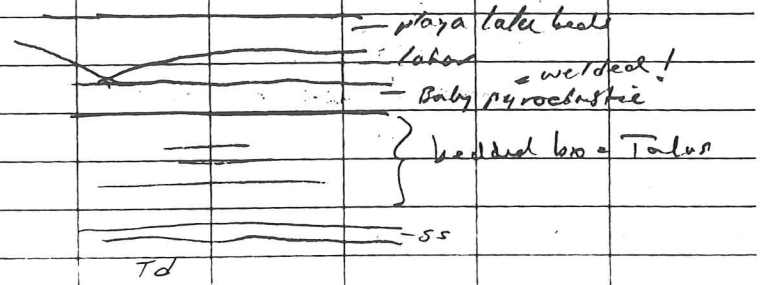
Ash flows + lava can have from 0 to 40% crystals

Gail M. = + N km^3 ignimbrite that is aphyric.

---

rhyolite domes have fall out units within them

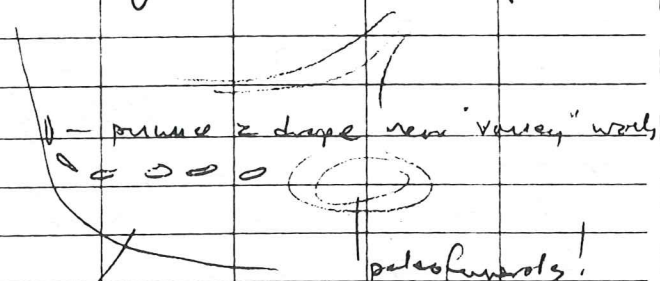




lahars = preserved = in valleys

dike alti = possibly H.T.

Weakly welded Ignimbrite = valley of lopen sinks



filling paleo canyon 100,000's to millions

Ages *→ few 10's of thousands to a few million

Erosion surface — lava dome = eroded

Note vert. lava (flow) in Td on outside of valley

1. Sequence = going in and out of lacustrine deposits + ignimbrites or resedimented + lahars significantly = "map the environment (facies) not the units"

lahars = doubly graded.

* platy jointing = clastic intermediate composition lava flow = probably latite to trachyte lava! two joint sets => pseudo tabular

if trachyte = not an andesite = a mafic trachyte.

Spots => alkalic intermediate compositions Hawaiites and up — these may be (icelandites?)

also lava flow bx!

→ near South side (roughly) a feeder dike — orange flow!

* White Aps Porphyry = feldspar trachyte

porphyritic (volcanic name) =

porphyry = frag-gravel (ophitic) gm > 2mm

Nomenclature

Monday 5-10-98 (Westland South Ridge)

Oscar Andesite - no plag, Aple (?) = ~ fresh (?) → some px?

relative felsic - possibly trachyte, but

By Road not normal andesite.

Dozer = closer to plag phyric Dozer (?)

oops → plag ± sanidine (?) + Qtz phenos =

Rosebud Quartz latite dike (?) = flow banded

Stop 2 possibly Rosebud Qtz latite = Pete's Tl (= latite) + glom. pl

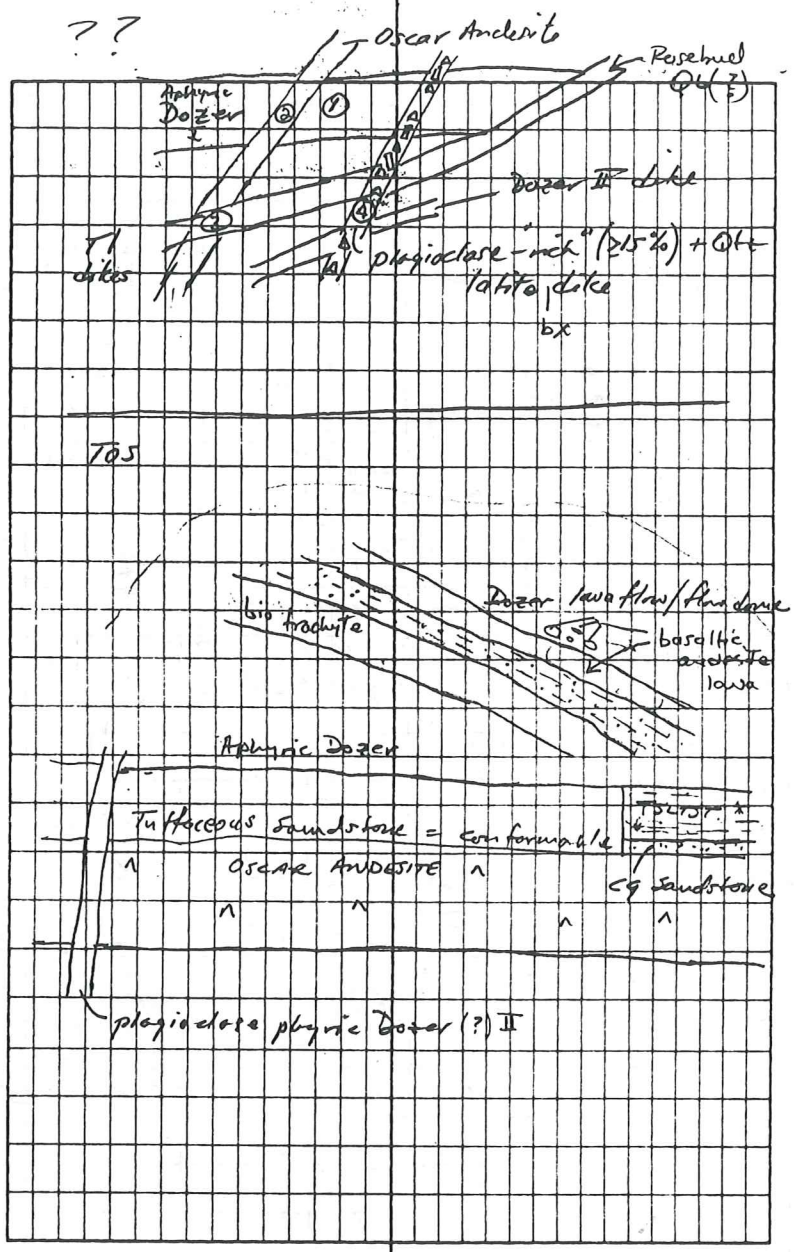
2 dikes, 1 w/ Qtz-San-bio and

1 w/ Qtz ± ?

Stop 3 = xenolithic ? feldspar-rich (bx) dike

fragments = (1) Dozer II pl + coarser grained

cuts Tl dikes + Oscar andesite



NWRA-3626

(195) 12 LBT = 9

Sodalite

only(?) different = no mnbs
± less sanidine, both have bio

Volcaniclastic lacustrine sediments
mass flow deposits ± pumice

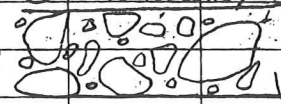
Note: should measure sections here at silicified pebble conglomer. + Eastern and western locations = 3 sections

NWRA-3627

probably trachytic?
Welding w/o much pumice = trachyte = ~900°C
HOT! Lithic rich

LBT?

lithic-rich xl- ± pumice-poor trachytic
13 (196) ignimbrite (?), columnar jointed (both hills) olas



Caldera wall
Collapse bx
(possibly retained in the ignimbrite)

tuffaceous mix w ign

one unit?

Stopped mapping

(?)

(197) 14 Baby ignimbrite from below

NWRA-3628

Fault ?? Epiclastic/volcaniclastic section

Welded Ignimbrite ≈ (14), maybe repeated section?? – Some big blocks = exotic blocks = Spalling off topographic high – less welding around blocks

~~Epiclastic/Volcaniclastic sediments~~

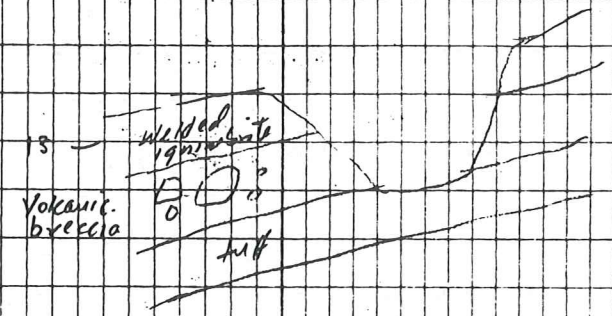
Spherulitic unit w/ zones of flow lineation

LBT (thick)

TOS(?) few feet to few m

Dozer Dikes Dozer I

LAHAR

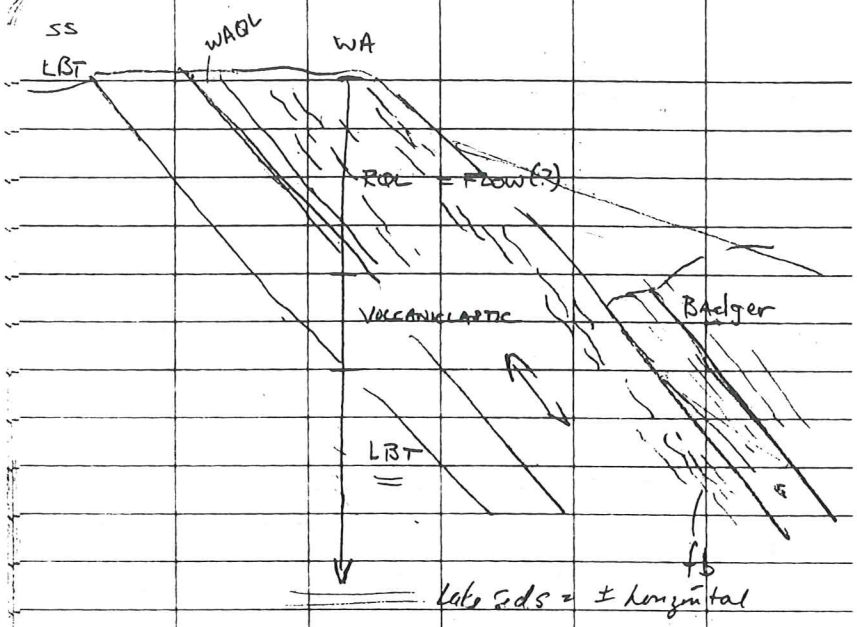


(1) ignimbrites give paleo-horizontal
(2) ignimbrites = planar surface = mappable unit
(3) Calderas w/ multiple flow dome fields + Acu

Spherulites = near edge of lava flow or dome = cool quickly – if cools slowly xln does not radiate outward from points = but more equal xln

Vapor phase alt mostly near the top of the flow/dome

% phenos doesn't vary much in a

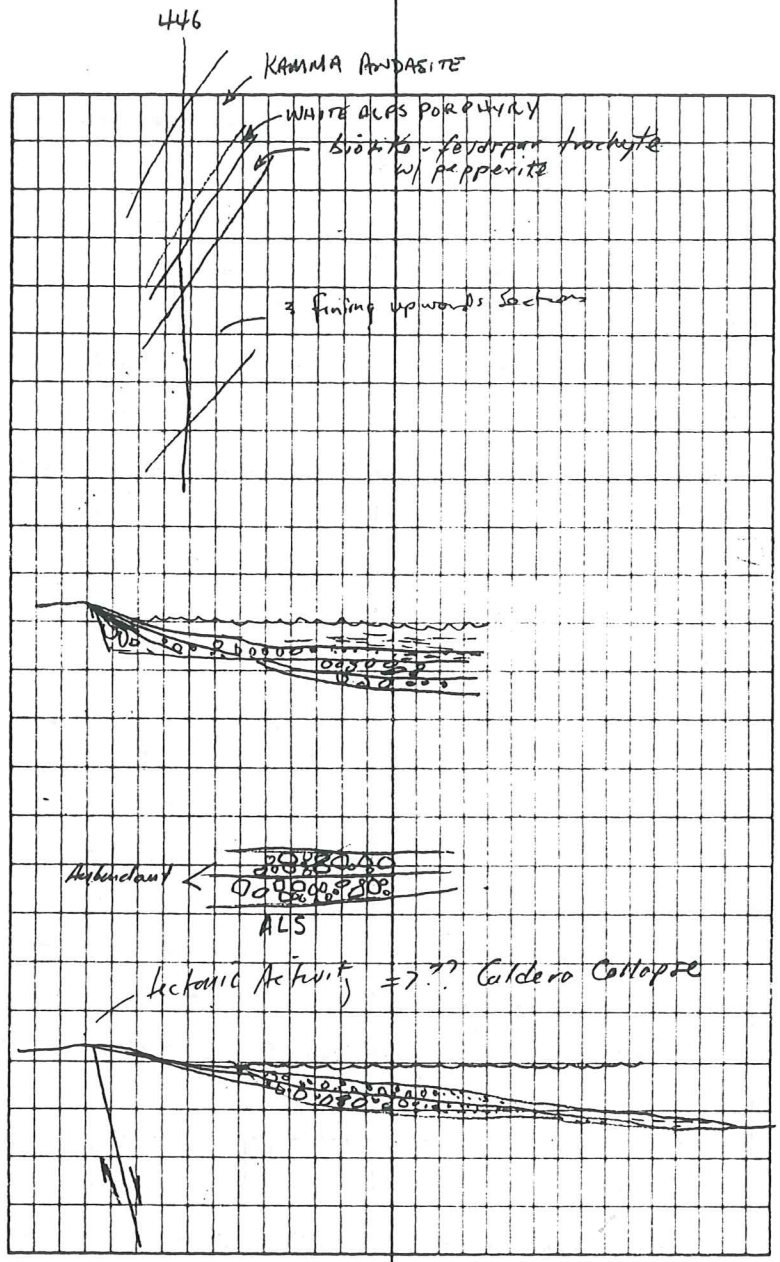


Dozer

Gail – Only use feldspar-bearing or feldspar absent for the dozer – Don't worry about plagioclase or sanidine which we probably can't tell.

(1) Megascopic Identification of volcanic rx

(2) Rock Nomenclature



Randy Barron

	18.00	Basic Wrace Rock	18.00	
	SiO_2	Extended Add on	16.00	
	Al_2O_3			
	TiO_2			
9.00	FeO			
	Fe_2O_3			
	MnO			
	MgO			
	CaO			
	K_2O			
	Na_2O			
	P_2O_5			
	LOI			
		8.00		
6.50	S	Ba	La	
16.00	Cl	Nb	Ni	
18.00	F	Rb	Th	
		Sr		
	Se	Y		
		Zr		

Report
Mulloge

porphyritic hornblende trachydacite lava 3 of 3

$\boxed{6A = NWRA-3620A}$

Phenos

Rosebud Quartz Latite (?) II

3% mafic magma blobs

~ 8% Feldspar

3% Sanidine

5% Plagioclase

≤1% Quartz

1% Smoky

0 Clear

4% Amphibole microphenocrysts

≤1% Magnetite

Rosebud Quartz latite II

5565

trachydacite lava

$\boxed{6B = NWRA-3620B}$

Phenos

Chocolate ! Alkali Rhyolite

1% mafic magma blobs

~ 4% Feldspar

1% Sanidine

3% Plagioclase

10% Quartz

Smoky

10% Clear

7% Amphibole

≤1% Magnetite

CHOCOLATE PEAK
ALKALI RHYOLITE

fine-medium grained gm of feldspar-quartz-Amphibole

FRIDAY 9-10-98

NOTE: IN DDH D-293 (9.9-11.5) = contact between TOS (mine) and LBT. Here the contact occurs over 1.5 to >2.0 feet and looks like a flow bottom to LBT where it is picking up fragments of TOS!

LBT - planar laminated grades into fine-grained massive and vitrophyre phases. The call between fine-grained massive and vitrophyre is a visual call: Usually the vitrophyre is highly fractured, but the fracturing is hydrothermal.

LBT in D-293 has mafic magma blobs, but no sanidine/plag phenos were obvious - possibly they are missing from the fg base and "vitrophyre" portions of the flow.

2096N 4756E } ~~SCREE~~ Rosebud Qtz latite (30%)
Volcaniclastic (10%)
~~LBT (60%)~~

2096N 4752E } ~~SCREE~~ RQL (≥50) / LBT (≤50) } Some slickensides in the float

Mud mix ± = precursor to Badger-like rocks

2096N 4748E } scree RQL = (≤20) / LBT = (≥80) } pf ~ 25' S = LBT in Road cut + Reclaimed.

2096N 4744E } s/pc to scree >95% LBT ≥18" wide
ENE ~60' = HT(?) Breccia Dike w/
At least one visible margin = 065,58E
Near 2096N/4748E (≈ 75' ESE = Slicken-
sides =

NOTE: to WSW in valley = Fault w/ associated bx + silicification = 085,74E, possible slicks = 265,22 rake. Px = LBT/wind Rose

NOTE: ON SW side of the main hill the LBT has columnar JOINTING OVER 15-20' of pc ~⊥ to flow-foliation
Here the LBT has tr feldspar - possibly sanidine, <1% Amphibole and possibly trace Qtz microphenocrysts, none larger than 3mm. no mafics

NOTE: ON TOP OF THE HIGHEST HILL LBT = <1% fp (probably plag) >80% White Clay w/o visible Qtz or Amph. Near flow??

14 = 197 = NWRA-3628 = poorly welded, crystal-bearing (fsp = sanidine? ≈ 1-2%; biotite <1%), lithic-rich, pumiceous ignimbrite

15 = 198 = Georges location

16 = 199 = NWRA-3630 =

17 = 200 = NWRA-3631 = Strongly flow-banded, crystal-poor (tr Amph, tr 1% sanidine?, trace ≤ 1% qtz) alkali rhyolite(?) lava

Badger	900-1000	Qal 0 to > 300'
chocolate flow	+300'	Conglomerate 40 to ≥ 230
chocolate tuff	+300'	Ts lake Sediments 2000
Upper Bud Seq	+300	
Brady Seq	90+26+185	
Lower Bud	+1000'	
Dozer	250-1800'	
TOS	0-50'?	
TCS	0-100'	

42½ = 1700' = 168.5

250' = 37.7

10.09

33.8

oscar seq

Rheomorphic Ignimbrite > 700' 213m

white tuff 90

Tuffaceous silt & mst 190 > ~230' 27m 43m > 70m

ALS pebble Congl ~250' (76m)

Tuffaceous silt/mst/sl + tuff > 2000' (610m)

1" = 500'

1" = 400' = 1:4800

1" = 200' = 1:2400

≥ 2000'	(610m)	Tuffaceous silt, mst, ss w/ intercalated pumiceous bx
~250'	(76m)	ALS pebble Conglomerate
~140'	(43m)	tuffaceous silt + mst > ~230' (70m)
~90'	(27m)	white tuff
> 700'	(213m)	Rheomorphic Ignimbrite

≥ 3180' (969m)

Fault — Fault

FRIDAY 9-10-98

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~ 90'	(27m)	white tuff
> 700'	(213m)	Rheomorphic Ignimbrite

≥ 3180' (969m)

Fault — Fault

NOT = flow!

7 = 190 = NWRA-3621 (= 3620A) > porphyritic hornblende trachyandesite lava

Rosebud Quartz Latite (?) – III

6A = 189A = NWRA-3620A — porphyritic hornblende trachydacite lava

Rosebud Quartz Latite (?) – II

6B = 189B = NWRA-3620B — trachydacite lava

Chocolate Peak Alkali Rhyolite

8 = 191 = NWRA-3622

Wild Rose alkali rhyolite – I (?) — trachydacite lava

9 = 192 = NWRA-3623

Wild Rose alkali rhyolite – I (?) — trachydacite lava

	6A	6B	7	8	9
mafic magma blobs	3	1	0	0	1
Feldspar	8	4	6	3	2
Sanidine	3	1	1		≤1
Plagioclase	5	3	5		≥0
Quartz	≤1	10	2	?	≤1
Smoky	0	0	0		0
Clear	≤1	10	2		≤1
Amphibole	4	7	5	?	4
Pyroxene	0	0	0	?	0
Magnetite	≤1	≤1	4	?	4

Phenos

Groundmass

6A — plagioclase, sanidine, Quartz, amphibole; fine-med gr

6B — "

7 — feldspar, Quartz, Amphibole; Cryptocrystalline v. fine-grained

8 — cryptocrystalline to glassy

9 — feldspar, Quartz, Amphibole; fine- to medium-grained

Spotted – maybe plagioclase ⇒ pl ≈ 40%

FRIDAY 9-10-98

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NOTE: ON TOP OF THE HIGHEST HILL LBT = <1% fp (probably plag → Bo white Clay) w/o visible Qtz or Amph. Near flow??

From: Odin Christensen
To: Dow, John
Date: Mon, May 3, 1999 6:57 AM
Subject: Request from Tom Westerveld to present paper on Mesel

I had a message on my voice mail today from Dr. Tom Westerveld of Fort Lewis College in Durango. You will recall that Newmont employed Tom three years ago to present classes in structural geology and do a structural study of the Mesel deposit and Ratatotok district. He will also be presenting a structural geology course to our geologists in Carlin later this month.

Tom has arranged to make a presentation to the **Barrick** geologists on the Mesel deposit. He just wanted to check with me to see if this is OK. I do not see a problem. We have already talked a lot about the deposit, and Steve Garwin published most of the information compiled in his district review. Most of what Tom found was pretty deposit-specific and not of direct exploration significance. Still, everything Tom knows he learned while in Newmont's employ.

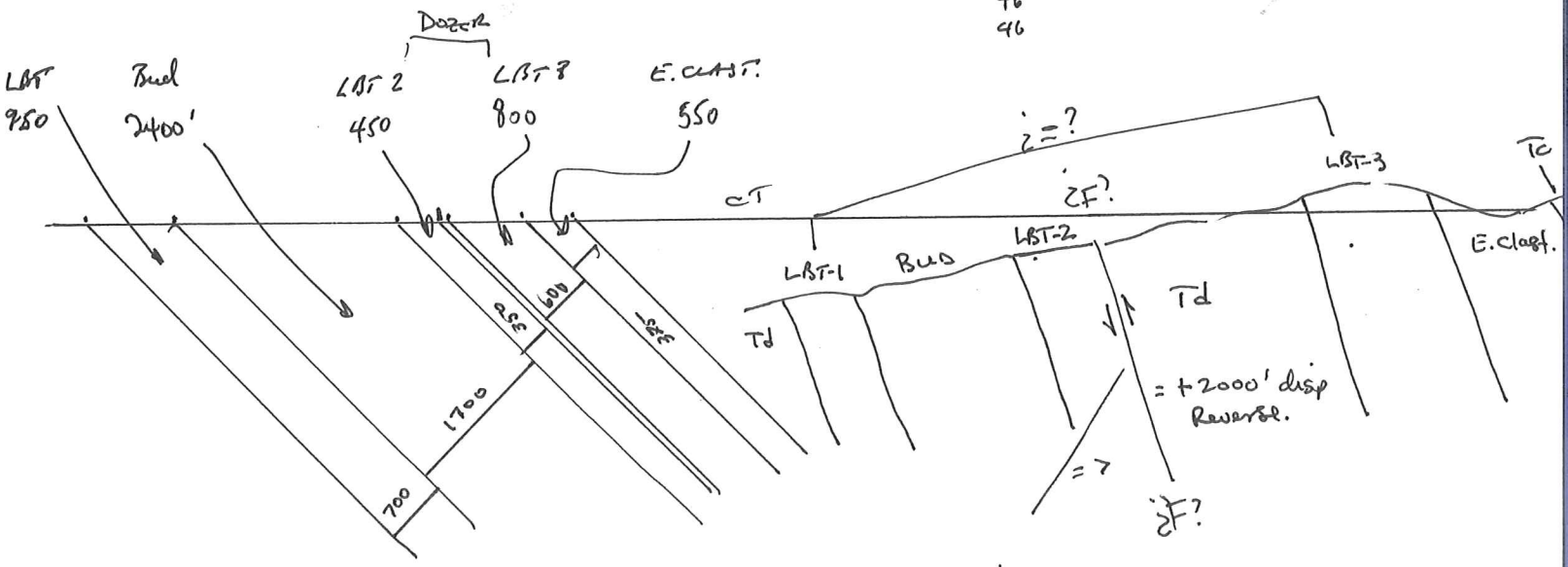
What should I tell Tom? I ask you John, since this crosses a number of areas of responsibility within our exploration organization.

Odin Christensen
Chief Geologist, Newmont Gold Company
10101 East Dry Creek Road
Englewood Colorado 80112
(303) 708-4164
(303) 708-4060 fax
e-mail: ochr6093@corp.newmont.con

TSH talk = 1180

31
40
42 ~ $\bar{x}$ = 45°
63
53
44
47
46
46

CC: Krol, Leendert, Mitchell, Peter



Qal = Lemon Yellow = 735 ½

Qc | Qoa = Goldenrod = 755

Tlb = Pêche clair = 757
Light peach

Tbg = Warm Grey = 734 ½

Tc = Tuscon Red = 746 ½

WAP = Dahila Purple = 752

Ka = Grass Green = 738

RQL = Parma Violet = 742 ½

LP = True Green = 751

Tbud = Apple Green = 738 ½

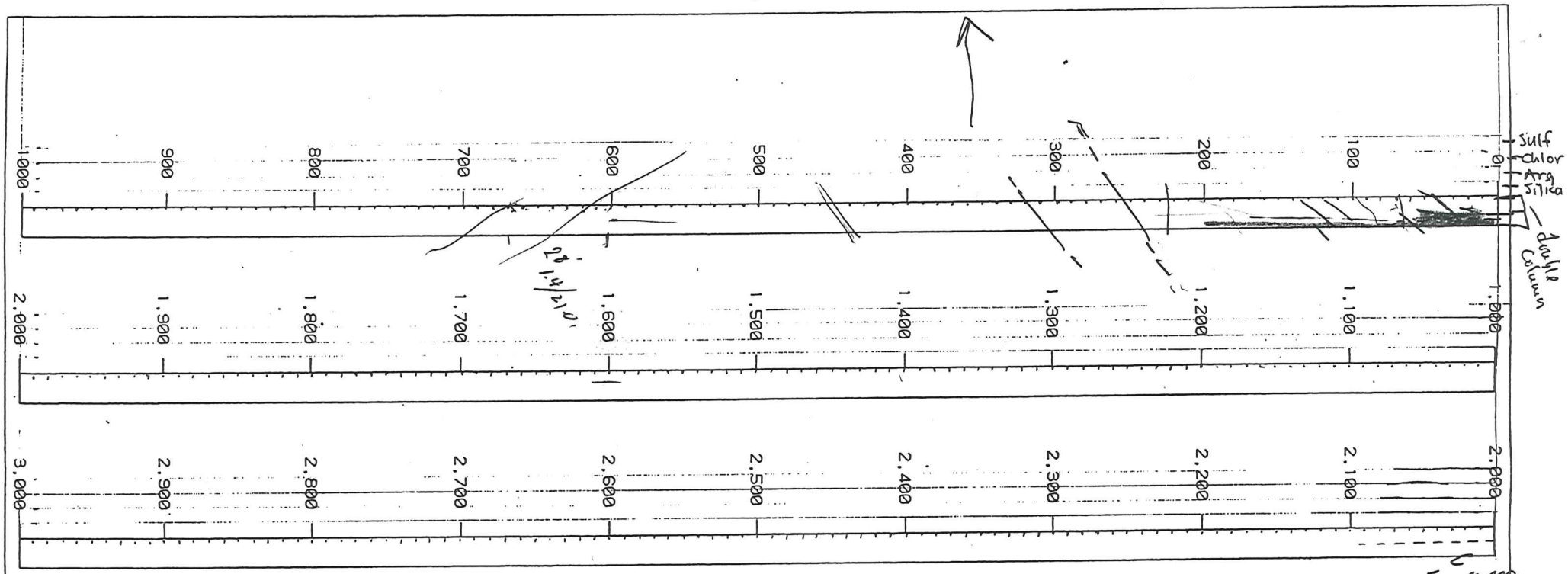
T Lbt = Process Red = 743 ½

Tos = Aquamarine = 737 ½

Td = Orange = 737

Toscar = Olive Green = 739 ½

ALS = Cool Grey = 747 ½



LITHOLOGY

- PLAT/FLOW
- MASSIVE AT/FLOW
- LST
- PMBX
- TOS/BUD Epiclastics
- BMB - Rhyolitic Porphyry
- RHYOLITE - DOZER
- ALS - PHYLLITES

TEXTURES

- LITHIC FRAGMENTS
- CRYSTALS
- LAPILLI
- AMYGDULES orange = 737
- Goldenrod = 755
- SPHERULITE
- light blue 741½
- SHARDS

STRUCTURES

- BRECCIA
- FAULT 741 Indigo Blue
- CLAY OR GOUGE
- FRACTURE ZONE
- VEINS Qtz
- sulfide Veins
- VEINLETS more Py
- VEINS CALC

F/f 80

CONTACTS

- LOST, GRADATIONAL OR INFERRED
- SHARP (WITH ANGLE TO CORE)
- WAVY
- ROUGH OR JAGGED

PYRITIZATION
CHLORITIZATION
ARGILLIZATION
SILICIFICATION 737
747½

GRAPHIC LOG

ALTERATION Intensity

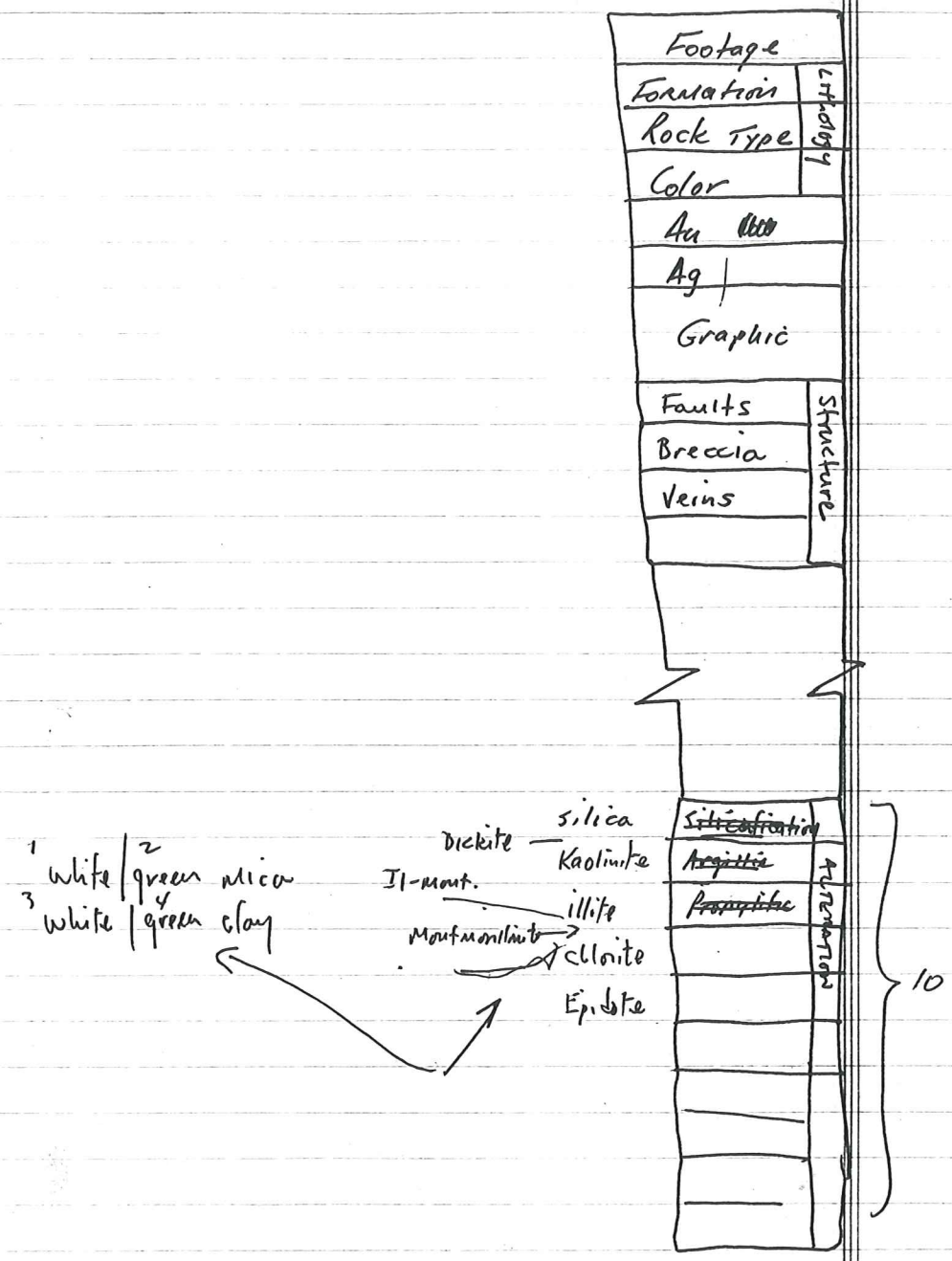
LOCATION ON GRID:	~~FINAL~~ COLLAR COORDINATES	START	FINISH	~~LOGGED BY~~ Smaller
	NORTH	HOLE TYPE	SURVEYED TO	
LAB	EAST			
JOB #	ELEV	BEARING	ANGLE -60	T. D.
DRILLING COMPANY	DRILLER			

Smaller

The Rosebud Mining Company LLC

PAGE 1 OF Smaller

HOLE # Big


Footage
Formation
Rock Type
Color
Lithology
Au
Ag
Graphic
Faults
Breccia
Veins
Structure
silica
Dickite
Kaolinite
illite
Il-mont.
Montmorillonite
chlorite
Epidote
Alteration
10
1 white | 2 green mica
3 white | 4 green clay

Newmont Gold Rotary Form

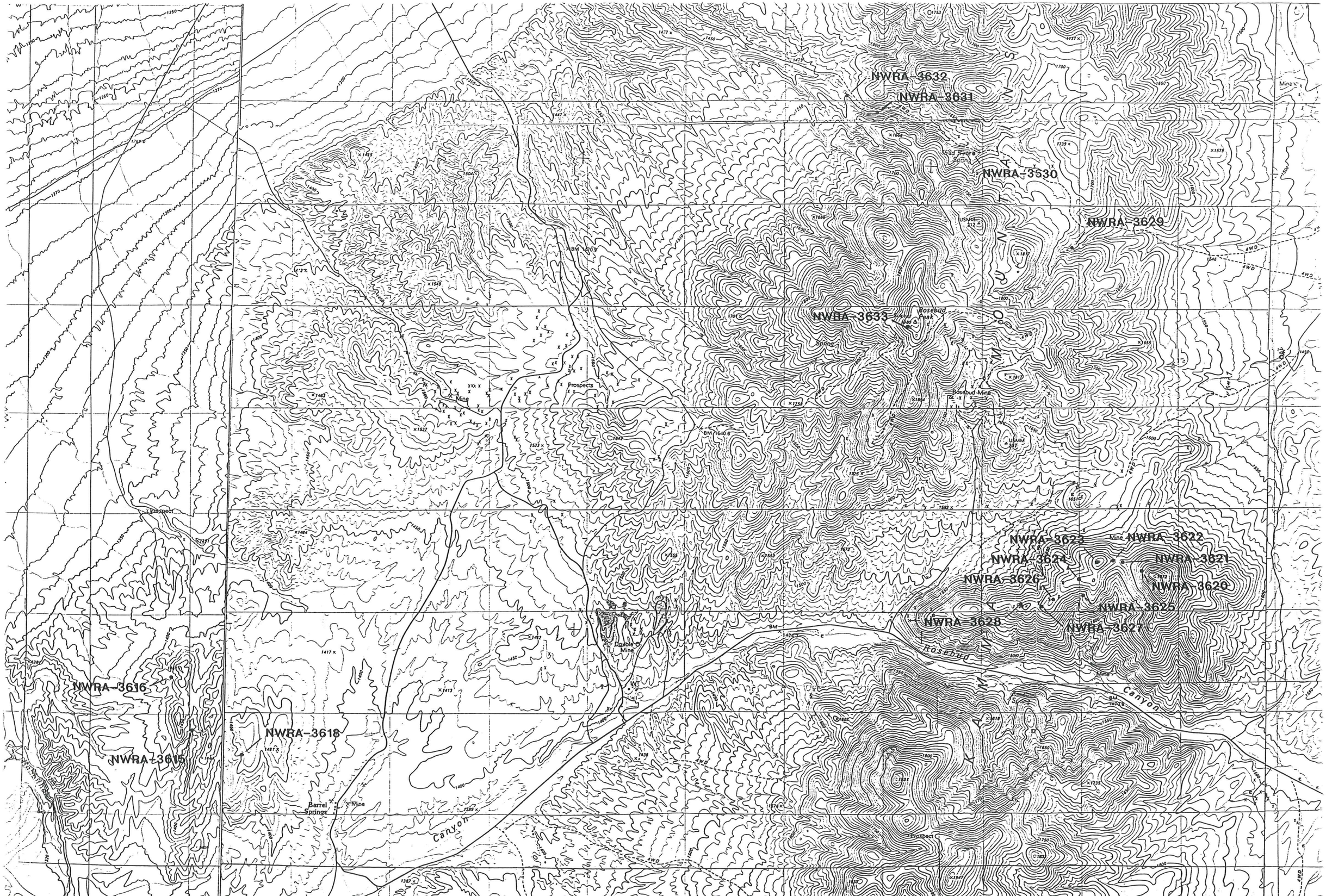
Hole# _____ Logged by _____ Date _____

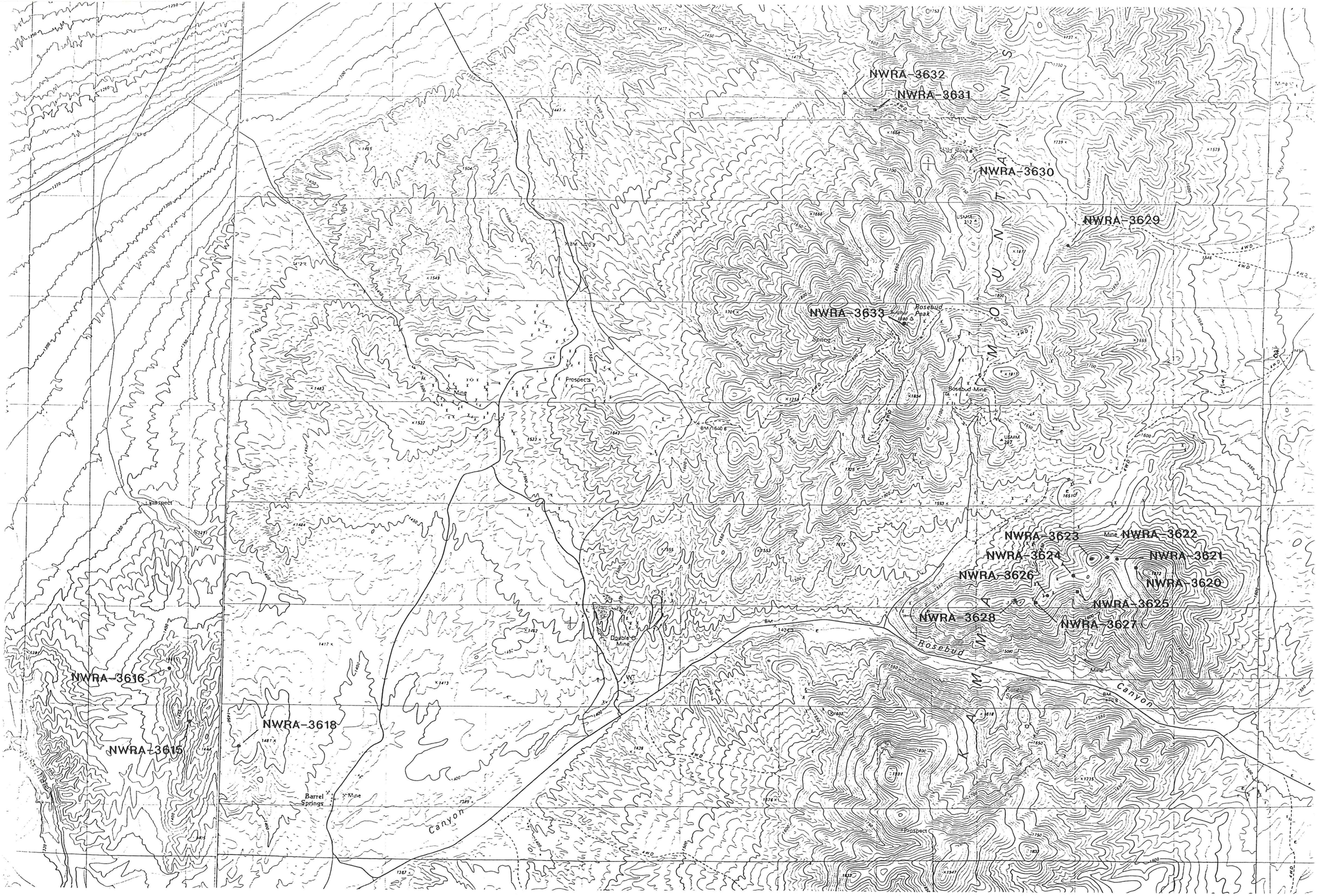
Area _____ Coords N- E- El-

Az/Incl _____ Total Depth _____ Contractor _____

Page ____ of ____

Footage	Litho: Formation	Litho: Rock type	Litho: Color	Au oz/st	Ag oz/st	Graphic	Structure: fault	Structure: breccia	Structure: vein	[redacted]	Comments	Alteration: Silic	Alteration: argillic	[redacted]	Alteration: prop	[redacted]	Alteration: [redacted]	Alteration: Green clay	Alteration: White clay / mica / mica	Met.: FEOX	Met.: CO3	[redacted]	Mineralogy: Pyrite %	Mineralogy: Marcasite	[redacted]	[redacted]
																	X									
													Orange = 73													
															Trul Green = 75											
													74 7½ Dark grey													


NWRA-3632
NWRA-3631
NWRA-3630
NWRA-3629
NWRA-3633
NWRA-3623
NWRA-3622
NWRA-3624
NWRA-3621
NWRA-3626
NWRA-3620
NWRA-3625
NWRA-3628
NWRA-3627
NWRA-3616
NWRA-3618
NWRA-3615
Rosebud Peak
Rosebud Mine
Prospects
Mine
Spring
Double G Mine
Barrel Springs
Rosebud Canyon
Canyon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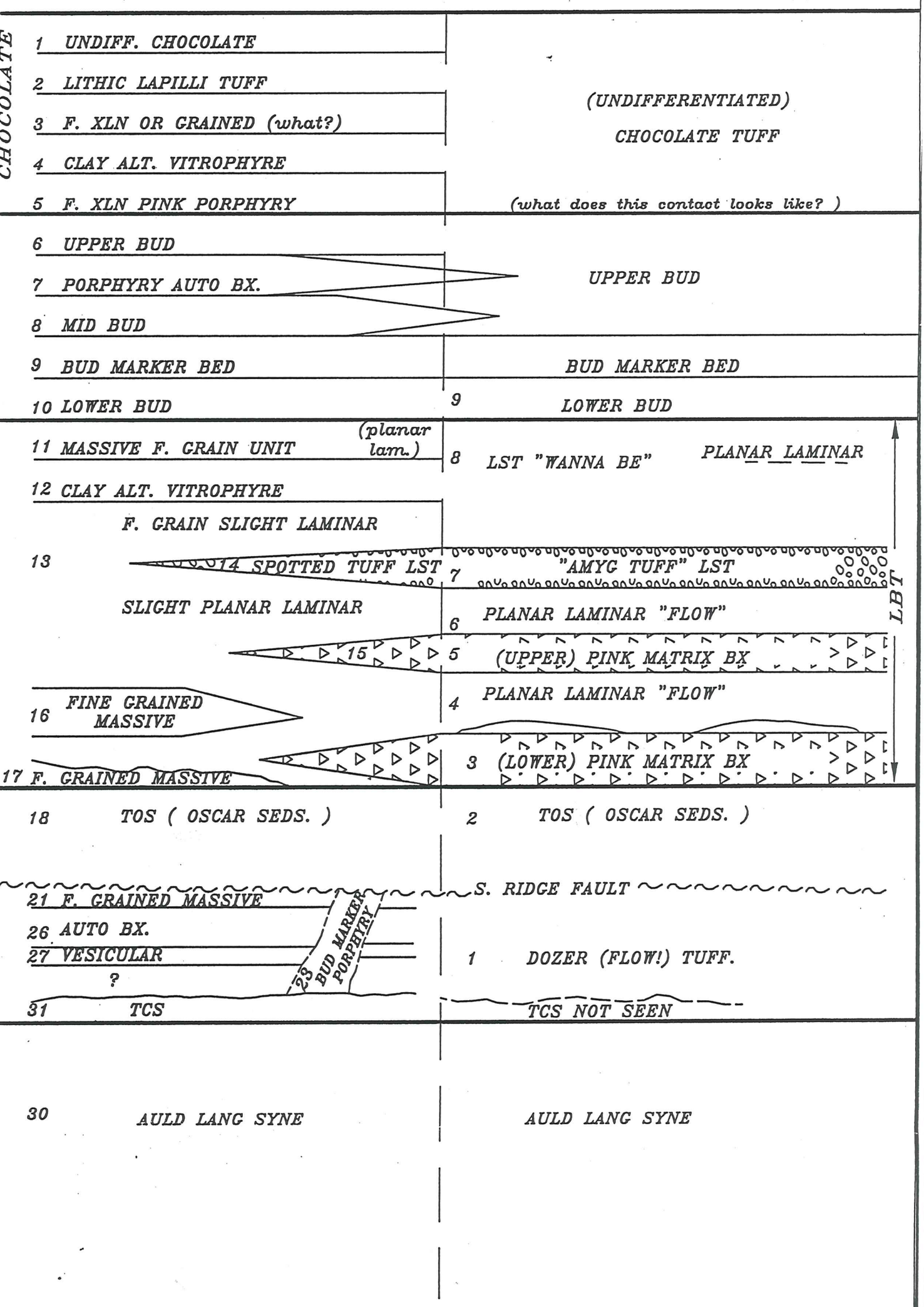
NWRA-3624
NWRA-3621
NWRA-3626
NWRA-3620
NWRA-3625
NWRA-3628
NWRA-3627
Rosebud
Canyon
Double O Mine
NWRA-3616
NWRA-3618
NWRA-3615
Barrel Springs
Canyon
Prospect

ROSEBUD STRATIGRAPHY

GROUP	FORMATION	MEMBER	COMPOSITION
LOWER SULFUR GROUP		ALLUVIUM, ELUVIUM FANGLOMERATE, COLLUVIUM, TALUS	
		CAMEL CONGLOMERATE	
		LACUSTRINE DEPOSITS	
KAMMA MOUNTAINS VOLCANIC GROUP	CHOCOLATE FORMATION	KAMMA "ANDESITE"	
		ROSEBUD SILL	Trachydacite
		BAGER MEMBER	
		CHOCOLATE LAPILLI TUFF	
		CHOCOLATE LAVAS	Trachydacite
		ROSEBUD MEMBER	Trachydacite
		SOUTH RIDGE LAVAS	Trachydacite
		BUD MEMBER	Rhyolite
		LBT LAVAS	Trachydacite
		MINE TOS	
	DOZER FORMATION	WILD ROSE MEMBER	Alkali Granite
		DOZER MEMBER	Alkali Granite
	OSCAR FORMATION	OSCAR COLLUVIUM	
		OSCAR "ANDESITE"	
		OSCAR MEMBER	
	BARREL SPRINGS FORMATION	BARREL SPRINGS MEMBER	Rhyolite
		RABBITHOLE CREEK MEMBER	Rhyodacite
		RABBITHOLE RIDGE MEMBER	Rhyodacite
AULD LANG SYNE GROUP	UNDIFFERENTIATED		

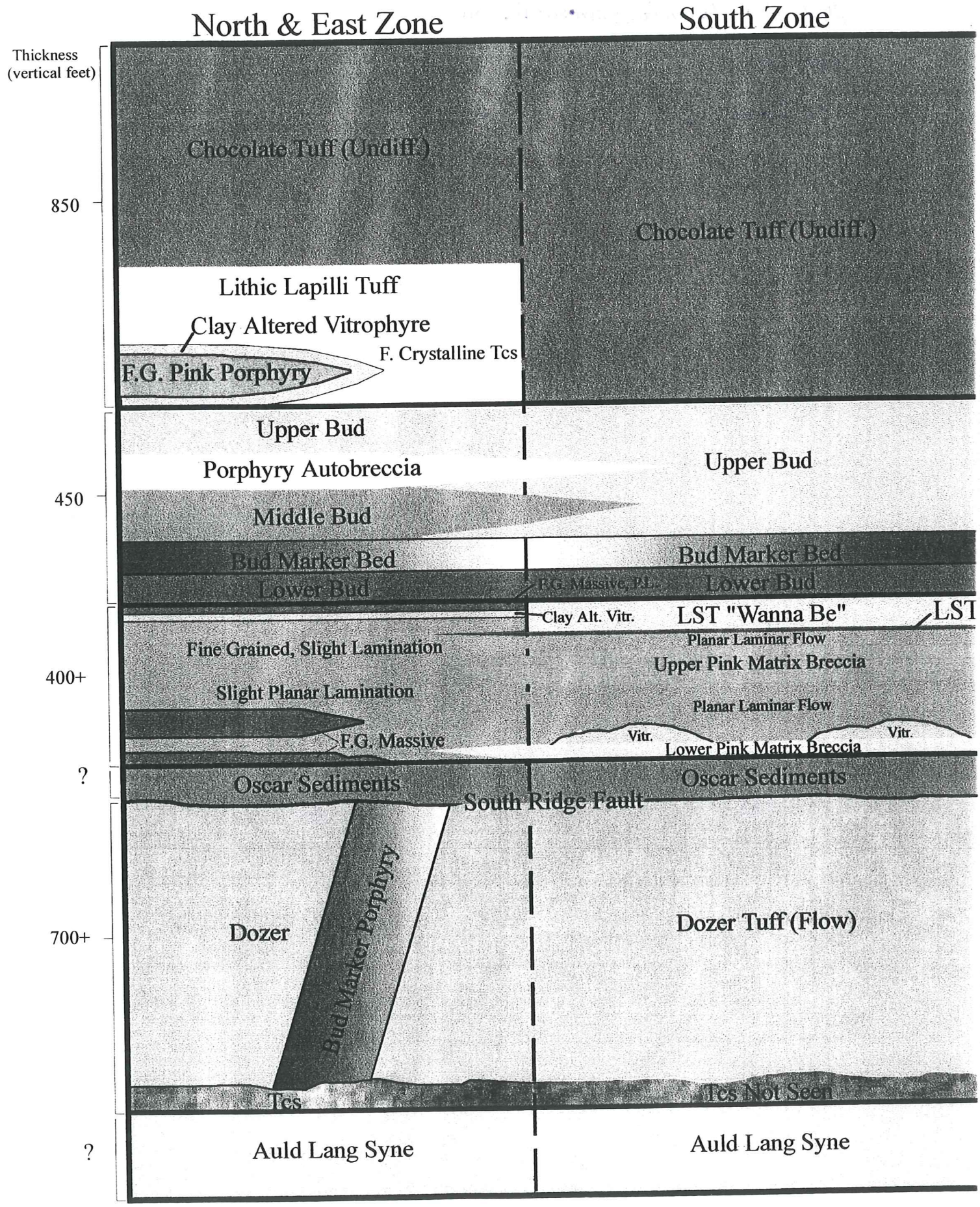
STRATIGRAPHIC CORRELATIONS

MINE STRATIGRAPHY		DISTRICT STRATIGRAPHY	
SOUTH ZONE	NORTH AND EAST ZONES	MEMBER	FORMATION
SULFUR GROUP UNDIFFERENTIATED			
MARKER PORPHYRIES		KAMMA "ANDESITE"	CHOCOLATE
		ROSEBUD SILL	
Not Present		BADGER MEMBER	
CHOCOLATE TUFF UNDIFFERENTIATED	CHOCOLATE TUFF UNDIFFERENTIATED	CHOCOLATE LAPILLI TUFF	
	LITHIC LAPILLI TUFF		
	FINE CRYSTALLINE TCS	CHOCOLATE LAVAS	
		ROSEBUD MEMBER	
	VITROPHYRE	SOUTH RIDGE LAVAS	
UPPER BUD	UPPER BUD	BUD MEMBER	
	PORPHYR AUTOBRECCIA		
	MIDDLE BUD		
LOWER BUD			
FINE-GRAINED MASSIVE, PLANAR LAMINATED		LBT LAVAS	
LST "WANNA BE"	VITROPHYRE		
LST	FINE-GRAINED, SLIGHT PLANAR LAMINATED		
UPPER PINK MATRIX BRECCIA			
PLANAR LAMINATED	FINE-GRAINED MASSIVE		
VITROPHYRE	SLIGHT PLANAR LAMINATED		
LOWER PINK MATRIX BRECCIA	FINE-GRAINED MASSIVE		
OSCAR SEDIMENTS		MINE TOS	
DOZER		WILD ROSE MEMBER	DOZER
		DOZER MEMBER	
TCS		OSCAR MEMBER	OSCAR
AULD LANG SYNE UNDIFFERENTIATED			



Note: LBT is NOT Lower Bud Tuff

ROSEBUD MINE STRATIGRAPHY



Kamma Mountain Volcanic Group

Sulfur Group

~~[illegible]~~

Chocolate Formation

(dome-building)

Dominantly effusive alkali granite and trachydacite volcanism punctuated by rhyolite pyroclastic eruptions, ~~and~~ mass wasting and erosion. The pyroclastic ~~rocks~~ and volcaniclastic rock were deposited in inter ~~and~~ ~~the~~ dome ~~and~~ valleys and regional lakes. ~~lakes~~

	Kamma "Andesite"		
	Rosebud Sill	trachydacite	
	Badger Member	Volcaniclastic, lahar, debris flow, tuff and lava	composition??
(203)	~~Chocolate Peak lava~~	trachydacite	Combine (hornblende + biotite + sanidine)
(204)	Chocolate lava	trachydacite	
(21)	Rosebud Member	trachydacite lava, tephra fall and volcaniclastic debris	
(22, 23)	South Ridge Lava	trachydacite	
(24)	Bud Member	rhyolite	
(26)	LBT Lava	trachydacite	biotite ± no hbn + sanidine

where?? White Alps porphyry

Dozer Formation

	Flow dome Complex		
	Wildrose lava dome	und.	alkali granite
(25A)	Eastern lava dome	und.	alkali granite
(25B) Dozer	Western lava dome	und.	alkali granite
	Flow dome Complex		

Oscar Formation

Mine TOS Member
Oscar Andesite lava
Oscar Member

Barrel Springs Formation

		clastic (ALS) conglomerate, sprit volcaniclastic lacustrine deposits
	Barrel Springs Member	rhyolite vitric lapilli tuff
	Rabbithole Creek Member	rhyodacite crystal vitric tuff
	Rabbithole ~~[illegible]~~ Ignimbrite	rhyodacite recrystallized ignimbrite
	Tephra?	

ALS

Rosebud Mining District

Stratigraphy (Mapable units)

Sulfur Group

CHOCOLATE FORMATION (trachydacite)

KAMMA "ANDESITE" ( )
Rosebud Trachydacite intrusion (sill or laccolith)
Badger Member
Chocolate ~~Member~~ Lavas
Rosebud Member
South Ridge ~~Member~~ Lavas
Bud Member (Rhyolite)
LBT ~~Member~~ Lavas

Kamma Mountains Volcanic Group

Dozer Formation (alkali granite)

WILDROSE (Member Lava Domes)
Dozer (Member Lava Domes)

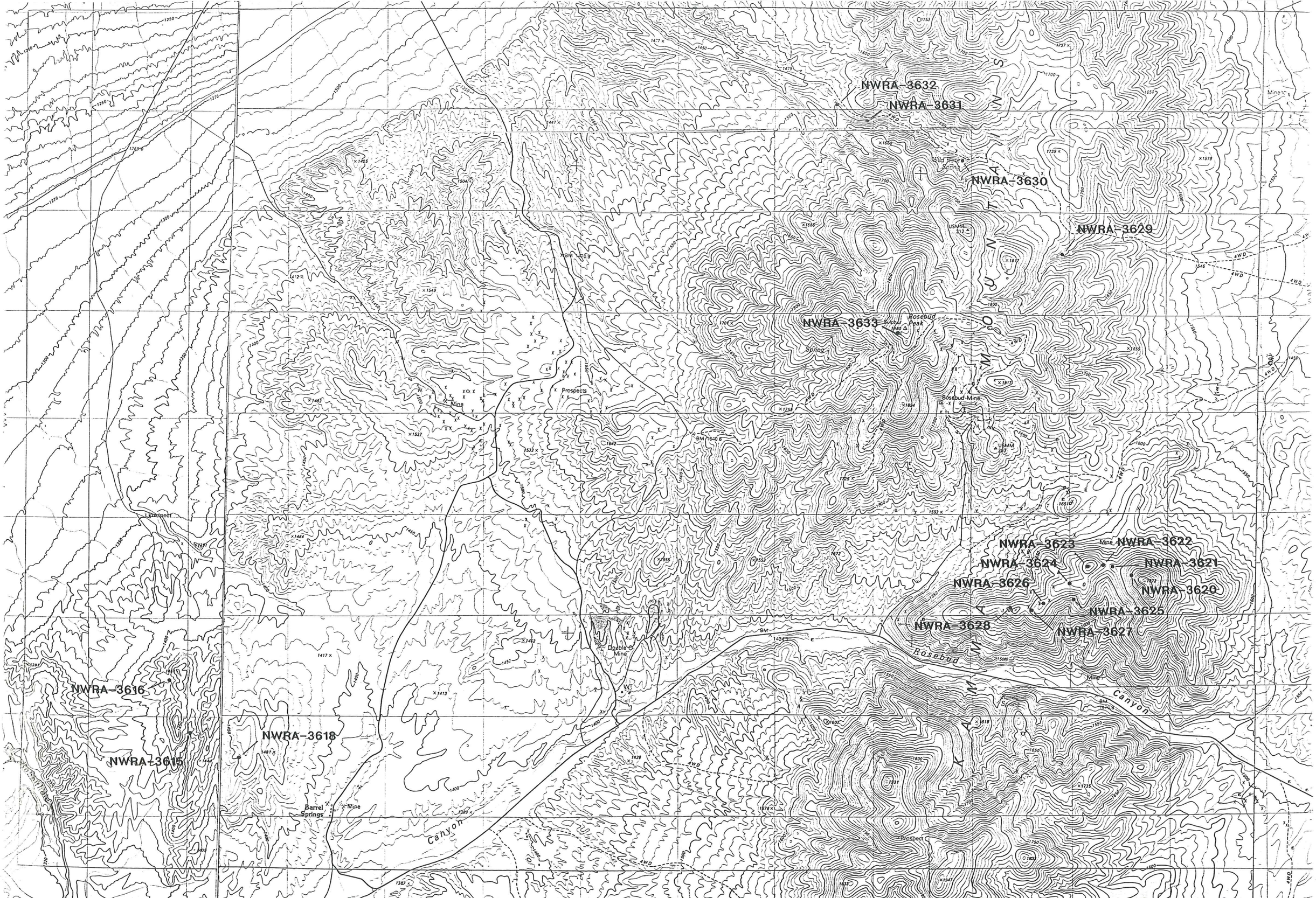
Oscar Formation

Mine TOS Member
Oscar "Andesite"
Oscar Member

Borrel Springs Formation (Rhyodacite)

Borrel Springs Member (Rhyolite)
Rabbithole Creek Member
Rabbithole Ridge Member

Auld Lang Syne Group


NWRA-3632
NWRA-3631
NWRA-3630
NWRA-3629
NWRA-3633
NWRA-3623
NWRA-3622
NWRA-3624
NWRA-3621
NWRA-3626
NWRA-3620
NWRA-3625
NWRA-3628
NWRA-3627
NWRA-3616
NWRA-3618
NWRA-3615
Rosebud Peak
Rosebud Mine
Spring
Prospects
Mine
Prospect
Double O Mine
Barrel Springs
Rosebud Canyon
Canyon
USMM 212
USMM 207
BM 1600
BM 1429

"Gail Mahood" Section

DOZER IV	ALKALI GRANITE DOME		
CHOCOLATE PEAK ALKALI RHYOLITE	ALKALI RHYOLITE	≥ 50 m	Chocolate Flow
ROSEBUD QUARTZ LATITE	QUARTZ LATITE LAVA FLOW		
	LACUSTRINE VOLCANICLASTIC AND PYROCLASTIC DEPOSITS		Upper Bud Seq
	OBSIDIAN TO CRYPTOCRYSTALLINE	LBT IV = mmbs !	
	TRACHYTE LAVA FLOW		
	SPHERULITIC TRACHYTE LAVA FLOW		
	LACUSTRINE VOLCANICLASTIC DEPOSITS		
	LAHAR		
	TALUS BRECCIA		
	AUTOBRECCIA		
DOZER III	ALKALI GRANITE DOME	≥ 1150' (≥ 350 m)	
	TRACHYTE LAVA FLOW (LBT III)	No mmbs	Bubby Seq / Mini Hoff Seq
	VOLCANICLASTIC (MASS FLOW) DEPOSITS LACUSTRINE		
	TRACHYTE LAVA FLOW (LBT II)	No mmbs	Lower Bud Sequence
	LITHIC-RICH, CRYSTAL- AND PUMICE-POOR TRACHYTE IGNIMBRITE DENSELY WELDED		
	COLLAPSE BRECCIA		
	MODERATELY WELDED IGNIMBRITE		
	VOLCANICLASTIC DEPOSITS		
	MODERATELY WELDED IGNIMBRITE		
	VOLCANICLASTIC DEPOSITS		
	SPHERULITIC FLOW		
WILD ROSE (LBT)	TRACHYTE FLOW	> 350' (> 100 m)	No mmbs
	TUFFACEOUS SANDSTONE AND SILTSTONE	(< 15')	
DOZER I	APHYRIC ALKALI GRANITE DOME	> 490' (> 150 m)	Dozer Rhyolite
	TUFFACEOUS SANDSTONE AND SILTSTONE	— TUFFACEOUS SILTSTONE — COARSE-GRAINED SANDSTONE	
OSCAR ANDESITE	TRACHYTE LAVA FLOW (TOS)		TOS — Oscar Seq
TCS	LAHAR		TCS

Lacustrine tuffaceous mst, siltst, ss interbedded lake turbidites and vitric, crystal pumiceous tuffs

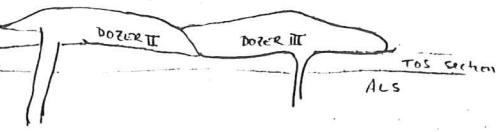
ALS pebble congl. Beach log

Lacustrine tuffaceous mst-siltst

Rheomorphic Ignimbrite

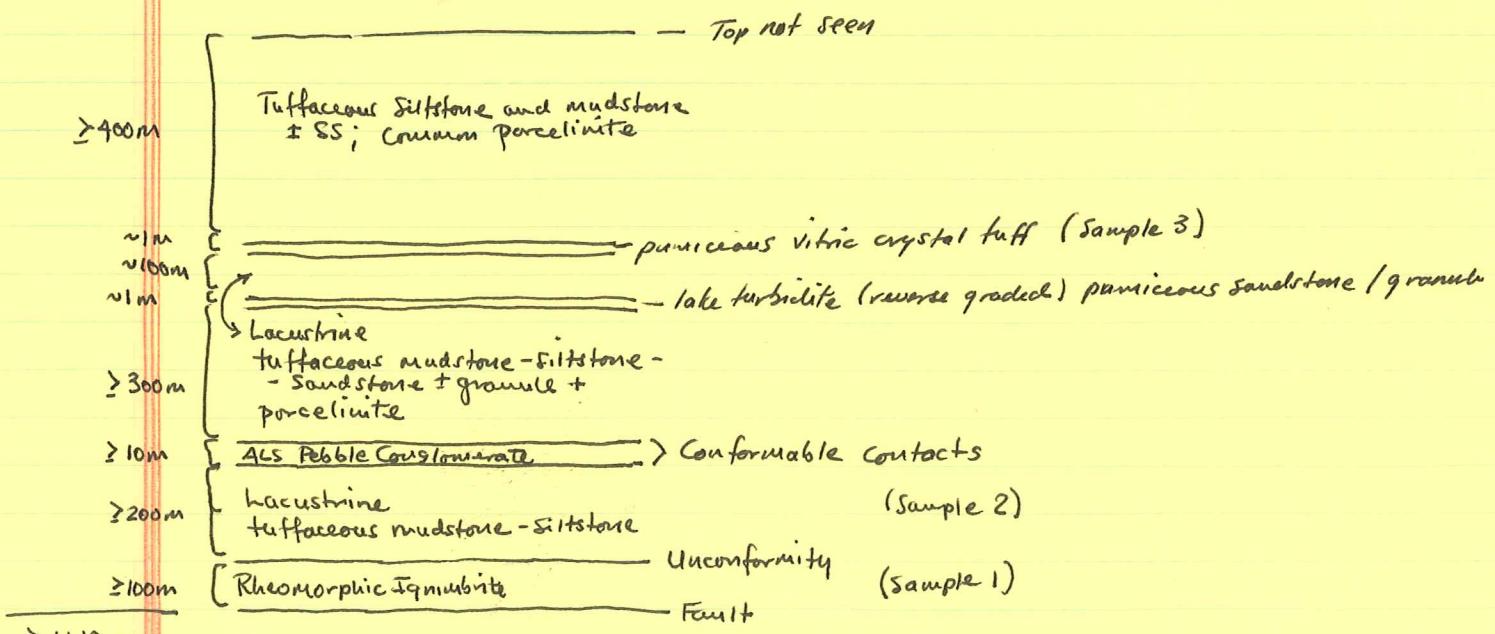
Guess = No Repeated Section

FAULTING FOLLOWED DOZER DOME EVENT(S)



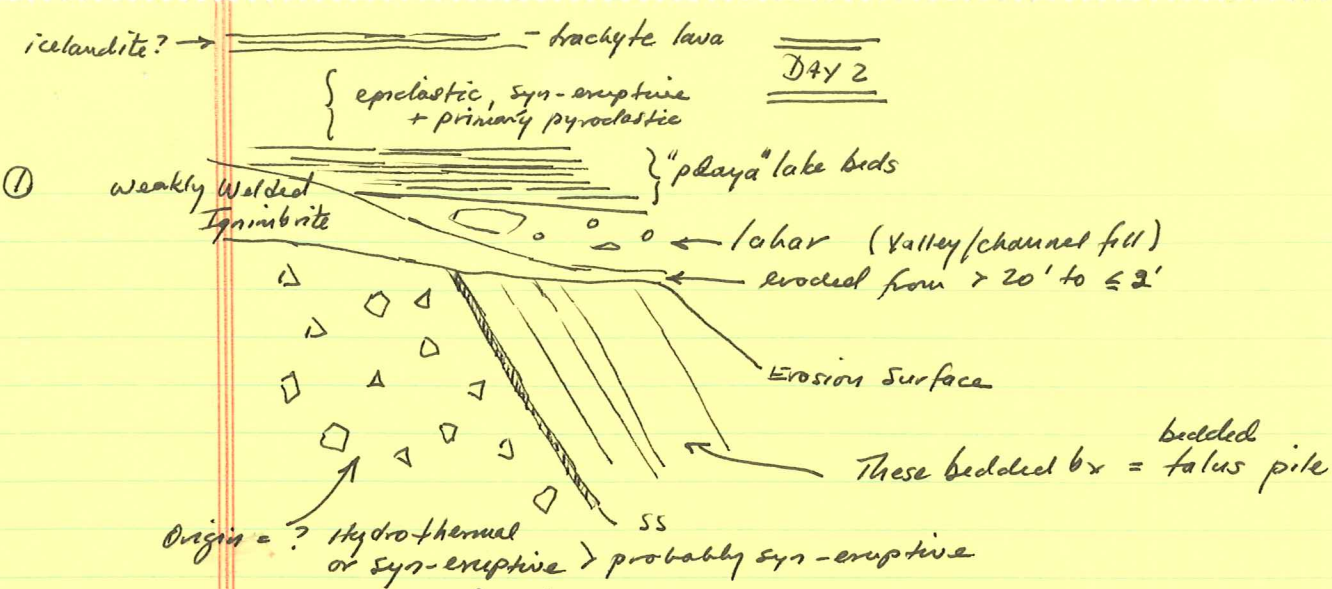
DAY 1

HAND SAMPLE	Rock / UNIT
1	Rheomorphic Ignimbrite / Barrel Springs Fm, Rabbithole Creek Member, >100m Ignimbrite that began to flow, holes are probably lithophysae, spherulites lithophysae = re-vesiculation due to entrained magmatic gas, sanidine-bio-qtz Densely welded 1 = v. hot magma or 2 = proximal to vent, Lithics = ? maybe vent material or mafic/intermediate magma blobs = look for flatening + crenulated margins, not angular (need fiamme-like edges)
2	Rhyolite-dacite (?) dike, tr to <1% Quartz => probably a trachyte = fall out tuff or lava
3	Tuffaceous Mudstone
4	Pumiceous vitric crystal tuff
5	Flow banded trachyte (comendite) lava



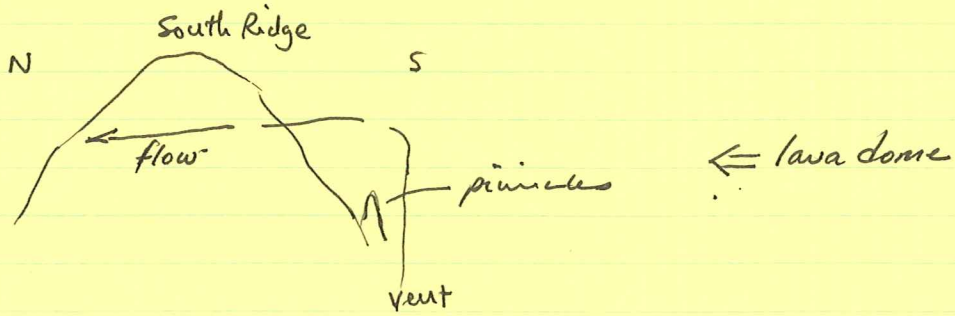
DAY 2

①

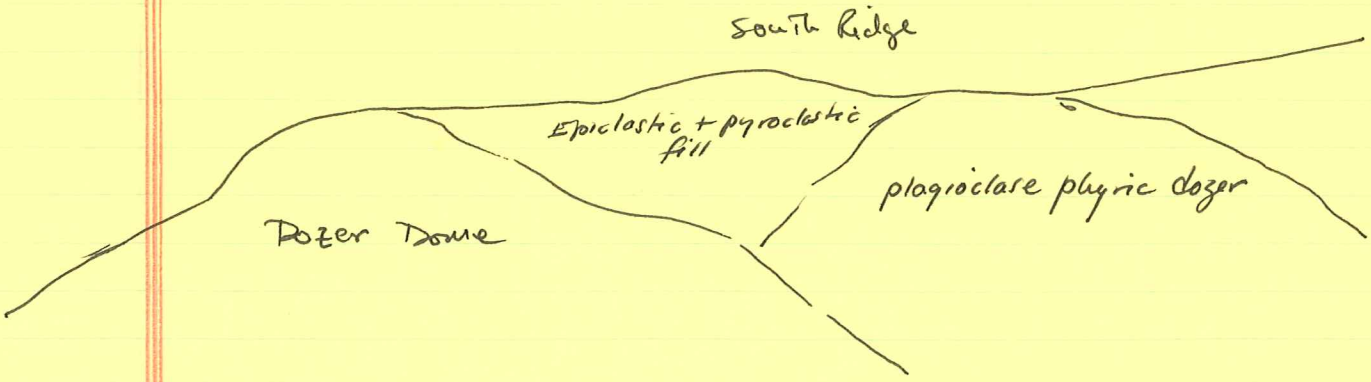


1. Rotation of the Dozer ~ 35° prior to erosion
2. Deposition of the weakly welded ignimbrite + overlying epiclastic rx

② Flow-banding at the Pinnacles is nearly vertical implies near vent



Map
1. erosional surface
2. weakly welded ignimbrite
3. epiclastic sequence
4. trachyte lava



DAY 2

Gorilla trachyte (?) not = Rosebud Quartz Latite
intrusive plug

trachyte breccia = probably syn-eruptive volcanic breccia "spalling-off" a lava dome = debris apron not a lava dome deposit/breccia
= not hot @ deposition & accumulation

Laminated rocks near road bend = trachyte lava flow or part of a lava dome

DAY 3

Quartz Latite

Lacustrine volcaniclastic ± pyroclastic rocks (relatively coarse-grained)

LBT Vitrophyre / microcrystalline (mmbs)

Lacustrine volcaniclastic rocks + spherulitic lava flow (relatively fine-grained)

Lahar (multiple units)

medium to thick bedded talus breccia (dominantly Dozer fragments)

Erosional Surface

Dozer lava dome (auto-brecciated dome margin)

Saddle

LBT (no mmbs)

~~Vole~~ Lacustrine volcaniclastic rocks (mass flow deposits)

LBT (?) (v. thin)

Lithic-rich, crystal-poor trachytic ignimbrite

~~too~~, Volcanic breccia with tuffaceous matrix

Densely welded

Lithic-rich, crystal-poor trachytic ignimbrite

one unit?

Lacustrine volcaniclastic rocks ← Fault

Fault? →

Densely welded ignimbrite (some big blocks)

Lacustrine volcaniclastic rocks

Saddle

LBT (v. thick)

~~Lahar~~ Lahar (?)

Dozer lava dome

Lahar

DAY 3

Qtz Latite

Lacustrine volcaniclastic rx

LBT

Lacustrine volcaniclastic rx

Lahars

talus breccia

Erosional Surface

Dozer lava dome

LBT

Lacustrine volcaniclastic rx

ignimbrite

L. volcaniclastic rx

LBT

Lahar

Dozer lava dome

LBT

Lahars + ignimbrite

Dozer Dome

WEDNESDAY 7-10-98

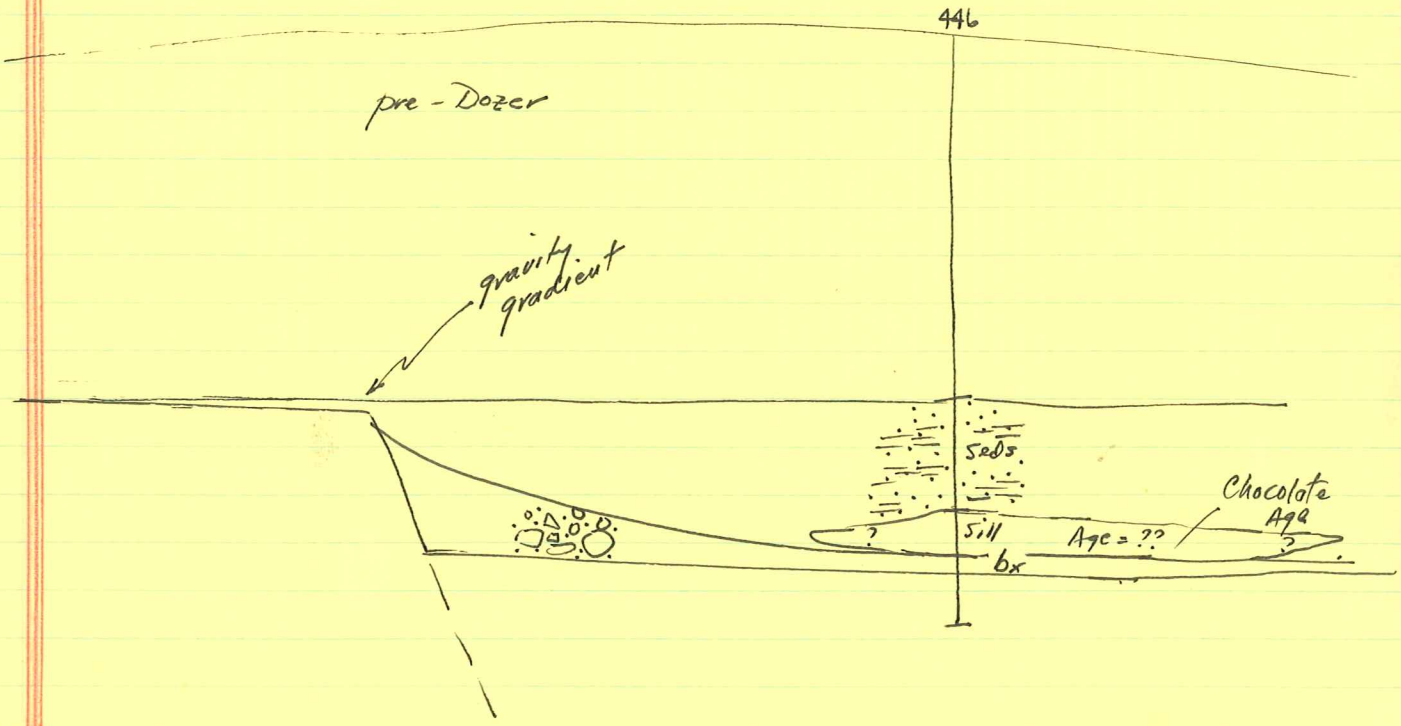
Call Marco - field trip

Randy - Gail's write-up

Bruce - Magnetic + Gravity modeling of suspected intrusion
- Extend Cross Section on South Ridge to East into ALS
- Extent of LBT along the west side of the range
- Variation between different "LBTs"

Ian Smith - High-Mg lava paper

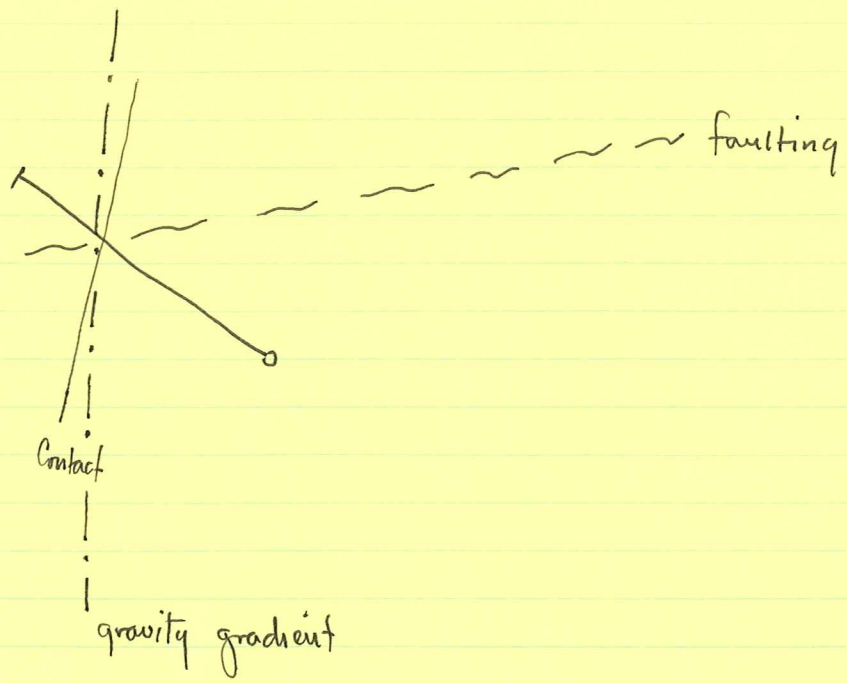
MTE - SKARN = Can't do it!



"Basement High" = gravity + magnetic highs = intrusion or flow

Cindy Moore sp?

sanidine, plag, clear Qtz, musb?



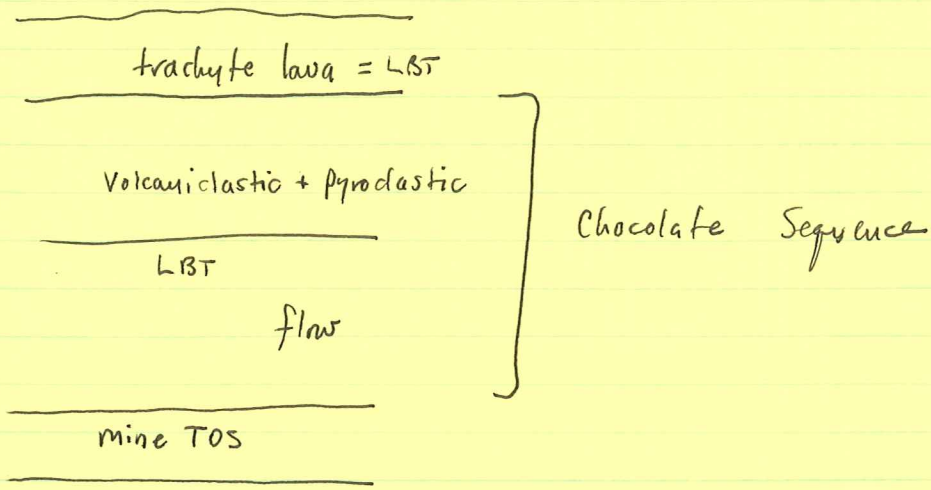
To Do

1. Plot surface geology onto drill sections around white alps
2. Geophysical profiles

Priorities

1. U/G drilling
2. Surface drilling
3. Mapping Surface
4. Geomodel + Down-hole geochemistry

A. Short Shot
B. South Ridge


trachyte lava = LBT
Volcaniclastic + pyroclastic
LBT
flow
mine TOS
Chocolate Sequence

	Lava flow
CHOCOLATE FM.	Volcaniclastic + pyroclastic
	LBT
DOZER FM.	~~[illegible]~~
	Domes
Oscar FM.	LAHAR (TCS)
	TRACHYTE LAVA FLOW (Brady Andesite)
	SLTST / SS / Conq

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ROCK CHIP SAMPLE

NWRA 3615

PROJECT ROSEBUD

SAMPLER PAM

DATE 10 / 3 / 98

QUAD. RABBITHOLE ~~CREEK~~

STATE NV CO. _____

T. _____ N. S.

R. _____ E. W.

SEC. _____

SAMPLE TYPE RG

ROCK DESCRIPTION: Rheomorphic Ignimbrite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

EL-109

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ROCK CHIP SAMPLE

NWRA 3616

PROJECT Rosebud

SAMPLER PAM

DATE 10 / 3 / 98

QUAD. Rabbithole

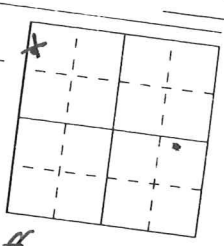
STATE NV CO. _____

T. _____ N. S.

R. _____ E. W.

SEC. _____

SAMPLE TYPE _____



ROCK DESCRIPTION: Fall-out trachyte (?) tuff

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: Thin Section

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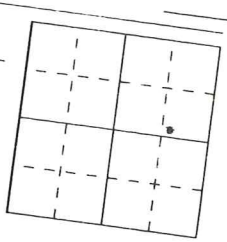
ROCK CHIP SAMPLE

NWRA 3617

PROJECT Rosebud
SAMPLER PAM
DATE 10 / 3 / 98
QUAD. RABBITHOLE
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE _____



ROCK DESCRIPTION: tuffaceous siltstone

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

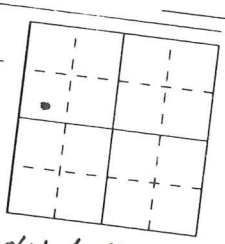
COMMENTS:

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3618

PROJECT ROSEBUD
SAMPLER PAM
DATE 10 / 3 / 98
QUAD. SULFUR
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE _____



ROCK DESCRIPTION: pumiceous, vitric, crystal tuff

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: Thin Section

L-109

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MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3619

PROJECT _____

SAMPLER _____ T. _____ N. S.

DATE ____/____/____ R. _____ E. W.

QUAD. _____ SEC. _____

STATE _____ CO. _____ SAMPLE TYPE _____

ROCK DESCRIPTION:

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

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NWRA 3619

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P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3620

PROJECT Rosebud
SAMPLER Pam
DATE 10 / 9 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE _____

ROCK DESCRIPTION: Rosebud Quartz latite (?) - 2 = 3620A
Chocolate Peak ~~Rosebud~~ Alkali Rhyolite = 3620B

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: Thin Sections

NEWMONT EXPLORATION LIMITED
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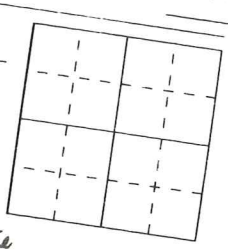
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3621

PROJECT Rosebud
SAMPLER PAM
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R



ROCK DESCRIPTION: Rosebud Quartz Latite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: Ts

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ROCK CHIP SAMPLE

NWRA 3622

PROJECT Rosebud
SAMPLER PAW
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R

ROCK DESCRIPTION: Wild Rose Alkali Rhyolite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

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MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3623

PROJECT Rosebud
SAMPLER PAM
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R

ROCK DESCRIPTION: Wild Rose Alkali Rhyolite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3624

PROJECT Rosebud
SAMPLER PAM
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE _____

ROCK DESCRIPTION: tuffaceous pebble conglomerate

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
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ROCK CHIP SAMPLE

NWRA 3625

PROJECT Rosebud
SAMPLER PAW
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R

ROCK DESCRIPTION: A = massive, aphyric pumiceous(?) lava
B = flow-banded, qtz-bearing, fsp-bearing lava

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

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ROCK CHIP SAMPLE

NWRA 3626

PROJECT Rosebud
SAMPLER PAW
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R

ROCK DESCRIPTION: Relatively aphyric, weakly ~~bedded~~ banded lava

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3627

PROJECT Rosebud
SAMPLER Pam
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE _____

ROCK DESCRIPTION: Densely welded, lithic-rich crystal-poor, pumice-poor ignimbrite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

L-109

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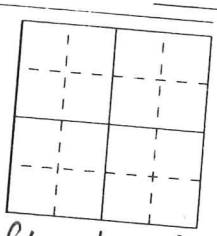
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3628

PROJECT Rosebud
SAMPLER PAM
DATE 10 / 5 / 98
QUAD. Sulfur
STATE NV CO. _____
T. _____ N. S.
R. _____ E. W.
SEC. _____
SAMPLE TYPE R



ROCK DESCRIPTION: massive to weakly flow-banded lava

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS: TS

NEL-109

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3629

No SAMPLE

PROJECT _____

SAMPLER _____ T. _____ N. S.

DATE ____/____/____ R. _____ E. W.

QUAD. _____ SEC. _____

STATE _____ CO. _____ SAMPLE TYPE _____

ROCK DESCRIPTION:

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

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MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN , NV 89822

NWRA 3629

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3630

No Sample

PROJECT _____

SAMPLER _____ T. _____ N. S.

DATE ____/____/____ R. _____ E. W.

QUAD. _____ SEC. _____

STATE _____ CO. _____ SAMPLE TYPE _____

ROCK DESCRIPTION:

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

NEWMONT EXPLORATION LIMITED
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P.O. BOX 669 CARLIN , NV 89822

NWRA 3630

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3631

PROJECT Rosebud

SAMPLER PAM T. _____ N. S.

DATE 10 / 6 / 98 R. _____ E. W.

QUAD. Sulfur SEC. _____

STATE NV CO. _____ SAMPLE TYPE R

ROCK DESCRIPTION: Relatively aplitic, flow-banded Alkali Rhyolite lava

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3632

PROJECT Roselul

SAMPLER PAM T. _____ N. S.

DATE 10 / 6 / 98 R. _____ E. W.

QUAD. Sulfur SEC. _____

STATE NV CO. _____ SAMPLE TYPE R

ROCK DESCRIPTION: Obsidian

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

NEWMONT EXPLORATION LIMITED
MAGGIE CREEK COMPLEX
P.O. BOX 669 CARLIN, NV 89822

ROCK CHIP SAMPLE

NWRA 3633

PROJECT Rosebud

SAMPLER PAM T. _____ N. S.

DATE 10 / 9 / 98 R. _____ E. W.

QUAD. Sulfur SEC. _____

STATE NV CO. _____ SAMPLE TYPE R

ROCK DESCRIPTION: Vesicular Rosebud Quartz Latite

ALTERATION:

MINERALOGY:

STRUCTURE:

ATTITUDES:

COMMENTS:

NEL-109

ROSEBUD STRATIGRAPHY

CHOCLOLATE FORMATION

Introduction

The Chocolate Formation formed during a period of trachydacite effusive volcanism and porphyry intrusion, puncuated by ephimeral to extended (Badger Member) periods of rhyolite (Bud Member) and trachydacite (Rosebud Member) pyroclastic eruptions, localized mass wasting and erosion. Pyroclastic and volcaniclastic debris accumulated in steep-sided, interdome valleys and regional lakes. The rhyolite ignimbrites that occur within the Bud Member are important time "lines" which may be traced across the Rosebud mining district, and possibly into the adjoining mountain ranges.

Trachydacite lavas are characterized by thin (1-3 mm) planar flow-laminations. Fine-grained massive, controted planar-laminated and autoclastic textures are less abundant, but not uncommon. The lateral extent of the flows is difficult to ascertain because of compositional and textural similarities between the flows, and the extent of relatively poor exposures. The lava flows appear to be only a few 10's of meters thick, except where they ponded(?). In these areas the trachyandesite lavas may exceed 50 meters in thickness. Individual flows can be followed for no more than 1 to 2 kilometers along "strike."

Trachydacite lava flows of the LBT and South Ridge Members are virtually indistinguishable in hand specimen and microscopically, and may be parts of the same eruptive sequence. The two members are separated by volcaniclastic and rhyolite ignimbrite deposits (Bud Member), which may represent a brief(?) hiatus in proximal volcanism. Because the pyroclastic units within the Bud Member are compositionally different from the remainder of the Chocolate Formation, is is possible that the Bud Member volcanic units originated from distal eruptions (separate magmas).

Intrusive phase include the Rosebud sill (laccolith?), Kamma "Andesite" and possibly the White Alps Porphyry. The Rosebud sill is the most extensive intrusion identifed within the Rosebud mining district.

Bud Member

Medium to thick bedded lacustrine volcaniclastic and possibly lahar deposits are intercalated with relatively thin rhyolite ignimbrite and tephra fall deposits. Ignimbrite flows are more common in the lower one half of the unit. Two of the ignimbrites are densely welded, eventhough they are thin, indicating that the fallout from the eruptions were exceptionally hot and/or that the flows are proximal (within 1 km) to the eruption vent. Intercalated within the pyroclastic-rich lower sequence is a cobble to boulder conglomerate or debris pile that may be a megabreccia resulting from the collapse of a caldera topographic wall.

LBT MEMBER

The LBT Member of the Chocolate Formation a relatively think (>50 m) trachydacite lava. Fflow textures vary from thin (1-3 mm) planar flow-laminations to fine-grained and massive. Autoclastic and vesiculated (LST) textures are common, but are not laterally continuous for more than a few 10's of meters to approximately 100 meters along strike.

HECLA MINING COMPANY – ROSEBUD PROJECT – PERSHING COUNTY, NEVADA

Qal – 0–±100' Alluvial (Qal), colluvial (Qc), landslide (Qls), and lake bed (Qlb) deposits.

EROSIONAL UNCONFORMITY

CT – 0–±600' Chocolate Tuff: fine-grained ash flow tuff & coarse-grained, poorly-sorted, matrix- & clast-supported heterolithic volcanic breccias; fractured, silicified, argillized w/ sporatic Au-Ag mineralization – Far East Zone.

UBUD – 0–100' Upper Bud: latitic lithic lapilli ash flow tuff & tuff breccia & epiclastic reworked tuff.

BMB – 0–100' (30-60') Bud Marker Bed: prophyritic alkali rhyolite flow; fractured, silicified, argillized w/ anomalous Au-Ag mineralization

LBUD – 0–100' Lower Bud: latitic lithic lapilli (fiamme) ash flow tuff & tuff breccia & epiclastic reworked tuff.

LBT – 0–±600' Lower Bud Tuff: fine-grained water-lain & airfall tuff, lithic ash flow tuff & breccia; fractured, silicified, argillized, potassic altered (alunite-adularia), & pyritized w/ Au-Ag mineralization (South & North Zone).

1. Monolithic autobrecciated, fine-grained tuff. < gradational EROS. SURFACE
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 w/ leopard spot texture (LST)
6. Massive, very fine-grained vitrophere.
7. Matrix-supported, chaotic-bedded, heterolithic tuff breccia.
8. Clast-supported, chaotic-bedded, mono/heterolithic tuff bx.
9. Flow-banded, matrix-supported, lithic tuff breccia → FLOW FOLIATE BRECC

95% of the tu

Tos – 0–±200' Oscar Sediments: coarse-grained, matrix- & clast-supported, heterolithic epiclastic reworked tuff & interbedded lithic ash-flow tuff.

DT – 0–±600' Doger Tuff: aphanitic, fine-grained, siliceous, weakly flow-laminated ash flow tuff; local "ghost" monolithic auto breccias; fractured, silicified, argillized, pyritized w/ Au-Ag Mineralization (East & North Zone).

Tcs – 0–100' Basal Tertiary Sediments: carbonaceous sandstone, siltstone, & pebble conglomerate; fractured, silicified w/ Au-Ag mineralization (Far North Zone).

EROSIONAL UNCONFORMITY

JTRa – ~1000' Auld Lang Syne Group: folded & faulted metasediments – graphitic slate, phyllite, quartzites, & hornfels; fractured, brecciated, silicified, pyritized w/ sporatic Au-Ag mineralization (North, Far North, & East Zones).

ROSEBUD DISTRICT STRATIGRAPHY

SULFUR GROUP

LOWER SULFUR GROUP

Camel Conglomerate

Poorly sorted, matrix-supported epiclastic volcanic breccia with poorly developed bedding; dominantly subaerial deposition, talus and fanglomerate deposits, local hydrothermal eruption breccias (Crofoot Breccia) and sinter horizons.

Lacustrine Deposits

Poorly consolidated mudstone, siltstone and sandstone, minor pebble conglomerate and tuff, local marl and limestone horizons; fluvial and subaqueous deposition, fanglomerate, flood-plain and lacustrine deposits.

KAMMA MOUNTAINS VOLCANIC GROUP

CHOCOLATE FORMATION

Badger Member

Red Beds: dominantly resedimented, clast- and matrix-supported volcaniclastic and volcanogenic breccia with a hematitic silt to granual matrix, minor interbeds of pebble to cobble conglomerate, lenses of hematitic siltstone and sandstone, and fine (ash) tuff beds; normal and reverse grading, subaerial mass wasting, subaerial, fluvial and lacustrine deposition, debris flow, talus, and fangomerate deposits.

Basal *Red Beds*: interbedded sanidine-, quartz- and biotite-bearing mudstone, siltstone, sandstone, pebble and cobble conglomerate and resedimented volcanic breccia intercalated with white fine (ash) tuff; normal grading, subaqueous deposition, flood-plain(?) and turbidite deposits.

White Alps Porphyry

Feldspar porphyry; massive, fine-grained intrusion comprised of 3 to 8% unoriented, dominantly equant feldspar phenocrysts ~3mm across randomly distributed in a fine-grained groundmass of plagioclase and quartz.

Kamma Andesite(?)

Glomerophyric feldspar andesite intrusions consisting of 3 to 5% hornblende(?) <5mm long and ~5 to 8%, dominantly clustered, plagioclase phenocrysts supported by a fine-grained crystalline groundmass of plagioclase, quartz(?) and minor magnetite, local flow lineation of phenocrysts.

PROPOSED STRATIGRAPHIC NOMENCLATURE FOR THE ROSEBUD DISTRICT

Introduction

Stratigraphic nomenclature at Rosebud has evolved through several different companies and mapping programs. Government geological maps have not subdivided the Kamma Mountain Volcanic Group, so the formations and units are used in an informal sense. The usual protocol for stratigraphic naming is to continue using early subdivisions, unless these are not clearly defined or the names are not reasonable for the rock types included. At Rosebud, earlier subdivisions were not always well defined, and some names are incorrect i.e., Lower Bud Tuff for the Mine Host sequence of ?trachytic flows and breccias. Rock compositions are also not clearly or consistently defined from the available petrographic work. Hence, different nomenclature has been used for the same stratigraphic units (Fig. 5).

Following are comments on each of the main units recognized from the Rosebud Canyon - South Ridge section, with recommendations for changes. These are proposed to provide a consistent stratigraphic framework for both exploration and mine geology.

Auld Lang Syne Group (JT a)

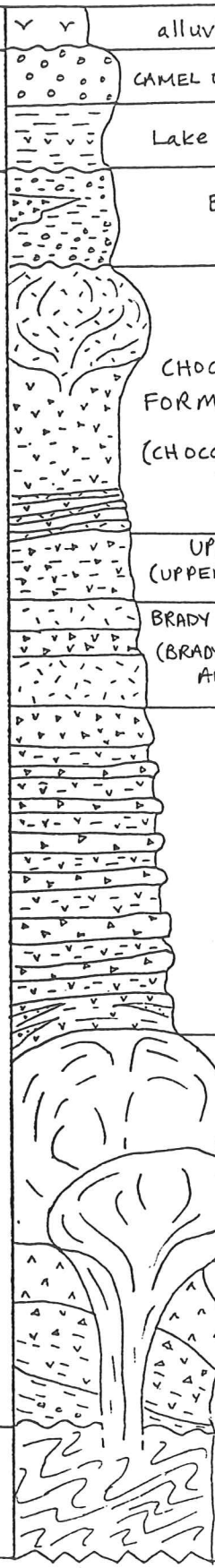
This basal sequence of deformed metasedimentary rocks underlies the Kamma Mountain Volcanic Group. The contact is commonly faulted. Fragments of these rocks are distinctive, and are recognized as clasts in the 'Lower Bud Tuff'.

Oscar Sequence (Tos)

A sequence of andesitic to basaltic andesitic flows and breccias, locally underlain by tuffaceous sedimentary rocks intercalated with pebble conglomerate. These sedimentary rocks have been termed Tcs (Basal Tertiary Sediments) where encountered in drill holes. Walck et al. (1993) originally described these sediments as the lower part of the Oscar Sequence, and it is recommended that this be continued.

FIGURE 5 : ROSEBUD CANYON STRATIGRAPHIC SECTION

SCALE 1" = 500'



			SYMBOLS	
QUATERNARY	alluvium, colluvium		Qal	alluvial gravels with placer Au
TERTIARY (MIOCENE) — KAMMA MOUNTAIN VOLCANIC GROUP	CAMEL CONGLOMERATE	SULFUR GROUP	Tsc	conglomerate and scree breccia 40 to +250'
	Lake Sediments		Ts	volcanic ash and lacustrine sediments : to 2000'
	BADGER FORMATION (GATOR)		Tb	hematitic volcaniclastic and conglomeratic breccias - red silty matrix 900-1000'
	CHOCOLATE FORMATION (CHOCOLATE TUFF)	Chocolate Flow	Tc	flow banded, sparsely porphyritic latitic flow - local eruptive center +300'
		Chocolate Tuff		non-welded lithic tuffs +300'
		Marker Porphyries		glomeroporphyritic flows or sills +125'
	UPPER BUD SEQUENCE (UPPER BUD TUFF, UPPER SURGE)		$Tbs_{\frac{2}{1}}$	well-bedded lithic tuff-breccias graded bedding +150'
	BRADY SEQUENCE (BRADY ANDESITE)	see MINE HOST SEQUENCE	Ta	fine-grained flow, planar flow 90' lamination - intervening lithic 26' tuff-breccia 185'
	LOWER BUD SEQUENCE (LOWER BUD TUFF; LOWER SURGE; OSCAR SEDIMENTS; WILD ROSE)		$Tbs_{\frac{1}{2}}$	heterolithic, well-bedded lithic tuff-breccias and volcaniclastic units with reverse and normal grading - includes fragments of the Auld Lang Syne Group and clasts of Dozer towards the base. +1000'
	DOZER RHYOLITE DOZER FORMATION (EQUIVALENT TO 'BROWN FLOW' OR WILD ROSE FLOW DOMES)		Td	flow banded, locally vesicular probable exogenous rhyolitic flow dome(s) with significant relief on its upper surface. - upper flow laminated zone. 250 - 1800'
	OSCAR SEQUENCE	OSCAR ANDESITE	Tos	andesitic flows, generally fine-grained with flow breccias and tuffs (?)
		Basal Tertiary Sediments	Tcs	carbonaceous sandstone, siltstone and pebble conglomerate 0-100'
JURASSIC-TRIASSIC	AULD LANG SYNE GROUP		JTRa	deformed, dark grey metasediments - graphitic slate, phyllite, quartzite, hornfels.

NOTES : 1. selected compilation of previous descriptions with alternate unit names shown in brackets. Recommended new terminology is highlighted.

2. thicknesses for the upper Dozer to the Chocolate Fm. are from a measured section on South Ridge; other thicknesses are schematic only.

Petrographically, the rocks are vesicular, probable hornblende andesitic flows (phenocrysts ; ~8% plagioclase, 4-5% mafic minerals / hornblende). Alteration is typically propylitic with an assemblage of chlorite - epidote - carbonate - hematite - chert.

Dozer Rhyolitic Dome (Td)

The lower, and several upper contacts of the Dozer unit were carefully examined in the field on South Ridge. At the lower contact with the Oscar Sequence a narrow, 3 - 5' rhyolitic dike with chilled margins clearly cuts a dark, fine-grained flow and extends as a feeder to the Dozer Rhyolite. A second, possible major feeder dike has a weakly sheared and brecciated southern margin. In contrast, the upper contact is not intrusive. This contact is sharp but irregular and locally shows considerable paleo-relief, as noted by Walck et al. (1993). Well-bedded volcaniclastic units infill this irregular contact, with considerable variations in thickness, and stratigraphic pinch outs against the original dome margins. The unusual outcrop pattern of Dozer and 'Lower Bud Tuff' mapped on the southern side of South Ridge is therefore attributed to paleo-topography. Fragments of Dozer are present in the lowermost volcaniclastic beds overlying the dome.

The Dozer Rhyolite Dome may be subdivided into a lower, more massive fine- to slightly coarser-grained unit, and an upper, strongly flow laminated unit succeeded by a zone of large, rounded lithophysae up to 5" in diameter. These lithophysae have been infilled with chalcedonic to crystalline quartz, manganiferous carbonate and clays. The upper part of the dome is strongly auto-brecciated (all Dozer clasts), and in places is altered to chalcedonic and jasperoidal silica, carbonate and green clays. This alteration is believed to be early, and may be related emplacement of the dome into a shallow subaqueous environment. The lithophysae are consistent with this interpretation. Rockchip samples are not anomalous for Au in this area.

Phenocrysts are very sparse in the Dozer, and compositionally it has been described as rhyolitic, andesitic or latitic. Trace sanidine, 1% plagioclase and up to 3% mafic minerals have been recognized.

Whereas the Dozer at this location does not exhibit intrusive relationships, equivalent units (the Wild Rose flow domes) are not necessarily extrusive, and their contact relationships would need to be examined separately.

Lower Bud Tuff (Tbs_1)

This is a well-bedded sequence of volcaniclastic deposits and breccias which are typically heterolithic, planar bedded, locally with both reverse and normal grading. The matrix is commonly either hematitic, or a bright green clay which was described by Walck et al. (1993) as a mixture of celadonite and glauconite. These have been interpreted as base surge deposits, however, the heterolithic clast content, the graded bedding and lack of cross bedding and scour or channel structures is not typical of base surge origin. A base surge should also mantle the original topography of the Dozer dome, rather than exhibit the stratigraphic pinch outs described. They are more likely to be subaqueous volcaniclastic debris flows, similar to those described by McPhie et al. (1993; p.150). The presence of glauconite supports a subaqueous origin. Both glauconite and celadonite are probably products of deuteric alteration, and not a later hydrothermal overprint.

should see some cross bedding

yes they are

This is typical redistribution + deposition morphology

They could also be base surge deposits.

?

agreed

The term 'base surge' is not recommended, and while Lower Bud Tuff may be an acceptable exploration term, Lower Bud Sequence may be better (the symbol Tbs would remain the same).

only if it represents multiple events

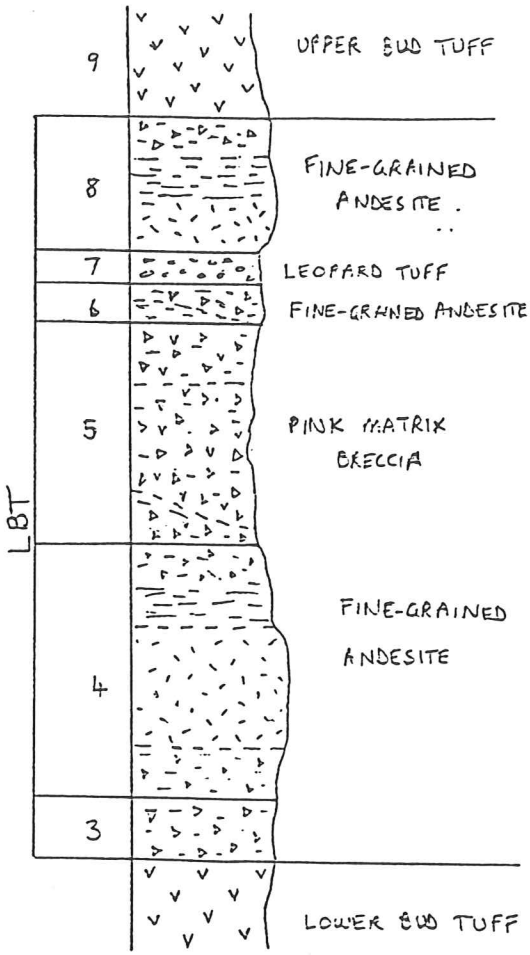
Brady Andesite or Mine Host Sequence (Ta)

Contains fragments of Auld Lang Syne Group

CORRELATION PROBLEM

Field evidence supports this sequence as that which hosts the Au mineralization in the South and North orebodies at Rosebud, although the mine geologists do not agree (Fig. 6). It comprises at least two fine-grained, probable flows separated by volcanic breccia. Petrographically it is described as having a trachytic texture but the composition is uncertain. It is darker in outcrop than the Dozer Rhyolite and has therefore been interpreted to be andesitic, although other characteristics are very similar to the Dozer i.e., strong platy flow laminations, local vesicularity and diffuse spherulites

FIGURE 6 : MINE HOST SEQUENCE



massive, planar to convoluted fine-grained 'tuff'

vesicular, flow-banded 'tuff'

convoluted to planar, laminated fine-grained 'tuff'

vitrophyric upper contact

heterolithic, matrix-support tuff-breccia; some flow foliated

convoluted to planar, laminated fine-grained 'tuff'; locally flow brecciated

massive to weakly foliated fine-grained 'tuff'

planar, laminated fine-grained 'tuff' breccia

heterolithic breccia.

EQUIVALENT TO THE BRADY ANDESIT (Ta)

NOTES :

1. The symbol LBT (Lower Bud Tuff) for the Mine Host sequence is an old term, which is now confusing and should be discontinued.

2. Similarly the descriptions and symbols within the Mine Host sequence refer to fine-grained tuff, whereas the general consensus is that these units are flows, or possibly sills. The symbols and references to tuff (apart from the pink-matrix breccia) should be changed.

3. The exploration group would equate the Mine Host sequence with the Brady Andesite (Ta), whereas there is conjecture from the mine geologists that the Mine Host may correlate with the upper Dozer. My observations are that the exploration correlation is a more comfortable fit and would recommend that this be adopted unless new evidence comes to light.

derived from devitrification of a glassy rock. Some of these characteristics were also observed in the mine exposures. In the mine the intervening volcanic breccia is termed the 'pink-matrix breccia'.

Petrographically, this unit has a more distinct phenocryst population than the Dozer, with 1-3% sanidine, up to 3% plagioclase, 2-3% biotite, and 1-5% mafic minerals / needle-like hornblende. It has been variably defined as a latite, trachyte, andesite or even a basalt. The k-feldspar : plagioclase ratio is variable.

LBT should be discontinued as a term for this sequence. It is recommended that Mine Host Sequence or Brady Sequence be used instead, avoiding 'andesite' until the composition can be better determined.

Upper Bud Tuff (Tbs_2)

This sequence is similar to the Lower Bud Tuff, but the heterolithic breccias lack fragments of Auld Lang Syne, which were present in the lower sequence. A similar origin as subaqueous debris flows is also suggested.

It is recommended that this unit be renamed the Upper Bud Sequence.

Chocolate Formation (Tc)

This is a sequence of flows and volcanic lithic tuff-breccias, with a distinctive brown, hematitic appearance where alteration is minimal. The upper contact with the Upper Bud Tuff has been placed either at the uppermost 'green tuff' or 'surge' horizon, or the lowest glomeroporphyitic flow or sill unit (termed the Marker Porphyries). The Marker Porphyries should probably be used to denote the basal Chocolate Formation, and a broad subdivision into Marker Porphyries, Chocolate Tuffs and upper Chocolate Flow is reasonable. The Chocolate Tuffs are poorly exposed but appear to be lithic tuff-breccias, and auto-brecciated flows. On Big Chocolate Hill there is a flow banded, vesiculated latitic flow which is probably a local eruptive center.

Petrographically, the flow unit is most consistently defined as latitic, or quartz latitic, with 10 - 15% plagioclase, trace sanidine, 3% biotite, 4% mafic minerals and rare resorbed quartz. The groundmass is coarser textured than other units.

Badger Formation (Tb)

Above the Chocolate Flow is a fragmental unit composed almost entirely of fragments of the Chocolate flow. This could equally well be designated as uppermost Chocolate Formation or lowermost Badger Formation. The Badger is a widespread volcaniclastic to conglomeratic breccia with a distinctive oxidized reddish brown matrix. It has been interpreted as a fanglomerate deposit, and this seems reasonable.

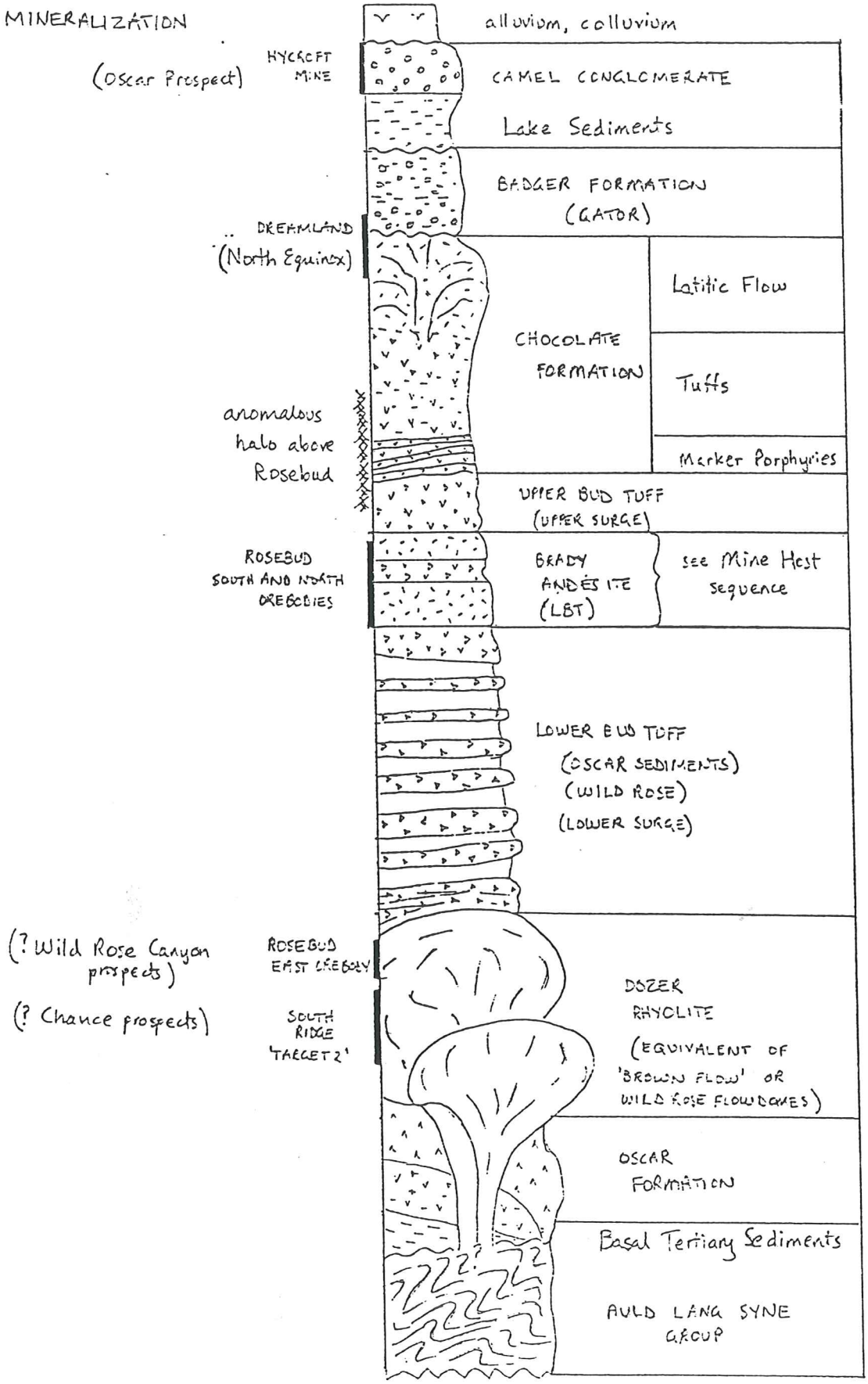
Both the Chocolate and Badger have been termed formations, and there is probably sufficient exposure to define a type section, so this usage is reasonable, even though a formal section has not been measured. Gator is a poorly defined unit which is presumably at the same stratigraphic level as the Badger Formation. It is recommended that it be considered part of the Badger Formation.

Post-Badger Sequences

The Lake Sediments and Tertiary Fanglomerate mapped by Mike Brady at, and to the west of the Oscar Prospect are probably part of the Sulfur Group (Wallace and Friberg, -), which are the host rocks to the Hycroft mine. The Tertiary Fanglomerate is probably equivalent to the Camel Conglomerate member.

It is recommended that the Sulfur Group stratigraphic equivalents be adopted, if they can be reasonably correlated.

FIGURE 7 : MINERALIZED INTERVALS IN THE ROSEBUD STRATIGRAPHY



General Comments

1. the volcanic stratigraphy exhibits variations in facies and thickness of units along strike, so the section described will differ at Wildrose and other locations. Thicknesses of individual units have been used to decide where a stratigraphic contact should be in a drill hole. This may 'force' contacts where the variation is simply due to changes in volcanic facies. Mike Brady noted that the dip of bedding is commonly steeper on the ridges than on the sides of the valleys. This can be explained in that the centers of volcanic activity have been preferentially preserved on the ridges, with steeper original dips than the more distal volcanic units.

2. there does not appear to be a stratigraphic horizon that is more consistently mineralized than another (Fig. 7). There are more favorable lithologies, but these only become important where they are intersected by mineralizing structures.

3. most of the flow dome and lava flows were originally glassy and fine-grained, with upper auto-brecciated margins, which may be hyaloclastitic. These were probably erupted in a subaqueous environment.

References

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Walck, C.M., Bennett, R.E., Kuhl, T.O., and Kenner, K.L., 1993. Discovery and geology of gold mineralization at the Rosebud Project, Pershing County, Nevada. SME Annual Meeting, Reno, NV, Feb. 15 - 18, 1993, Preprint No. 93-175.

Wallace, A., and Friberg, R.S., -. Sulphur Mining District : Geology and mineral deposits of the Sulphur Mining District, Humboldt County and Pershing County, Nevada.

Sulfur Group

- Recent talus-fanglomerate
- Camel Conglomerate
- Bager (basal unit)

Kamma Mtns ~~Volcs~~ Group

- Kamma Mtn Volcanics

SULFUR Group (>610 m)

Recent talus-gravel beds

≥ 430m — fanglomerate or talus gravel

Crofoot Breccia

Camel Conglomerate = poorly sorted, mx-supported w/ crude bedding dipping E.

talus-fanglomerate

Lower Sulfur Group

(post + sign) = poss upper Kamma Mtn ~~Volc~~ Group

Lower Sulfur Group

SLTST, TUFF, SS, pebbless, minor pebb congl.

domin. metased vf from ALS

Bager Fm

- reddish colored congl w/ c.g. volc. clasts near the base

Fanglomerate

Tuff + Tuffaceous SS
· Med. to thick bedded

---

pebble
ACS Conglomerate 100%

Sandy tuff w/ Sanidine (tuffaceous SS)

tuffaceous mudstone to siltstone

ash tuff

flow-banded rhyolite welded w/ ACS frags
welded bx-dom
welded ~~Pumice~~ ash-dom
welded bx-dom

---

thin bedded platy ash

poorly to mod. welded pumiceous rhyolite xl-lith tuff

Thin bedded tuffaceous siltst
fossil;

Conglomerate

---

lacustrine mudstone

---

hbn-bio rhyolite, mod-strong welded tuff

Spherulitic rhyolite tuff = densely welded
lapilli tuff

---

1. Barrel Springs = basal(?) section
2. White Alps
3. Gorilla (Mother Lode)
4. Dreamland = upper section

Description
Hand Sample
Primary Mineralogy
Alteration Mineralogy
Plagioclase
Sanidine
Polished Thin Section

Rosebud

	NW EOS		SE EOS	
	NORTHING	EASTING	NORTHING	EASTING
Section 10N	~~2211215~~ 2211215 ~~467800~~	467800 ~~2211215~~	2205600	490800
Section ~~E~~ 1N	2204910	467800	2196775	490800

File = RBF – SH1A.dwg

X-sections + Drill Holes @ 1:6000

Looking NNE (N20°E) 020°

Clawsson Manuf.

~~Clawsson Manuf.~~

~~Classon Manuf~~

Terry Baldwin
273-6596
Come out on Monday –

~~Cli~~ ~~Clawsson~~
543-3161

1" = 500'
12

1 = 1000
500
6000

Kurt Allen
± Charlie Muerhoff

GEOLOGY

STRATIGRAPHY:

Rocks intersected by the 1995 Far East and Southeast Target drilling program belong to the Tertiary Chocolate and Tertiary Dozer formations. The 1995 drill hole data and all older Far East drill hole data were plotted on cross-sections at a scale of 1:480. All older available RVC drill hole chips and core photographs were re-logged and added to the new Far East geologic cross-sections. These cross-sections show rocks belonging to the following formations from youngest to oldest: 1) Quaternary Colluvium; 2) Tertiary Chocolate Formation; 3) Tertiary Bud Formation; 4) LBT Formation (north and east zone); 5) Tos Formation (north and east zone); 6) Tertiary Dozer Formation; and 7) Triassic-Jurassic Auld Lang Syne Formation.

Quaternary Colluvium:

Bedrock geology in the Far East Target area is covered by a shallow colluvium derived from the surrounding ridges. Colluvium ranges in thickness from 2 to 35 feet.

Tertiary Chocolate Formation:

Rocks belonging to the Tertiary Chocolate Formation are effusive and intrusive volcanics ranging from latitic to andesitic in composition. The Chocolate Formation has been subdivided into the following 5 sub-units (from youngest to oldest): 1) Tcfg undifferentiated; 2) Tcllt; 3) Tcfg; 4) Tc fgmpp; and 5) Tcvitro. Total thickness of the Tertiary Chocolate Formation is in excess of 1200 feet.

Tcfg
Tcllt
Tc fgmpp
Tcvitro

The undifferentiated Tcfg sub-unit consists of dominantly fine-grained, porphyritic, latitic to andesitic, volcanic flows with inter-bedded auto breccias. In hand specimen this rock consists of a glassy to sugary textured groundmass with 10 to 15 percent 1mm to 8mm subhedral to euhedral plagioclase phenocrysts replaced by varying amounts of clay, hematite, pyrite, and calcite, and 5 percent 0.5mm to 3mm subhedral to euhedral hornblende and biotite phenocrysts replaced by hematite. This sub-unit is in excess of 800 feet thick.

Sub-unit Tcllt consists of a monolithic lithic lapilli tuff breccia or autobreccia with minor block sized clasts. Compositionally the sub-unit is latitic to andesitic with the same phenocryst content as the Undifferentiated Tcfg sub-unit described above.

Sub-unit Tcfg consists of a fine-grained, porphyritic, latitic to andesitic, volcanic flow, containing up to 5 % fine-grained disseminated specular? hematite some of which have replaced hormblende? Phenocrysts rarely achieve lengths of 0.6mm. Unit contains rare clay altered probable augite phenocrysts up to 0.6mm and minor clay altered plagioclase phenocrysts. The unit is reddish-brown in color.

Sub-unit Tcfgmpp is a fine-grained, massive, lt. pink to tan, slightly porphyritic andesitic intrusive. In drill cuttings the unit contains 0.5-1.0% phenocrysts of 0.6mm long laths of clay altered plagioclase phenocrysts in an aphanitic groundmass. The unit contains up to 2% of 0.1-0.2mm disseminated pyrite cubes. A white to light green vitrophyre, Tcvitro, surrounds the margin of this intrusive. The intrusive is up to 170 feet thick with up to 40 feet of vitrophyre. The vitrophyre consists of a glassy margin of the intrusive that subsequently has been devitrofied and altered to a lt. green to white clay. The clay still retains the devitrofied textures.

Tertiary Bud Formation:

Rocks belonging to the Tertiary Bud Formation are effusive and intrusive volcanics ranging from latitic to andesitic in composition. The Bud Formation is typically a green, crudely-bedded, poorly sorted, lithic lapilli tuff with local interbedded zones of volcanic breccia and epiclastics. During 1996, Mike Brady interpreted the upper, middle, and lower portions of the Bud Formation as base surge deposits. The Bud Formation has been subdivided into the following 5 sub-units (from top to bottom, not necessarily oldest to youngest): 1) Ubud; 2) Porphyritic autobreccia; 3) Mbud; 4) BMB; and 5) Lbud.

Sub-unit Ubud consists of a fine-grained base surge deposit (Brady 96) with clasts up to 4mm in size of fine-grained volcanics of uncertain composition. Flow laminations are common throughout the unit. Clasts are angular to sub-angular and dominated by <1.0mm andesitic with rare rhyolite? clasts in a clayey matrix. Unit is lt. to dk. green in color with common chlorite?.

Sub-unit Porphyritic autobreccia is a fine-grained, slightly porphyritic, rhyolitic? autobreccia. Clasts are sub-angular to sub-rounded, lapilli to small block in size, and composed of the same slightly porphyritic matrix material. Unit contains 1% clay altered plagioclase phenocrysts, and up to 1% disseminated pyrite. This autobreccia appears to be stratabound.

Sub-unit Mbud is a base surge deposit that contains a base of flow laminated moderately coarse-grained mostly clast supported lithic tuff breccia with an average grain size of 0.5-1.0 inches. This basal portion of the sub-unit grades upward into a fine-grained mostly clast supported lithic tuff breccia with an average grain size of approximately 0.12 inches. Grading continues upwards into a coarse-grained matrix supported lithic tuff breccia with an average clast size of 0.5-1.0 inches. Clasts in the upper portion of this sub-unit appears to contain clasts composed of the Chocolate Formation. This sub-unit is generally lt. green to dk. green in color.

Sub-unit BMB (known as the Bud Marker Bed) is a porphyritic andesitic dike or sill. Unit contains up to 4% 1.0-2.0mm sized lath shaped phenocrysts of clay altered plagioclase with possible minor clay altered augites. Pyrite is common in this unit. This sub-unit is generally lt. brown in color. The BMB appears to slightly cross-cut stratigraphy. In past interpretations, the BMB, Porphyritic autobreccia, and Tcfgmpp (Fg Pink Porphyry), were interpreted as being the same unit (BMB). This incorrect interpretation brought about the need for large offsetting faults to justify the apparent large displacements between the "BMB"

Sub-unit Lbud is a base surge deposit grading from a strongly flow-laminated coarse-grained, matrix to clast supported, volcanic lithic tuff breccia into a fine-grained, matrix supported, lithic tuff breccia. The sub-unit is lt. to dk. green in color containing common chlorite. Clasts are angular to sub-angular and dominated by <1.0mm andesitic with rare rhyolite? clasts in a clayey matrix, very similar to the Ubud sub-unit.

Tertiary Lbt Formation:

Rocks belonging to the Lbt Formation contain effusive (possibly intrusive?) andesitic to latitic volcanics. This formation is sub-divided here into the following 7 sub-units (from oldest to youngest): 1) Fg mass, 2) vitrophyre, 3) Fg Splat, 4) Fg-mg speckled flow; 5) Bx, 6) Mass-vitro, and 7) Fg mass.

Sub-unit Fg mass consists of a fine-grained massive andesitic to latitic ash tuff or lava flow. The unit contains no visible phenocrysts and lacks laminations.

Sub-unit Vitrophyre is a clay altered or replaced devitrofied glass that retains the devitrofication textures. The clay is lt. green to white in color.

Sub-unit FgSplat is a fine-grained slightly planar laminated andesitic to latitic lava flow or ash tuff. This unit is aphanitic containing no visible phenocrysts.

Sub-unit Fg-mg speckled flow is a fine- to medium-grained andesitic to latitic vesicular lava flow. This sub-unit contains varied vesicle sizes and percentage of vesicles within the sub-unit. This vesicular unit probably correlates to the Leopard Skin Tuff of the South ore zone.

Sub-unit Bx appears to be a monolithic, matrix to clast supported, volcanic block and ash flow tuff, or autobreccia. Clasts range in size from lapilli to block and are composed of slightly planar laminated ash tuff or flow. This breccia correlates to the Pink Matrix Breccia in the South ore zone.

Sub-unit Mass-vitro appears to be a fine-grained massive ash tuff or flow that a portion of which is a clay altered devitrofied glass

Sub-unit Fg mass is a fine-grained massive andesitic to latitic ash tuff or lava flow.

Tertiary Tos Formation:

Rock belonging to the Tos Formation consists of a latitic? base surge deposit very similar to the Lbud Formation except the Tos Formation contains trace amounts up to 5% fragments of phyllite belonging to the Triassic-Jurassic Auld Lang Syne Formation.

Tertiary Dozer Formation:

Rocks belonging to the Dozer Formation consists of Rhyolitic (latitic? as petrographically described by Ted Paster) fine-grained flow laminated (planar) lava flow or intrusive? with areas of auto brecciation and vesicular-rich portions. This unit is usually lt. Green in color but can vary into redish browns.

Triassic-Jurassic Auld Lang Syne formation:

Rock belonging to the Triassic-Jurassic Auld Lang Syne Formation consists of dominantly black graphitic phyllites.

STRUCTURE:

The dominant structure within the Far East target area, East ore zone, and North ore zone is the South Ridge Fault. This fault is the major structure associated with the mineralization of the area. The East ore zone is hosted within and in the footwall of the South Ridge Fault.

ALTERATION:

Alteration within the Far East target is best observed near small high-angle faults and fractures and the large low-angle South Ridge Fault. Alteration paragenetic sequence appears to be as follows from youngest to oldest or weakest to strongest as evidenced in the 1995 Far East target drilling: 1) fracture; 2) propylitic alteration; 3) argillic alteration; and 4) silicification.

The youngest or first alteration stage is appears to be propylitic. Propylitic alteration within the Far East target area consists of chloritic clay and possibly pyrite. Propylitic alteration gives the rock a lt. to dk. green coloration. As fluids continued to flow through the fractures, argillic alteration bleaches the rock and alters feldspar phenocrysts to clays. Argillization is followed by silicification of the fractures.

MINERALIZATION:

Gold and silver mineralization within the Far East target area appear to be confined to thin, high-angle faults and fractures in the hanging wall of the South Ridge fault and to low angle structures within the footwall of and within the low-angle South Ridge fault. A list of 1995 Far East target significant intercepts is attached. There are a total of 5 intercepts from the 1995 Far East target drilling above 0.100 opt gold with an average true thickness of 2.7 feet containing 0.145 opt Au and 1.30 opt Ag.

Two of the 5 intercepts above 0.100 opt Au were hosted above the South Ridge Fault in the Chocolate Formation and three of the 5 intercepts above 0.100 opt Au were hosted within or in the footwall of the South Ridge Fault. Both intersepts hosted by the Chocolate Formation above the South Ridge Fault consists of thin graphitic or carbonaceous material filled fractures or faults. Two of the three intercepts hosted within or in the footwall of the South Ridge fault are contained in silicified rock with pyrite and silver sulfosalts with one hosed by a graphitic or carbonaceous material filled fracture or fault.. The above intersected mineralization appears to lack continuity in both grade and thickness.

Other lower grade minereralization was intersected in the 1995 Far East target area drilling. A total of 20 intercepts of gold mineralization above a 0.010 opt cutoff grade. Ten of the 20 intercepts contain various amounts of graphitic or carbonaceous material along fractures or faults.

Hecla mine sections (1:20 scale)
South Zone Looking NE

Apparent thicknesses (in feet) of the major modelled stratigraphic units

	Unit	Abbrev.	100S	50S	0N	100N	200N	300N	400N	500N	700N
lower Bud	9	Bud	>50	>60	>45	>60	145	>160	>120	>110	
	8	FGT	30	42	35,42	70	60,70	60,40,70	60,150	150	150
LBT	5	PMBX	120	95	75,115	58,130	130	137	140,190	65,110	95
	4	FGT	93	90	84	102	>75	>110	135	100	96
TOS	2	Tos	>40	>65	>120	>55	-	-	>50		>60
Total Thickness			333	352	406	417	420	477	645	470	401

Notes: RBV, 10/97

Unit numbers refer to modelling domains, not stratigraphic units.

LST (leopard spotted ~~texture~~ tuff) is identified only on the northern 4 or 5 sections, and occurs in the upper FGT unit. Where LST is present, the unit numbers are 6 for FGT, 7 for LST, and 8 for FGT

Numbers separated by commas indicate different thicknesses across high angle faults.

Peter,

A year ago I closely examined the units on Hecla's mine geology sections were the units they had modelled in Note that the thicknesses change section to section, and across fau same section! Also, the LBT orig units, and now is up to 9.

—Randy

I found a note from Bob Bennett with clarifications on the LAC stratigraphy:

1. red brown ugly (was) is easily confused w/ Wildr.
2. Wildrose is f.g., few phenos
3. SGT = sage green tuff (= Dozer)
4. LBT transitions into Wildrose Section (presumably down section or along strike?)

—RBV

Figure 5. Hecla's Rosebud mine stratigraphic section

Qal alluvium, Qc

erosional unconformity

CT Chocolate tuff
UBUD Upper Bud
BMB Bud marker bed
LBUD Lower Bud
LBT tuff (0-600 feet)

1. monolithic autobrecciated, fine-grained tuff (FGT)
2. massive-bedded, fine-grained tuff (FGT)
3. planar-laminated, fine-gr. tuff, local flow-shear (PLAT)
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

Tos Oscar sediments
DT Dozer tuff
Tcs Basal Tertiary sediments

erosional unconformity

JTra Auld Lang Syne Group

Recent Sedimentary Deposits			
SULFUR GROUP	Lower Sulfur Group	Camel Congl.	Poorly sorted, matrix-supported epiclastic volcanic breccia with poorly developed bedding; dominantly subaerial deposition, talus and fanglomerate deposits, local hydrothermal eruption breccias (Crofoot Breccia) and sinter horizons.
			Poorly consolidated mudstone, siltstone and sandstone, minor pebble conglomerate and tuff, local marl and limestone horizons; fluvial and subaqueous deposition, fanglomerate, flood-plain and lacustrine deposits.
KAMMA MOUNTAINS VOLCANIC GROUP	Chocolate Formation	Badger Member	*Red Beds*: dominantly resedimented, clast- and matrix-supported volcaniclastic and volcanogenic breccia with a hematitic silt to granual matrix, minor interbeds of pebble to cobble conglomerate, lenses of hematitic siltstone and sandstone, and fine (ash) tuff beds; normal and reverse grading, subaerial mass wasting, subaerial, fluvial and lacustrine deposition, debris flow, talus, and fangomerate deposits.
			Basal *Red Beds*: interbedded sanidine-, quartz- and biotite-bearing mudstone, siltstone, sandstone, pebble and cobble conglomerate and resedimented volcanic breccia intercalated with white fine (ash) tuff; normal grading, subaqueous deposition, flood-plain(?) and turbidite deposits.
		White Alps Porphyry	Feldspar porphyry; massive, fine-grained intrusion comprised of 3 to 8% unoriented, dominantly equant feldspar phenocrysts ~3mm across randomly distributed in a fine-grained groundmass of plagioclase and quartz.
		Kamma Andesite	Glomerophyric feldspar andesite intrusions consisting of 3 to 5% hornblende(?) <5mm long and ~5 to 8%, dominantly clustered, plagioclase phenocrysts supported by a fine-grained crystalline groundmass of plagioclase, quartz(?) and minor magnetite, local flow lineation of phenocrysts.
		Rosebud Quartz Latite	Porphyritic quartz latite(?) intrusion (and flow ?) comprised of 2 to 3% hornblende(?), ~4% plagioclase (locally glomerophyric), 2 to >5% euhedral and broken sanidine (<2 cm in length), and <2% quartz (<3 mm across; <<1% bipyramidal smoky quartz, <1% clear quartz) phenocrysts set in a cryptocrystalline to fine-grained groundmass of plagioclase, sanidine, magnetite (2 to 4%) and quartz(?); the unit contains 2 to >5% dark, subrounded volcanic(?) xenoliths and is commonly flow foliated; lapilli-sized auto(?) breccias and chilled margins are common.
		?	
		Chocolate Tuff	Hematitic, crystal- and lithic-bearing fine (ash) tuff containing phenocrysts of acicular (<0.2 by 2 mm) hornblende(?) (3 to 5%), plagioclase (<2%), sanidine (<1%), fine-grained magnetite (<2%) and biotite(?), and <1 to 5% subrounded, volcanic (?) xenoliths; the unit is thinly bedded (planar laminated) and locally flow foliated.
		Bud Sequence	Well-bedded and locally graded heterolithic, tuff breccias; subaerial and subaqueous epiclastic deposits (see mine stratigraphy).
		LBT	Well-bedded, heterolithic tuffaceous mudstone, siltstone and sandstone, lapillistone and tuff breccia intercalated with fine (ash) tuff; subaerial and subaqueous syn-eruptive and epiclastic deposits.
		South Ridge Rhyolite	Quartz-bearing rhyolite dikes; commonly flow foliated.
	?		
	Dozer Formation	Wild Rose Member	Aphyric to weakly (<2%) feldspar porphyritic fine (ash) tuff, characteristically massive with local flow foliation and auto(?) breccia; subaerial deposition.
		Middle Member	Aphyric fine (ash) tuff characterized by thin bedding (planar laminated texture); subaerial to subaqueous deposition.
		Basal Member	Aphyric fine (ash) tuff, characteristically massive with local flow foliation and auto(?) breccia; subaerial deposition.
	Oscar Formation	Tcs	Carbonaceous, siltstone, sandstone and pebble conglomerate.
		Lava	Fine- to medium-grained andesite lava flow(s) and tuff.
		Tcs	Carbonaceous, siltstone, sandstone and pebble conglomerate.
	?		
KAMMA MOUNTAINS VOLCANIC GROUP	Barrel Springs Formation	Barrel Springs Member	Massive latite(?) fine (ash) tuff and volcanic breccia; subaerial deposits.
			Thick tuffaceous mudstone, siltstone and sandstone beds capped by a relatively thin bed of Auld Lang Syne pebble conglomerate; subaerial, fluvial and subaqueous deposits.
		Rabbithole Creek Member	Densely welded rhyolite pyroclastic breccia overlaid by sanidine-bearing pumiceous fine (ash) tuff; subaerial deposits.
	?		
AULD LANG SYNE GROUP	Undifferentiated		Graphitic slate, phyllite and quartzite with local calcareous siltstone and limestone horizons; milky and locally pyritic metamorphic quartz veins are common.

Erosional Unconformity

Scale: 1 : 10,000

1 cm = 100 m

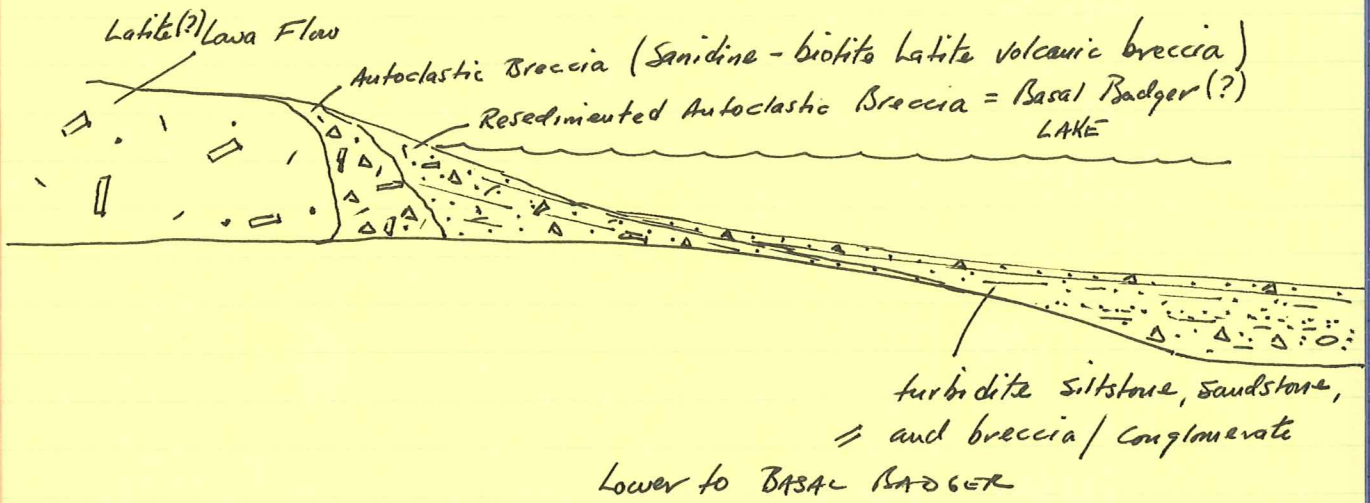
7-23-98

P. Mitchell

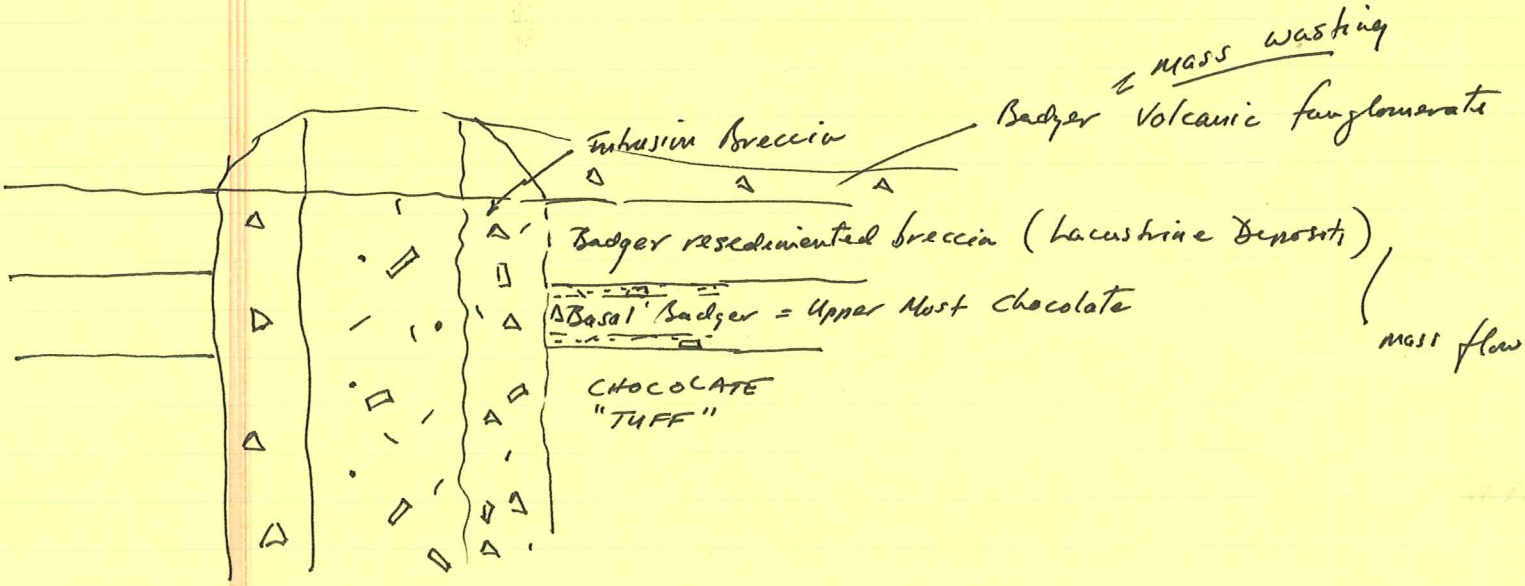
¿ Models ?

White Alps - Dreamland - Mother Lode

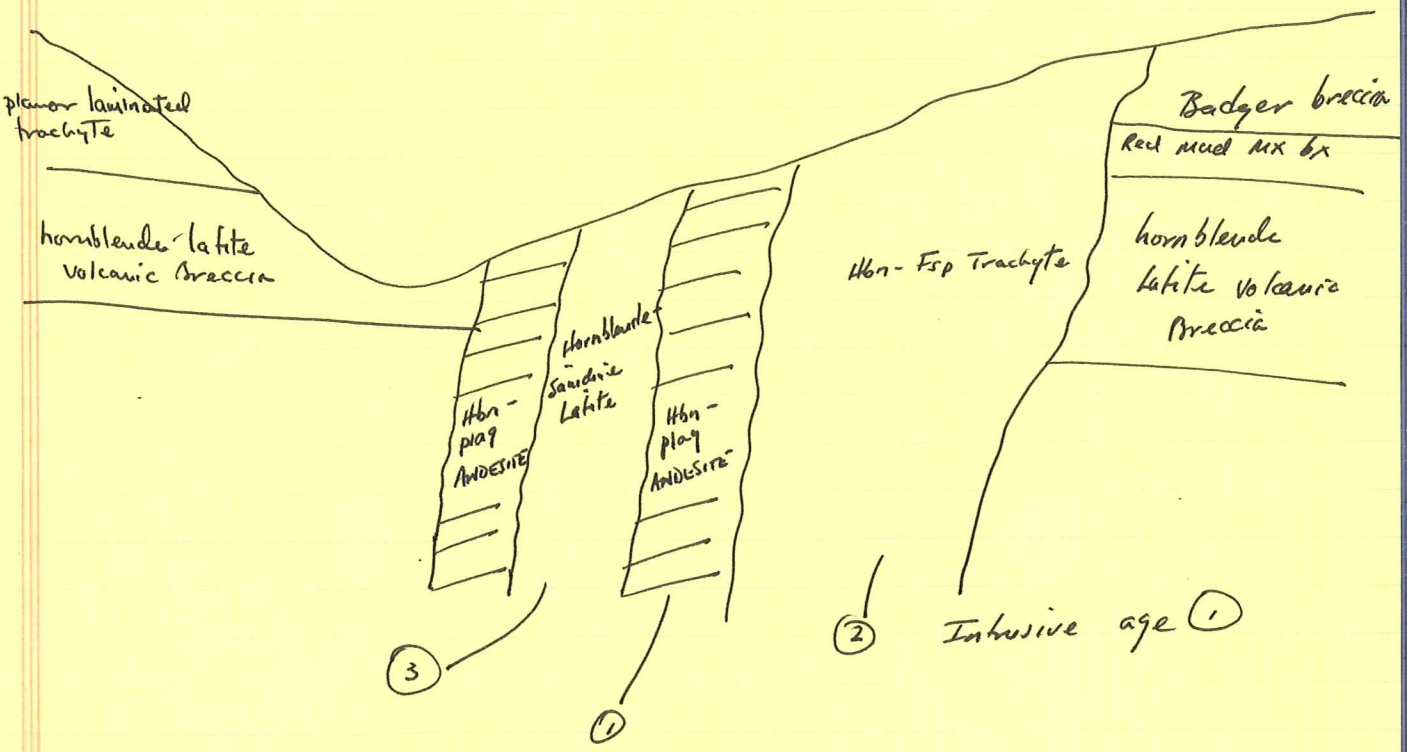
Dreamland Lava Flow

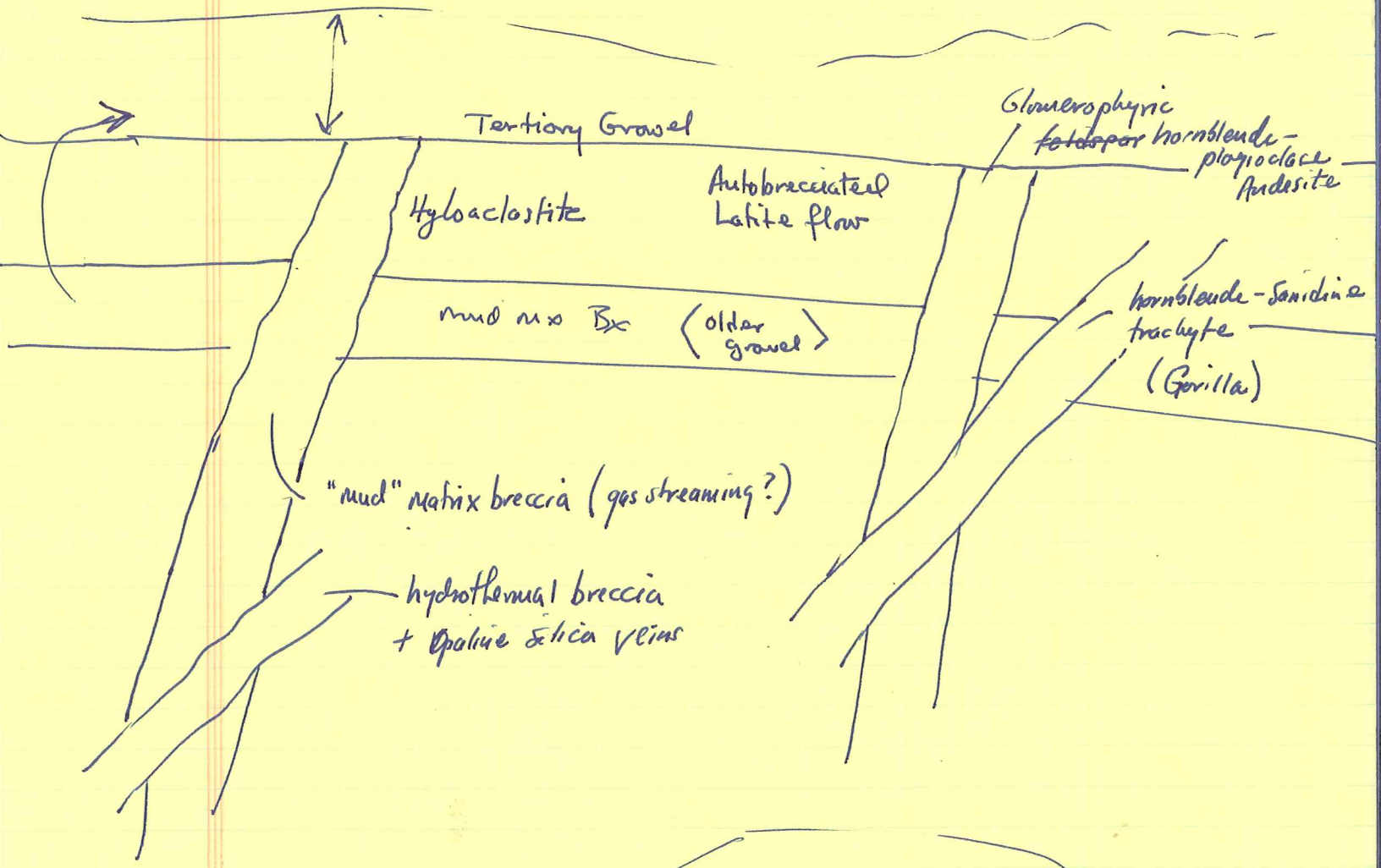


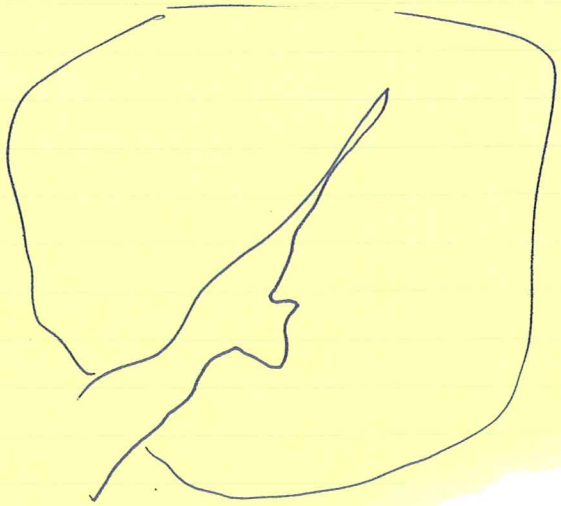
Dreamland Intrusion



Gorilla Intrusive Complex




Tertiary Gravel
Glomerophyric
~~feldspar~~ hornblende-
plagioclase
Andesite
Hyloaclastite
Autobrecciated
Latite flow
mud mix Bx
(older gravel)
hornblende-Sanidine
trachyte
(Gorilla)
"mud" matrix breccia (gas streaming?)
hydrothermal breccia
+ opaline silica veins



Intro Prograding Sequence Subsidence ? / water = ~~deepening~~ shallowing

"Badger" Resedimented Autoclastic Breccia - red sand/mud matrix
locally reverse grading = mass wasting (flow) deposits
thin to medium ± thick bedded

Resedimented Autoclastic breccia w/ sanidine + biotite?
red mud to sand matrix w/ turbidite deposition + bx mass flow deposits
thin - med. bedded

Red silt-sand matrix volcanic breccia (autoclastic)
Matrix contains pale green to white mica and sanidine, locally smoky quartz
intrusive breccia, possible pepperite, ~~or resedimented autoclastic breccia~~

Smoky Quartz-Biotite - Hornblende - Sanidine Latite (?)

Dreamland Latite (?)

Locations 60 & 61

* A good demarcation between the Badger and Chocolate formations may be the color change to Red, ie. red bed deposition / formation with the Badger = to all secondary sedimentary red beds.

This will separate out the recent fanglomerates except where the source is Badger.

BADGER FM — No biotite - Sanidine - Smoky Quartz / Red beds

CHOCOLATE FM — Biotite + Sanidine ± Smoky Quartz / Red beds

BREAK

Red volcanic breccia and conglomerate with interbedded siltstone and sandstone

Red mudstone, siltstone and sandstone

RED BEDS

Resedimented volcanic breccia

x-bedded, very-fine volcanic sand

Resedimented volcanic breccia and conglomerate

Very-coarse sand

Graded breccia bed, breccia to pebble conglomerate

Siltstone and very-fine lower sand, graded

Resedimented volcanic breccia and pebble conglomerate

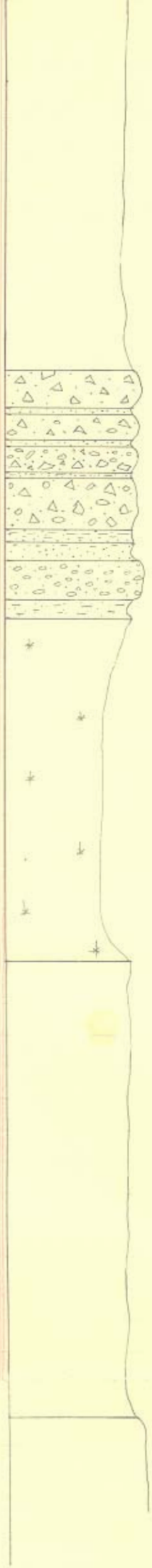
Siltstone and sandstone

Medium lower sand and minor very coarse lower sand graded upward to siltstone

Pebble conglomerate with subrounded clasts, clast supported

Red siltstone

white ash tuff



Red mudstone, siltstone and sandstone

Resedimented volcanic breccia

x-bedded, very-fine volcanic sand

Resedimented volcanic breccia and conglomerate

Very-coarse sand

Graded breccia bed, breccia to pebble conglomerate

Siltstone and very-fine lower sand, graded

Resedimented volcanic breccia and pebble conglomerate

Siltstone and sandstone

Medium lower sand and minor very coarse lower sand graded upward to siltstone

Pebble conglomerate with subrounded clasts, clast supported

Red siltstone

white ash tuff

Red mudstone, siltstone and sandstone

Red volcanic breccia with interbedded siltstone and sandstone

Stratigraphy

1. Describe and name (rock type) rock types in outcrop and Drill Core
2. Group the ~~units~~ above newly defined lithologies into "mapable" packages or units
3. Describe changes in rock texture, color and composition due to varying alteration types and intensities.
4. Evaluate ~~previous~~ existing factual geology and model.
5. Refine Stratigraphic Column
6. Identify marker horizons for ~~strat~~ sequence stratigraphy approach.

Prospects

1. 'Map' and identify drill targets at:

RECENT			Alluvium: fanglomerate, colluvium, eluvium, talus
	FLUVIAL + LACUSTRINE DEPOSITS	SULFUR GROUP	Camel Conglomerate
			Lacustrine Deposits (Sediments)
			Badger Formation
		KAMAB MOUNTAINS VOLCANIC GROUP	Chocolate Formation
			Barrel Springs Formation (See white note pad sheets)
			AULD LANGE SYNE GROUP

ROSEBUD DISTRICT STRATIGRAPHY

SULFUR GROUP

LOWER SULFUR GROUP

Camel Conglomerate

Poorly sorted, matrix-supported epiclastic volcanic breccia with poorly developed bedding; dominantly subaerial deposition, talus and fanglomerate deposits, local hydrothermal eruption breccias (Crofoot Breccia) and sinter horizons.

Lacustrine Deposits

Poorly consolidated mudstone, siltstone and sandstone, minor pebble conglomerate and tuff, local marl and limestone horizons; fluvial and subaqueous deposition, fanglomerate, flood-plain and lacustrine deposits.

KAMMA MOUNTAINS VOLCANIC GROUP

CHOCOLATE FORMATION

Badger Member

Red Beds: dominantly resedimented, clast- and matrix-supported volcaniclastic and volcanogenic breccia with a hematitic silt to granual matrix, minor interbeds of pebble to cobble conglomerate, lenses of hematitic siltstone and sandstone, and fine (ash) tuff beds; normal and reverse grading, subaerial mass wasting, subaerial, fluvial and lacustrine deposition, debris flow, talus, and fangomerate deposits.

Basal *Red Beds*: interbedded sanidine-, quartz- and biotite-bearing mudstone, siltstone, sandstone, pebble and cobble conglomerate and resedimented volcanic breccia intercalated with white fine (ash) tuff; normal grading, subaqueous deposition, flood-plain(?) and turbidite deposits.

White Alps Porphyry

Feldspar porphyry; massive, fine-grained intrusion comprised of 3 to 8% unoriented, dominantly equant feldspar phenocrysts ~3mm across randomly distributed in a fine-grained groundmass of plagioclase and quartz.

Kamma Andesite(?)

Glomerophyric feldspar andesite intrusions consisting of 3 to 5% hornblende(?) <5mm long and ~5 to 8%, dominantly clustered, plagioclase phenocrysts supported by a fine-grained crystalline groundmass of plagioclase, quartz(?) and minor magnetite, local flow lineation of phenocrysts.

Rosebud Quartz Latite

Porphyritic quartz latite(?) intrusion (and flow ?) comprised of 2 to 3% hornblende(?), ~4% plagioclase (locally glomerophyric), 2 to >5% euhedral and broken sanidine (<2 cm in length), and <2% quartz (<3 mm across; <<1% bipyramidal smoky quartz, <1% clear quartz) phenocrysts set in a cryptocrystalline to fine-grained groundmass of plagioclase, sanidine, magnetite (2 to 4%) and quartz(?); the unit contains 2 to >5% dark, subrounded volcanic(?) xenoliths and is commonly flow foliated; lapilli-sized auto(?) breccias and chilled margins are common.

Chocolate Tuff

Hematitic, crystal- and lithic-bearing fine (ash) tuff containing phenocrysts of acicular (<0.2 by 2 mm) hornblende(?) (3 to 5%), plagioclase (<2%), sanidine (<1%), fine-grained magnetite (<2%) and biotite(?), and <1 to 5% subrounded, volcanic (?) xenoliths; the unit is thinly bedded (planar laminated) and locally flow foliated.

Bud Sequence

Well-bedded and locally graded heterolithic, tuff breccias; subaerial and subaqueous epiclastic deposits (see mine stratigraphy).

LBT

Well-bedded, heterolithic tuffaceous mudstone, siltstone and sandstone, lapillistone and tuff breccia intercalated with fine (ash) tuff; subaerial and subaqueous syn-eruptive and epiclastic deposits.

DOZER FORMATION

South Ridge Rhyolite

Quartz-bearing rhyolite dikes; commonly flow foliated.

Wild Rose Member

Aphyric to weakly (<2%) feldspar porphyritic fine (ash) tuff, characteristically massive with local flow foliation and auto(?) breccia; subaerial deposition.

Middle Member

Aphyric fine (ash) tuff characterized by thin bedding (planar laminated texture); subaerial to subaqueous deposition.

Basal Member

Aphyric fine (ash) tuff, characteristically massive with local flow foliation and auto(?) breccia; subaerial deposition.

OSCAR FORMATION

TCS

Carbonaceous, siltstone, sandstone and pebble conglomerate.

Oscar Andesite

Fine- to medium-grained andesite lava flow(s) and tuff.

TCS

Carbonaceous, siltstone, sandstone and pebble conglomerate.

BARREL SPRINGS FORMATION

Upper Barrel Springs Member

Massive latite(?) fine (ash) tuff and volcanic breccia; subaerial deposits.

Lower Barrel Springs Member

Thick tuffaceous mudstone, siltstone and sandstone beds capped by a relatively thin bed of Auld Lang Syne pebble conglomerate; subaerial, fluvial and subaqueous deposits.

Rabbithole Creek Member

Densely welded rhyolite pyroclastic breccia overlaid by sanidine-bearing pumiceous fine (ash) tuff; subaerial deposits.

AULD LANG SYNE GROUP

Graphitic slate, phyllite and quartzite with local calcareous siltstone and limestone horizons; milky and locally pyritic metamorphic quartz veins are common.

SFPG Composite
Measured Section
South Ridge

Hecla schematic
Stratigraphic Section
Mine Area

2750

Chocolate Porphyritic Lava >300' thick

2500

Medium gray, dense, flow banded, sparsely porphyritic pheno andesite. Contact poorly exposed. Lower contact appears uncfm. Flow foliation discordant w bedding.

2250

Chocolate Tuffs >300' thick

Non-welded lithic tuffs w Chocolate frags.

Marker Porphyries >125' thick

Thin 5- 30' glomeroporphyritic lava flows

2000

Upper Bud Tuff >150' thick

Tan, brown, white, and red poorly sorted lithic tuff breccias

1750

Upper Brady Andesite:(see below) 90' thick

Brady Tuff: Mottled xtal lithic tuff. 26.5' thick

1500

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

1250

Lower Bud Tuff >1000' Thick

Heterolithic non-welded tuffs.
Largely pink rhyolite dominant clasts
Local phyllite chips from bsmnt.

1000

750

Local medium brown pumice rich moderately welded ash flow tuff

500

Coarse lithic tuffs contain pink flow banded rhyoliteclasts. Tuffs are deformed near contact.

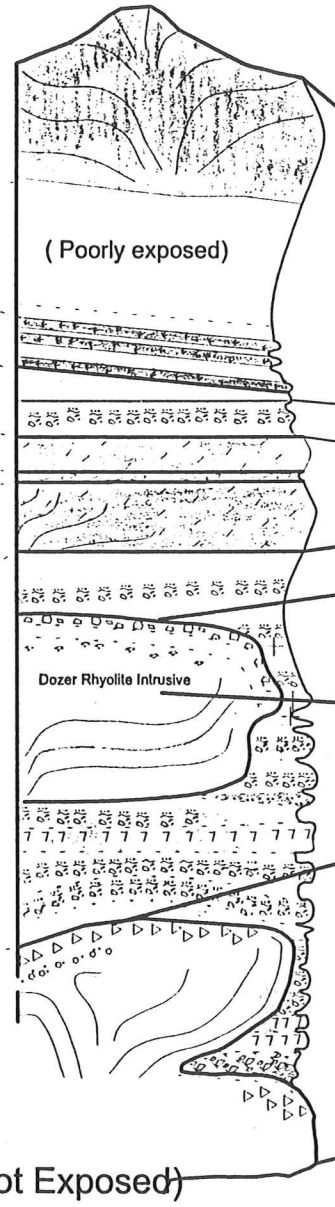
Dozer Rhyolite (Upper laminated member)

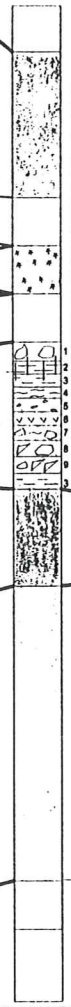
250

Pale tan, white to pinkish flow banded rhyolite.Locally spherulitic especially near contact. Well developed monolithic autobreccia within 100'feet of contact.

0

Dozer Rhyolite (Lower granular member)





Alluvial, colluvial, and lake bed deposits

Chocolate Fm.

Upper Bud

Bud Marker Bed

Lower Bud

LBT (Lower Bud Tuff)

1. Monolithic autobxf'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

C:\MYDATA\ROSEBUD\DRAWINGS\cdiag2.VCD 10/29/1996

RB trailer

Dear Randy Vance,

June 19, 1999

Included in this package should be a copy of my final report, my last expense report, a floppy disk containing the final report with and without color codes, and the strat picks (Dreamland.xls) that correspond with stratigraphic breaks on my re-logs. I hope they are suitable for data entry into Geomodel and/or Surpac. I think that the stratigraphic units in the Dreamland area are sufficiently planar that they should show the location of fault offsets well when viewed in three dimensions. I have much more confidence in my strat picks than I do in the faults as currently modeled on the cross-sections.

I will be at home (635-5399) through Tuesday the 22nd, and travelling thereafter until the 4th of July.

Sincerely,

Holly McLachlan

Holly McLachlan

6/26/99

TO: X Rick

__ Peter M.

FYI - Holly's Summary

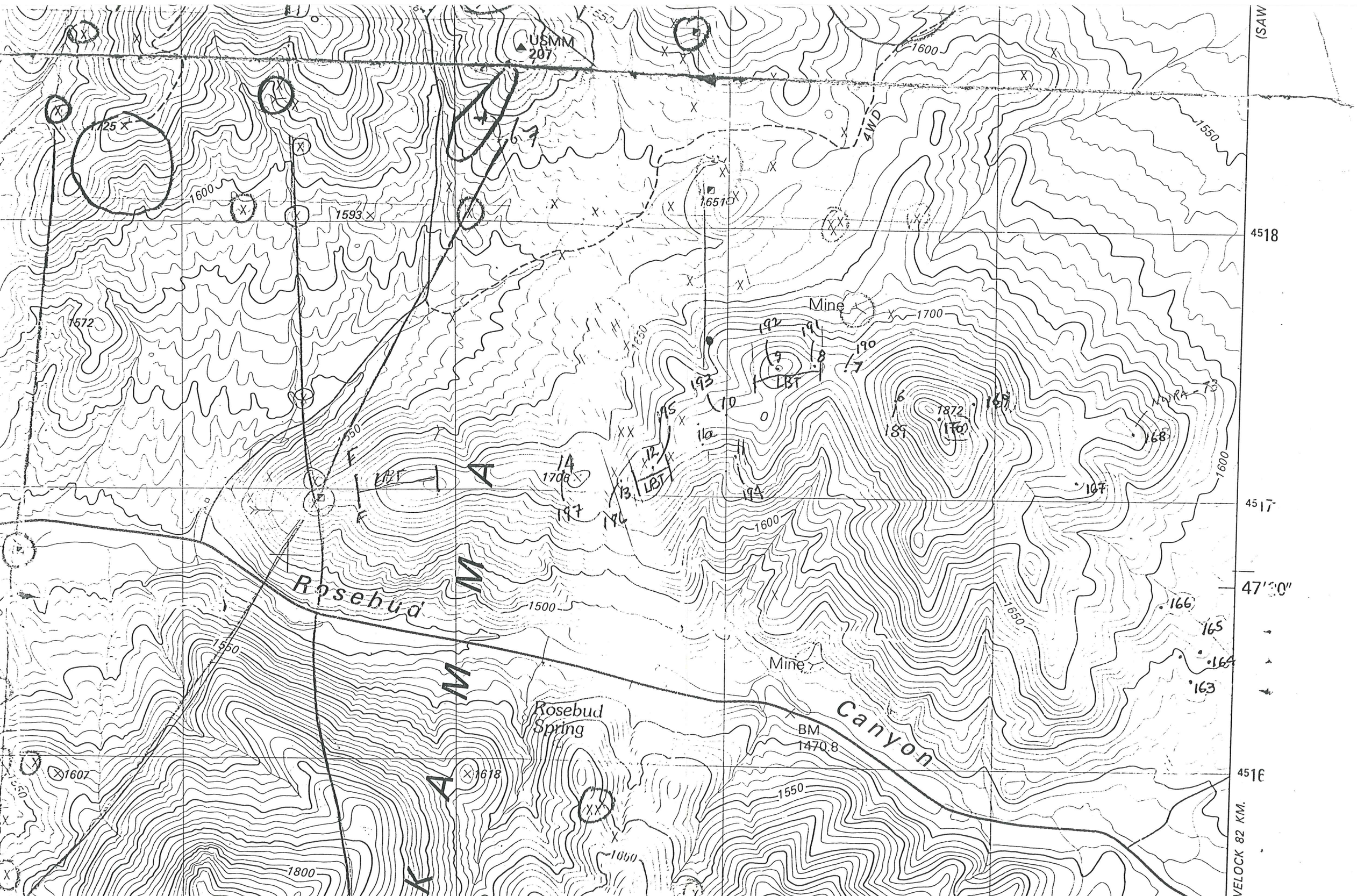
RBAOI \ Targets \ Dreamland \ Holly McLachlin

Please return when finished

-RBV

ROSEBUD STRATIGRAPHY
Thin Section Samples

SAMPLE NUMBER		LITHOLOGY		DESCRIPTION	HYDROTHERMAL ALTERATION
Field	Newmont	Unit	Field Name		PIMA Clay Analysis
	NWRA-6200	Porphyritic Autobreccia	Porphyritic Andesite Autobreccia	Intrusion: Cross cutting "Sill"	Strong Montmorillonite
	NWRA-6201	LBT(?)	Spotted Vitrophyrre	Intrusion(?): Dikes and Sills	Not Detected
	NWRA-6202	Relay Porphyry	Porphyritic Trachydacite	Intrusion: Dike or Plug	Not Detected
	NWRA-6203	Kamma Andesite	Porphyritic Andesite	Intrusion and/or Lava Flow	Not Detected; Plagioclase → Montmorillonite
	NWRA-6204-A	Gorilla Porphyry	Porphyritic Trachydacite – Block	Intrusion: Dike	Not Detected
	NWRA-6204-B	Gorilla Porphyry	Porphyritic Trachydacite – Flow	Intrusion: Dike	Not Detected
P-362	NWRA-6205	White Alps Porphyry	Porphyritic Andesite	Intrusion: Cross cutting "Sill"	Moderate Kaolinite
P-362	NWRA-6206	White Alps Porphyry	Porphyritic Andesite Autobreccia	Intrusion: Cross cutting "Sill"	Moderate kaolinite
P-361	NWRA-6207	Kamma Andesite	Porphyritic Andesite	Intrusion and/or Lava Flow	Weak Kaolinite
P-365	NWRA-6208	Lower Bud	Pebble Conglomerate	Volcaniclastic or Lapilli Tuff	Not Detected
P-364	NWRA-6209	Wild Rose	Relatively Aphyric Alkali Rhyolite	Flow-laminated Lava Flow	Not Detected
P-423	NWRA-6210	Rosebud Quartz Latite	Porphyritic Trachydacite	Intrusion: Dikes and Sills	Moderate Kaolinite
P-375	NWRA-6211	Upper Bud	Ignimbrite	Welded Trachydacite Ignimbrite	Weak Montmorillonite
P-358	NWRA-6212	Rosebud Quartz Latite	Porphyritic Trachydacite	Intrusion: Dikes and Sills	Weak Montmorillonite
P-360	NWRA-6213	Upper Bud	Pebble Conglomerate	Volcaniclastic or Lapilli Tuff	Weak Kaolinite
P-359	NWRA-6214	Chocolate Lavas	Hornblende (biotite) Trachydacite	Flow-laminated Lava Flow	Very Weak Kaolinite
	NWRA-6215	Rosebud Quartz Latite	Porphyritic Trachydacite	Diatreme(?) Breccia	Moderate Kaolinite
	NWRA-6216				
	NWRA-6217				


USMM
207
1725
1600
1593
1572
1651
4WD
1550
Mine
1700
1872
1650
1708
Rosebud
1500
Mine
Rosebud
Spring
BM
1470.8
Canyon
1607
1618
1800
(SAW
4518
4517
47'30"
4516
VELOCK 82 KM.

ROSEBUD STRATIGRAPHY

AGE	GROUP	FORMATION	MEMBER		COMPOSITION	THICKNESS (Feet)
Pleistocene	LOWER SULFUR GROUP		ALLUVIUM, COLLUVIUM, TALUS			
Pliocene (<6 Ma)			CAMEL CONGLOMERATE			40 to >250
Pliocene			LACUSTRINE DEPOSITS		?	
	KAMMA MOUNTAINS VOLCANIC GROUP	?	INTRUSIONS	KAMMA "ANDESITE"	?	
		CHOCOLATE FORMATION		RELAY PORPHYRY	?	
				ROSEBUD QUARTZ LATITE	Trachydacite	
				SPOTTED VITROPHYRE	?	
				WHITE ALPS PORPHYRY	?	
			BAGER MEMBER		?	
			CHOCOLATE MEMBER	CHOCOLATE LAPILLI TUFF	?	
				SOUTH RIDGE LAVA	Trachydacite	
				ROSEBUD MEMBER		
				CHOCOLATE LAVA		
			BUD MEMBER		Rhyolite	
			WILD ROSE MEMBER		Alkali Rhyolite	
			LBT LAVAS		Trachydacite	
			MINE TOS		?	2 to >250
		DOZER FORMATION			Alkali Rhyolite	
		OSCAR FORMATION	TCS			
			OSCAR "ANDESITE"		?	
			OSCAR MEMBER		?	
		BARREL SPRINGS FORMATION	BARREL SPRINGS MEMBER		Rhyolite	>2000
			RABBITHOLE RIDGE MEMBER		Rhyodacite	
Triassic to Jurassic	AULD LANG SYNE GROUP	UNDIFFERENTIATED				

STRATIGRAPHIC CORRELATIONS

MINE STRATIGRAPHY		DISTRICT STRATIGRAPHY	
SOUTH ZONE	*NORTH AND EAST ZONES*	*MEMBER*	*FORMATION*
SULFUR GROUP UNDIFFERENTIATED		SULFUR GROUP UNDIFFERENTIATED	
Not Present		KAMMA ANDESITE	
MARKER PORPHYRIES Includes the Fine-grained Pink Porphyry and Vitrophyre		GORILLA PORPHYRY	CHOCOLATE
		RELAY PORPHYRY	
		ROSEBUD QUARTZ LATITE	
Not Present		BADGER MEMBER	
CHOCOLATE Undifferentiated	CHOCOLATE LAVA Undifferentiated	CHOCOLATE LAVA Amphibole-dominant	
	LITHIC LAPILLI TUFF	CHOCOLATE LAVA AUTOBRECCIA	
	CHOCOLATE LAVA Undifferentiated	CHOCOLATE LAVAS Biotite-dominant	
	FINE CRYSTALLINE TCS	ROSEBUD VOLCANIC MEMBER	
	CHOCOLATE LAVA Undifferentiated	SOUTH RIDGE LAVAS Amphibole-dominant	
BUD Undifferentiated	UPPER BUD	UPPER BUD	
	PORPHYRITIC AUTOBRECCIA	WHITE ALPS PORPHYRY	
	MIDDLE BUD	LOWER BUD Undifferentiated	
	LOWER BUD		
FINE-GRAINED MASSIVE, PLANAR LAMINATED		LBT / WILD ROSE LAVAS	
LST "WANNA BE"	VITROPHYRE		
LST	FINE-GRAINED, SLIGHT PLANAR LAMINATED		
UPPER PINK MATRIX BRECCIA			
PLANAR LAMINATED	FINE-GRAINED MASSIVE		
VITROPHYRE	SLIGHT PLANAR LAMINATED		
LOWER PINK MATRIX BRECCIA	FINE-GRAINED MASSIVE		
OSCAR SEDIMENTS		MINE TOS	
DOZER		PORPHYRITIC DOZER	DOZER
		APHYRIC DOZER	
TCS		OSCAR MEMBER	OSCAR
AULD LANG SYNE GROUP Undifferentiated		AULD LANG SYNE GROUP Undifferentiated	

DREAMLAND REPORT **June 1999**

Holly McLachlan

Dreamland Re-logging Project:

The Dreamland re-logging effort was undertaken in order to identify the structures that were most likely responsible for the deep 0.8 oz Au hit in the Dozer unit in RS-425, and to determine how to best pursue this newly identified target with further drilling. In order to do this it was necessary to establish a working stratigraphy in the 'Chocolate Formation' cover unit in the Dreamland area.

19 drillholes were re-logged, 8 with core tails. These were strictly stratigraphic re-logs, done on the basis that grade was structurally controlled at Dreamland, and that the purpose in re-logging was to locate significant structures that either controlled or offset grade (see accompanying Dreamland.xls spreadsheet with strat picks).

The project was completed in 38 working days. It took about 25-30 days to identify mappable and loggable stratigraphic units that could be correlated from hole to hole in the immediate Dreamland area. The remaining time was used to draft the suite of 9 sub-orthogonal cross-sections that accompany this report:

- 4 long, N55°W mine x-sections (1900NW, 2100NW, 2300NW and 2500NW)
- 4 N03°E x-sections
- 1 N60°E x-section

Surface information: Peter Mitchell's 1"=200' map, and Craig Byington's structural map in the Dreamland area were used in creating and interpreting the cross-sections.

STRATIGRAPHIC UNITS: The rock units employed in the Dreamland cross-sections correspond for the most part with those used by Peter Mitchell in surface mapping over the Dreamland target area. The Badger, RQL, Kamma Andesite (KA) and, the FeMag-phyric sub-unit of the Chocolate effusives are four units he delineated in mapping that were readily identifiable in drill cuttings. The Dozer and Auld Lang Syne are present at depth in the Dreamland area, but do not crop out. Color codes are the same for logs and x-sections, and are given with the unit descriptions below.

Badger: The Badger conglomerate had been identified in previous, small-scale mapping of the Rosebud land package. It is a heterolithic to monolithic conglomerate, and is exposed at surface on the north side of the Dreamland area. In chips it can be pervasively lightly bleached compared to the underlying, fully indurated rocks, or it can yield soft, brick-colored sandy-clay chips. It is difficult to pick the base of the unit.
(Standard color code for this unit is light grey, Verithin 734½)

RQL: The RQL is the surface unit in the south 3/4ths of the Dreamland area. The RQL is sill-like to laccolithic in overall shape. It is a comparatively late intrusive feature that cuts the Tcs sediments, the Dozer and the Chocolate Group volcanics. The upper, glassy portion is strongly recrystallized along flow foliation and locally strongly to moderately bleached and argillized. It appears to be relatively flat lying in the Dreamland area and displays a moderately constant thickness of about 300' away from the feeder zone intersected in RS-444.

Feeder zone: the RQL may have come up a long the same break that drops the Dreamland rock package obliquely down to the south. Dikes of RQL are found at depth in

the Dozer in RS-444, however it has not yet been identified as cutting ALS in this area. While the sill-like, upper portion of the unit tends to be flow-banded and may have originally been glassy, at depth the groundmass is fine grained and massive. Phenocryst content is the same in both. The color code is Lavender for the flow-banded RQL, and Violet for the deeper, massive RQL, reflecting the fact that I was not initially sure that they constituted one unit.

The RQL is characterized by variably elongate to equant sanidine (or possibly orthoclase) phenocrysts that have distinctive rounded corners. These tend to resist alteration to a greater degree than the more numerous plagioclase phenocrysts, which occur either singly or commonly in glomeroporphyritic clusters +/- relict amphibole. The unit contains characteristic sparse "quartz" eyes which are more common in the aphanitic, flow-banded, flat-lying portion of the body. Pete Rogowski has suggested that some if not all of these are entrained particles of glass, especially the 'smoky' quartz phenocrysts that I have only found in the upper, sill-like portion of the unit.

The RQL extends northwest of the Dreamland target area as a narrow dike. It appears as a sill closer to the mine in 96-385, and in the mine workings (Peter Mitchell).

Kamma Andesite: This highly distinctive unit appears to cross-cut stratigraphy and is comparatively weakly altered in most places. It varies between about 200-300' in thickness and dips gently to the west. It has a fine-grained, massive, brown to dark brown groundmass that is locally bleached to tan, and is characterized by strongly glomeroporphyritic, white plagioclase phenocrysts.

This is the least altered of the major rock units in the area and may be a comparatively late, intrusive body. It was not observed cutting the Dozer or Tcs sediments as was the RQL, but the Kamma Andesite *may* be correlative with the 'Bud Marker Porphyry' dike in the East Zone deposit. I do not remember seeing the diagnostic rounded sanidines in the East zone dike that were characteristic of the BMP in the Dreamland holes or in 96-385, which is the hole closest to the mine in which I have identified RQL. Peter Mitchell stated that he has seen both the Kamma Andesite and the RQL as late, cross-cutting features in the current mine workings.

Chocolate Flows (country rock): The Chocolate package described here lies below the Kamma Andesite and is in apparent fault contact with the ubiquitous Dozer. It is modeled as a set of shallowly west-dipping subunits, based primarily on the textural features identifiable in chips. This package is modeled as dipping subparallel to the overlying Kamma Andesite.

FeMag-phyric sub-unit: This is the major 'type' **Chocolate Lava** identified by Peter. It has a tan, massive, fine-grained groundmass and is characterized by acicular subhedral to euhedral dark brown relict amphiboles +/- biotites. The amphiboles average about 3mm to 1-0.5 mm, and have an unusually skinny, almost platey habit. The distribution of these characterizing FeMag phenocrysts is highly variable. They can be almost completely absent over thicknesses of 100-200', and tend to be more densely distributed in the upper portions of the unit (solid Tuscan Red). There are also very sparse plagioclase phenocrysts locally in this unit, or in related sub-units in the Chocolate Flows package.

Bud-like volcaniclastics: Locally, clay-altered unwelded to semi-welded volcaniclastics are found within and at the base of the Chocolate Lava. The chips through these intervals are soft, mottled or highly variable in color. These volcaniclastic or epiclastic units are usually 20-35' thick.

Mmb/sub-aphyric/flow-banded: This unit extends into the core tails of 3-4 drillholes and is characterized on the basis of some larger-scale textural features that do not show up readily in chips. It is often separated from the overlying Chocolate Lava by a thin bud-like layer. It contains sparse feldspar and amphibole phenocrysts, and is characterized by its mmb's, aphanitic to fine-grained devitrified groundmass and planar laminations. It varies in color from dusty lavender to off-white, depending on the degree of bleaching.This unit is **not** the **LBT**. The LBT as seen in RS-446 lacks mmbs, lacks phenocrysts, and is texturally distinct, exhibiting none of the signs of glassy/devitrified.

Dozer: The Dozer is in the footwall of the Cave Fault throughout the Dreamland area. It is fine-grained, totally aphyric, and variably grey, cream or light sage green in color. It is somewhat less aphanitic than many of the overlying units (LBT, mmb-bearing, sub-aphyric Chocolate Flow).

Tcs: Tertiary siltstone through conglomerate, with ALS clasts and grains common. Not seen in the immediate Dreamland drilling.

Auld Lang Syne: The Mesozoic basement is intensely carbonaceous and sheared in the Dreamland area. It is black, shiny and graphitic on shear planes, and shot through with sparry white calcite veins.

STRUCTURE: There are 2 main structural breaks in the Dreamland target area. A set of high angle strike-slip or oblique-slip structures are the most prominent surface features, and at depth the low angle Cave fault (or related faults) place Chocolate on top of Dozer in many drillholes.

Cave Fault: The Cave fault places mmb-bearing Chocolate on Dozer in RS-408 in the Dreamland area. The regional attitude of the Cave fault is N43°E, 24°NW (Byington), and I have modeled it accordingly, with an apparent dip of 8.5° on the N60°E cross-section. It appears to project in a fairly straight line from where Charlie Muerhoff and Kurt Allen identified it to the southeast near to mine area. This may be something of an accident however, given that it disappears across the significant offset between RS-444, and RS-408, 425, and 450. It may be dropped down to the south of the Dreamland area.

Conjugate High-angle shears: I have interpreted the Cave fault as being dissected by a nearly east-west striking, multi-strand, high-angle, oblique-slip fault set. This break was mapped by Craig Byington, and is well suited to explaining the changes in rock units as one goes south from the Dreamland target area. Byington has 3-4 strands mapped at surface; I've labeled them 0,1, and 2, with 2 splitting into 2A and 2B on the west side of the study area (see 1"=200' map) Fault #3 does not appear to affect the rock units in the immediate Dreamland area. Fault #4 takes over from this multi-strand break on the west side of the study area; Byington has it cutting off 1,2A, and 2B just east of my westernmost N03°E cross-section (478425E).

There appears to be only a modest amount of down to the south movement on the 2A and 2B strands of the fault, although with bedding dipping west this apparent offset could

be explained by modest left lateral movement, in keeping with Byington's interpretation for post-ore offset.

There must have been significant strike-slip movement on either the 0 and/or 1 strands of this fault set. The rock units in RS-423 and (even more so) in RS-424 are sufficiently different from the Dreamland stratigraphy that up/down motion cannot account for the changes. Most of the apparent down-to-the-south motion is likewise taken up on the #1, although there may have been just as much motion on the #0. There is not enough drill data to the south of the Dreamland target area to say otherwise.

DRILLHOLE RECOMMENDATIONS:

RS-425 *appears to be in the same structural block as* RS-408 (see N60E cross-section for the best view). If my interpretation is correct and the #2A & 2B fault traces come through north of the 0.8 oz Au hit in RS-425, then a possible explanation for the grade could be that it is located just below the intersection of a major high-angle shear trace and the Cave fault. These high-angle faults (0 thru 2A&B) were mined historically at the surface, and Byington postulates that they form a set of conjugate shears with the South Ridge and Cave fault set. The intersections of these fault sets would be prospective, and may be tested by drilling an angle hole from the RS-408 pad designed to intersect the Dozer just below the present intercept. If there were a low angle trace extending up to the northeast from RS-408 it would be intersected. Given the uncertainty over where specific high-angle fault traces cut through these rocks, a pair of 180° angle holes would probably be needed to begin to pin down an ore trend.

Dreamland Lithology Table

Holly McLachlin, June,

Drillhole #	Badger from	RQL from	Mixed Lith Breccia from	RQL from	Kamma Andesite from	Tc:Bud-like from	Kamma Andesite from	Tc:Bud-like	Tc: Femag-phyric from
97-399	0	30	365	450	535	null	null	null	768
RS-400	0	170	null	null	490	null	null	null	837
RS-401	0	145	null	null	520	null	null	null	675
RS-402	null	0	null	null	null	null	null	null	null
RS-405	0	155	400	null	450	null	null	null	835
RS-408	0	17	810	null	840	null	null	null	1078
RS-423	0	35	null	null	null	null	null	null	393
RS-424	0	75	290	null	null	null	null	null	350
RS-425	null	0	435	null	640	null	null	null	1020
RS-443*	0	20				null	null	null	
RS-444	null	0	150	500	null	null	null	null	1300
RS-450	0	100	360	null	445	null	null	null	895
RB-1	null	0	390	null	null	null	null	null	null
RB-2	null	0	350	null	null	null	null	null	433
RB-5	null	0	null	null	null	null	null	null	null
RB-6	0	null	null	null	null	null	null	null	null
RL-223									
RL-224									
* need to relog									
RS-446	null	0	130	null	265	550	645	855	991

Dreamland Lithology Table

Tc: Bud-like from	Tc: mmb/aphyric from	Cave Flt from	Dozer from	RQL from	Dozer from	RQL from	Dozer from	ALS from	TD
910	null		1005						
977	1000		1310	1490	1501.5	1593	1609	2365	
null	null		null	null	null	null	null	null	200
1000	1045		1225	null	null	null	null	null	1500
1431	1442.5		1565	null	null	null	null	2257	2269
null	null		null	815	null	null	null	null	1140
null	null		null	585	965	null	null	null	1500
1250	1300		1551	null	null	null	null	2397.5	2418
null	null		1746	1778	1871.5	1872.5	1970	null	2047
975									
null	null	null	null	null	null	null	null	null	500
null	null	null	null	null	null	null	null	null	660
null	null	null	null	null	null	null	null	null	425
null	null	null	null	null	null	null	null	null	405
	Bud	mixed	LBT	Low angle fault	Bud	LBT	fault	LBT BX	LBT
	1648-1749.5	1749.5-1767.5	1767.5-2021.3	2005.6-2021.3	2021.3-2043	2043-2189.5	2189.5-2195	2195-2236	2236-2362

Dreamland Lithology Table

Holly McLachlin, June

RQL	Wht Alps?	Tos?	Tcs	RQL	Tcs	ALS
2362-2447.6	2447.6-2460	2460-		2866.6-2952.2	2952.2-3024	3024-3070.

PM

Newmont Exploration Ltd
Rosebud Mining Company LLC

To: George Langstaff Date: October 27, 1997

Fr: R. B. Vance

Re: Reply to your 10/20/97 memo on **Rosebud stratigraphy**

The compilation table you assembled will be most useful as a consolidated reference as we move forward in our attempt to figure out the true stratigraphy at Rosebud. In response to your memo, I commented directly on the text (copy attached). I also expanded a few points below; the following numbers correspond to those written on the text.

1. I've found some petrographic reports in the mine office, and I will get copies for the trailers. There also are some files of whole-rock data generated by LAC, and perhaps Hecla. For whole-rock data, we probably will have to collect our own samples. We should discuss standardized procedures for collecting samples. I likewise am not especially impressed by Pasteur's petrographic descriptions, which seem to encompass every chemical type under the sun.
2. I believe Formation with a capital F are units that are formally defined (type section, etc.). Formation with a lower-case "f" are informal mappable units. The Kamma Mtns group and its components are all informal. The Auld Lang Syne Group is formal.
3. Yes, I've noticed quite a variation. We will resolve this using petrography.
4. Isn't it exposed on the South Ridge? Perhaps that is not the best place to see it? We have many drill holes that should penetrate it. Once we know what it looks like, we can decide how to define it.
5. We will discuss the correlation over time, but I was leaning towards Steve's interpretation, except units 1-2 were Lower Bud, and units 8? and 9 were Bud Tuff.
6. Ditto for Tcs, Tos, and Oscar sediment problem. I do not believe they are the same.
7. By the way, is the rhyolite "flow" northeast of the mine area in the Badger, mapped by Brady, truly a flow in the Badger?
8. There are distinctive marker beds, they just may not be extensive. (So they are distinctive "locally", and not very useful).
9. The red color in the Badger stands out nicely on the air photos. At the base it is orange, going up it is red to maroon. I'm more convinced than ever that the color photos will help us in the mapping.
10. Alteration: most of the light colored outcrops (except for some of the Dozer) are argillized. Many of Brady's Tri units are silicification and argillization along structures.

Hecla's Stratigraphy from the Geology Model

Table 1 was assembled from Hecla's geology model. The units are not exactly the same as the 9 stratigraphic units in Table 2, but I haven't had time to discuss the differences with Kurt. (The model as shown on the sections may be somewhat dated.) There are several contradictions in the geologic model. I make the following points. First, the units change thickness on the same section as one crosses the high-angle NE striking faults. I asked Charlie Muirhoff why, but he didn't offer a reasonable explanation, except for the PMBX, which he conceded could be hydrothermal alteration. Second, the very important LST is not modelled in the southern part of the South zone. If they can't see it in core holes spaced 25 feet apart, then its usefulness as a stratigraphic unit in the greater mine area is limited, and it has little value across the district. Third, the FGT shown below, and on the modelled sections, has apparently been subdivided into the Upper Bud--Bud Marker--Lower Bud Tuff units. Fourth, the Bud Marker Bed actually consists of 3 marker beds (two are common, 1 is less common, according to Charlie). If it really is seen in 2 or 3 places, it is not really a marker bed. Kurt believes it is a sill. Lastly, we discussed the other day the Tcs/Tos/Oscar sediments problem.

Charlie and I also discussed the presence or absence of Tcs at the base of the Tertiary pile. As we develop the structure contour map, and supplement it with logging and relogging, we should routinely make a judgment call on whether the basal contact of the Tertiary section is faulted or depositional. (I would quickly add that RS-410 is a faulted contact, with an impressive number of intensely polished shear planes and lacking any sandstone, pebble conglomerate, or siltstone.)

Recommendations for Attacking the Stratigraphic Problems

I have several thoughts on where we go from here. The next step requires an emphasis on the rocks, which means we should begin relogging select holes across fences through the mine area. We've spent enough time examining what others have done, and I don't see the answers we need using the previous data. Santa Fe was on the right track, but they relogged and correlated only one hole (RL-89c), instead of dozens.

1. We should construct a northwest and/or northeast fence of 5-10 holes extending from outside the deposit, through Dozer Hill, and beyond the other side. The holes should be deep ones, showing as much of the section as possible. We can't get bogged down with alteration at this point, so it might work best to start on both ends and work towards the deposit. As alteration intensity increases, we may have to rely on earlier logs, the mine model, etc. Undoubtedly structures will complicate things, but we should try to work around them.

2. The emphasis should be on the Bud-Chocolate and Dozer-Bud contacts, with further internal subdivisions, if possible. As we build the fence diagram, more details will emerge. The ultimate goal is to correlate Hecla's LBT (which on average is only 300-400 feet thick, including PMBX) with its stratigraphic corollary outside the mine.

3. For each hole relogged, a strip chart should be prepared, showing rock type and color, and interpreted strat unit. The strip charts should be at a common scale (1: 10?). This will allow us to "hang" the various strat columns on the wall for correlation.

4. We need to assemble all of the past petrographic studies in one file (in the trailer) and assess which are most useful, before we begin submitting more thin sections or samples for whole-rock oxide analysis.

5. After studying the air photos, I'm suspicious that there may be significant periods of erosion between some of the pyroclastic units and flows. If correct, the contacts will not be planar, but instead will be irregular, showing channels and fills (typical of many volcanic sequences, of course!). As one example, the contact on the eastern end of South Ridge between the Upper Bud and Chocolate is not parallel to the base of the welded contact on the upper flank of Big Chocolate Mountain. Additional field checking of existing 1:2400 maps should resolve these problems. I noted on Friday the SFPG geologists recognized this phenomenon (summarized in their monthly reports). Incidentally, they concluded late in the year (1996) that the mine sequence (LBT) does correlate to the Brady andesite.

Table 1. Hecla modelled stratigraphy

Hecla mine sections (1:20 scale)
South Zone Looking NE

Apparent thicknesses of the major modelled stratigraphic units, in feet

Unit	Abbrev.	100S	50S	0N	100N	200N	300N	400N	500N	700N
9	Bud	>50	>60	>45	>60	145	>160	>120	>110	
8	FGT	30	42	35,42	70	60,70	60,40,70	60,150	150	150
5	PMBX	120	95	75,115	58,130	130	137	140,190	65,110	95
4	FGT	93	90	84	102	>75	>110	135	100	96
2	Tos	>40	>65	>120	>55	-	-	>50		>60
Total Thickness		333	352	406	417	420	477	645	470	401

Notes:

RBV, 10/97

Unit numbers refer to modelling domains, not stratigraphic units.
LST (leopard spotted texture) is identified only on the northern 4 or 5 sections, and occurs in the upper FGT unit. Where LST is present, the unit numbers are 6 for FGT, 7 for LST, and 8 for FGT.
Numbers separated by commas indicate differing thicknesses on the same section, segregated by high angle faults.

Table 2. Hecla's Rosebud mine stratigraphic section

Qal	alluvium, Qc

erosional unconformity

CT	Chocolate tuff
UBUD	Upper Bud
BMB	Bud marker bed
LBUD	Lower Bud tuff
LBT	~~Lower Bud tuff~~ (0-600 feet)

1. monolithic autobrecciated, fine-grained tuff (FGT)
2. massive-bedded, fine-grained tuff (FGT)
3. planar-laminated, fine-grained tuff, local flow-shear (PLAT)
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

Tos	Oscar sediments
DT	Dozer tuff
Tcs	Basal Tertiary sediments

erosional unconformity

Jtra	Auld Lang Syne Group

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From: Gail Mahood <gail@pangea.Stanford.EDU>
To: VA_WINN.Winnemucca(PMIT1)
Date: Fri, Apr 23, 1999 5:55 PM
Subject: Rosebud petrography

Hi Peter:

I've sent some petrographic observations by snail mail and am sending them as an attachment to this e-mail. Forgot to mention in that letter that I looked over the chemistry you sent. It's a little hard to interpret because I'm not sure which samples are which, and the petrography shows many of the rocks to be highly silicified or to contain lots of calcite, but the main point I take away from the data is that the rocks are a little on the alkalic side, but not likely to have been truly peralkaline. Maybe the best comparison to unaltered rocks would be to the Yellowstone silicic rocks.

Give me a call if you have any questions after reading it.

Regards,
Gail

4/23/99

Dear Pete:

I've been looking at the thin sections and hand specimens you sent me. The following comments are based entirely on petrographic affinities, since I still struggle with the Buds, the LBT (which isn't the same thing as the Lower Bud Tuff), the tuffs versus lavas flip flops, and the various rose names as they relate to stratigraphy! With some feedback from you about where the rocks fit into the stratigraphy, we might be able to come to some firmer conclusions.

SOUTH RIDGE TRAVERSE

3620A and **3621** look similar in that they both contain relatively large glomeroporphyritic clots of good plagioclase plus a population of smaller feldspar phenocrysts that are strongly zoned, show poorly developed twinning, and often show anomalous blue extinction colors, which lead me to conclude that they are more anorthoclase-like in composition (these latter could look like sanidine in hand specimen). The abundance of mafic microphenos (all totally shot, but look like amphibole) and the abundance of groundmass mafics indicate that these are too mafic to be rhyolitic. Also, phenos are fairly abundant, at which stage I'd expect to see quartz, which I don't see as a pheno in thin section (though I could believe that you run across them occasionally in hand specimen). So I'd call these two samples porphyritic hornblende trachydacite lavas. The samples aren't from the same lava, because 3621 has a much higher proportion of phenocrysts (about 15%), but they could be related units.

3622, 3623, and 3626 are very similar-looking lavas; 3623 and 3626 are more highly altered with the development of incipient "spots" in the groundmass typical of slightly alkalic lavas. All of these lavas have sparse plagioclase phenocrysts and plag microphenocrysts in a felted groundmass rich in feldspar and oxides. Because 3622 is less altered, I can identify sparse opx microphenocrysts, and what looks like one olivine microphenocryst. These are the kinds of rocks that commonly used to get called latites. Now they'd probably be called trachydacites.

3620B is a lava intermediate between 3620A and 3622/23/26 in crystal content, but if one wanted to lump it with something else, I'd be inclined to lump it with 3622/23/26 because the microphenocrysts are sparse and they appear to be plag, rather than the ternary-ish feldspar in 3620A. This sample is strongly silicified.

3625A is a massive aphyric lava. Forced to give this aphyric rock a name, I'd call it an alkali rhyolite, but I am not confident of that name. The groundmass has enough oxides in it that this clearly isn't a typical rhyolite; it's got to be a more Fe-rich alkali rhyolite if it is a rhyolite. It's got the light color of rhyolites, as opposed to trachydacites or trachytes, but that could be a function of silicification.

3625B is a strongly silicified lava that contains very sparse small plagioclase phenocrysts and sparse plag microphenocrysts. Based on what I see in thin section, I believe that what appears to be quartz phenocrysts in hand specimen (as described on the hand-written sheet) is actually secondary quartz filling holes. This sample shares with 3622, 3623, and 3626 the presence of plag phenos and microphenos, though in smaller proportions. In terms of light color it is more like 3625A but this could just be silicification. So I don't know which way to assign it. This would be a case where an analysis might help.

3628 is listed as a massive to weakly flow-banded lava under "our name" and as Dozer under "old name", but the thin section and hand specimen of that number are rhyolitic crystal lapilli tuff. I think this must just be some sort of transposition of sample numbers. The majority of this tuff consists of ash-sized pumiceous clasts, but there are also fragments of dense perlitic glass and of other fragmental rocks (perhaps ignimbrites). The little reddish clasts look like trachytic volcanic rock with abundant oxides. Crystals are plagioclase and sanidine.

3624 is also a rhyolitic lapilli tuff. It differs from 3628 in consisting almost entirely of pumiceous clasts (though there are some dense perlitic clasts) that seem like they could have been derived from a single source. It also contains many fewer feldspar crystals. The sample is silicified.

3627 is a densely welded ignimbrite. It contains small phenocrysts of plagioclase, sanidine, and quartz, which makes it rhyolitic in composition. It contains volcanic lithics that have a felted groundmass texture like 3626. Contains abundant cc.

WILDROSE CANYON

3631 is a strongly flow-laminated, strongly silicified alkali rhyolite lava in Wildrose Canyon that contains sparse sanidine phenocrysts and microphenocrysts. I'd call it an alkali rhyolite based on the absence of plag phenos and the fact that I don't see ghosts of lots of mafics (though admitedly the rock is so far gone in silicification that this may have removed evidence for mafics). (Because it has obvious sanidine and no plag, I wouldn't lump it with **3622** and **3623**, which means it might be better to not call them Wildrose and to, instead, retain the name Chocolate.)

3632 is a perlitic alkali rhyolite vitrophyre that contains sparse phenocrysts of sanidine and plagioclase, as well as microphenocrysts of a green (Fe-rich?) amphibole. The glassy groundmass is strongly hydrated and perlitic. The texture looks a bit like the sort of densely welded vitriclastic texture characteristic of some of the high-temperature ignimbrites in NW Nevada, in which the glassy shards are blocky rather than tricuspate. On the other hand, I know that you can get psuedo-clastic textures in hydrated and altered rocks. So I'd want to walk out this feeder to see if it fed a lava or an ignimbrite.

ROSEBUD PEAK

3633 is listed as vesicular Rosebud quartz latite under "our name" and as Chocolate Tuff under "old name". The thin section looks to me like a very strongly silicified lapilli tuff. So does the sawed surface of the rock, but I can see how someone would call the weathered surface a quartz latite with mafic xenoliths. I suppose that another interpretation would be that it is an autobreccia of a lava flow. But even if that's what it is, I wouldn't make it an autobreccia of the Rosebud lava/intrusion because phenocrysts aren't as abundant as they are in **3620A** and **3621** and because the phenos are mostly sanidine (though, admittedly it does look like a fair number of the phenos were plucked in making the section). What looks to me like secondary quartz cements the grains together. I would call this a strongly silicified rhyolitic crystal lapilli tuff.

BARREL SPRINGS AREA

3615 is a rheomorphic porphyritic devitrified rhyodacitic ignimbrite.

3616 is a rhyodacitic crystal vitric tuff. Contains crystals of plagioclase and sanidine; little or no quartz. Probably of fallout origin or very slightly reworked in a lake setting.

3617 is a tuffaceous siltstone. Probably a lake deposit.

3618 is a rhyolitic crystal vitric lapilli tuff. It contains abundant crystals of plag and quartz and lesser sanidine. Most of the lapilli are pumice. It has beautiful vitriclastic texture, with delicate shard shapes preserved, indicating that it hasn't been reworked much.

If you've got any questions or comments, let me know. I figured I'd hold onto the thin sections and samples until we had talked, in case, based on your thoughts, I want to go back and take a look at them again.

Best regards,

Gail Mahood
Professor

Newmont Exploration Ltd.
Rosebud Joint Venture

To: Randy Vance **Date:** October 20, 1997

Fr: George Langstaff

Subj: **Problems of Stratigraphic Nomenclature**

The following findings are based on an examination of written material related to stratigraphic nomenclature of rocks in the Rosebud area (e.g., map legends, figures, reports). Eleven stratigraphic legends have been compiled into a single table for ease of comparison (attached). The table consists of direct quotations with punctuation changes, minor deletions (primarily for Brady), and the use of abbreviations. Text I have inserted is delineated by square brackets. No attempt has been made to reconcile the various stratigraphic legends with the various geologic maps or to verify the geologic maps. 0

There are few petrographic and no geochemical data to support written descriptions of the various rock units. Sample locations for the eight samples submitted to Paster by Kortemeier are not known. Paster's petrographic descriptions of Brady's 33 rock samples are not entirely consistent with Brady's descriptions of the respective rock units. For example, heterolithic tuff (according to Paster) was mapped as Chocolate vent facies, lithic tuff was mapped as lake sediments, vitric tuff was mapped as intrusive Dozer (Wildrose Canyon), and there is a high degree of variability between samples from the same rock unit. However, no attempt is made here to modify Brady's descriptions to match Paster's.

I'll look for them.

I agree.

In spite of the limited scope of this study and the uncritical reliance on what has been written, a few observations which should help us understand what has been done and what can still be done in terms of stratigraphy are possible.

1. Much of the stratigraphic nomenclature is inconsistent with standards for formal stratigraphic nomenclature. However, most workers have used the same sequence of units (though not necessarily the same characteristics or contacts) so established rock unit names will probably be adequate for exploration purposes., but we need to define and formalize them better. There are too many "buzz terms"

— Correct

2. Composition terms, such as Dozer Rhyolite and Brady Andesite, have not been documented by whole-rock geochemical data. Use of the term "formation" would be more proper but is probably not necessary at this point. Agree. We will get WRO data of the Dozer, and see if it is rhyolite. I suspe Brady andesi may not be "andesite."

Turner's proposal to use the term "sequence" for some units is inadvisable given the way the term is currently used by stratigraphers. 2 "Formation" and "member" can be used informally to subdivide the Kamma Mountains Group in whatever detail is necessary or expedient.

The generally indiscriminate use of the terms "tuff" and "base surge" as rock unit names has been rightly criticized by Turner.

I agree.

OK, but a general term. Must be pyroclastic, so Dozer tuff is incorrect.

not a rock, not OK.

3. Some rock units are unique to specific authors and would not be useful without field checking. Agree Examples include the Goblin Gulch Dacite and Knob Gulch Breccia of Mueller, the Brown

What is this?

Rhyolite Flow of Brady, and the Black Knob and AAA members of the Chocolate Formation of Kortemeier and McLachlan (CPK/HSM). Some we may adopt, most probably abandon.

4. Descriptions of the Gator formation differ substantially (compare Massingill and CPK/HSM). Either Gator or Badger overlies the Chocolate Formation on Massingill's map but CPK/HSM may not have recognized this. Field checking would be necessary to verify that the distinction between the Gator and Badger is a useful one. I believe it will be. Charlie has ideas on Gator also. Gator may be absent locally.

3 5. Reported phenocryst contents of massive Chocolate units differ. Sanidine reported by LAC geologists may have been misidentified (without the benefit of thin sections?). Brady, CPK/HSM, and Allen reported plagioclase. LAC, Brady, and Allen reported biotite but CPK/HSM reported amphibole as the mafic phase. CPK/HSM emphasized the glomeroporphyritic textures of plagioclase in massive Chocolate units but other observers did not mention it.

OK 6. There are contradictory interpretations of the Upper Bud. It is considered epiclastic breccia by Maynard, LAC, Mueller, Brady, Dirt Biker, and Allen but lithic tuff by Massingill, SFPG, CPK/HSM, and Muerhoff and Holmes.

4 7. The lower contact of the Chocolate Formation is one of the key contacts within the Kamma Mountains Group. Unfortunately, there are few guidelines for placing the contact. CPK/HSM even state that it is a gradational contact between Chocolate surge tuff and Bud surge tuff (no mention of the genetically related ash-flow tuff which should overlie a base surge) and Mueller also indicates that the lowermost Chocolate member is "Bud-like". Information examined so far does not indicate how one is to distinguish "Bud-like" Chocolate Formation from "genuine" Bud. Perhaps the contact has been placed at the top of the uppermost green rocks.

There are possibly three ways to pick the lower contact of the Chocolate Formation: at the base of the first massive flow or sill (as suggested by Turner), at the top of the bedded breccia underlying lithic tuff (as implied by Maynard and Dirt Biker), or at the top of the uppermost breccia or lithic tuff. The first choice will not work if the flows or sills are laterally discontinuous or if sills are not parallel to bedding. The second will not work if lateral facies equivalents of the bedded breccia are not bedded or if the bedded unit is only locally developed (such as in paleotopographic lows) and this choice may in fact split genetically related deposits into different formations. The third choice is the least ambiguous lithologically and stratigraphically but would also be compromised by lateral facies changes and may also split genetically related components of the same pyroclastic eruption.

8. SFPG geologists and Turner have postulated equivalence of the "Mine Host Sequence", or LBT, and the Brady Andesite. The following evidence suggests the Brady Andesite is more likely equivalent to the Bud Marker Bed:

	Brady Andesite	LBT	Bud Marker Bed
Depth below Choc. Fm.	>150' (SFPG), 200' (Maynard)	>200' (M&H)	<100' (M&H)
Thickness	300' (SFPG)	320-440' (Allen)	30-130' (Allen)
Height above Dozer Fm.	>1000' (SFPG)	0-200' (M&H)	400-500' (Allen)
Upper contact	Upper Bud Tuff (SFPG)	Lower Bud (Allen)	Middle Bud (Allen), Upper Bud (M&H)
Lower contact	Lower Bud (SFPG)	Tos, Dozer (Allen)	Lower Bud (Allen)
Phenocrysts	amph. (SFPG), plag & bi (Brady)	none	plag (Allen)
Vesicles	none	yes (Allen)	none (Allen)
Laminations/ Flow banding	yes (SFPG), not mentioned (Maynard, Brady)	yes (Allen)	none (Allen)
Breccia/Tuff	crystal-lithic (SFPG)	heterolithic (M&H), monolithic (Allen), ash (Allen)	none (Allen)

5

Contact relations and textures suggest the Bud Marker Bed is a better match to the Brady Andesite than the LBT. Thicknesses are imprecise but indicate the Brady Andesite and Bud Marker Bed are closer to the Chocolate Fm. than to the Dozer Fm. whereas the LBT is in contact with the Dozer Fm. or, locally, Tos. The absence of crystal-lithic tuff and the lesser thickness of the Bud Marker Bed could be explained by thinning and merging of the two sills (as named by Maynard) or flows of the Brady Andesite toward the mine area. Termination of the tuff could thus be due to intrusion or to stratigraphic pinchout. Alternatively, one of the sills or flows of the Brady Andesite may pinch out toward the mine area.

If the Brady Andesite and Bud Marker Bed are equivalent, where is the LBT on the surface? It would be equivalent to Tbb1 of Massingill, Tcb2 of Maynard, LBT of LAC, Wildrose Rhyolite of Mueller and Dirt Biker(?), and Tbs1 of Brady and would be included in the Lower Bud of SFPG.

9. Sedimentary rocks which directly overlie the Auld Lang Syne Group have been referred to by several names but are distinctive in that they contain clasts of only pre-Tertiary rocks. These sandstones and conglomerates are interbedded locally with basalt (Mueller) or andesite (Dirt Biker, Brady). They lie stratigraphically below the Dozer Formation. This suite of sedimentary and volcanic rocks has been named the Oscar Formation.

6

However, the Oscar Formation of Muerhoff and Holmes and of Allen includes lithic tuff and breccia which has only a minor amount of Auld Lang Syne clasts and is stratigraphically above the Dozer Formation. If the two Oscar Formations are equivalent, the formation must contain an upper part which is dominantly volcaniclastic and the intervening Dozer Formation must be intrusive.

Turner's "Lower Bud Sequence" contains Auld Lang Syne clasts near the base and so may include what Allen considers Oscar Formation.

10. The Kamma Mountains Group contains an abundance of pale, massive, very fine grained to aphanitic volcanic and subvolcanic rocks. Phenocrysts are generally rare and fine grained. Although they may be of some help in identification in core, they are probably of little use at the surface. Identification of these fine grained rocks is problematic. Most workers have lumped most such rocks within the Dozer Formation.

To complicate matters further, the Dozer is described as a flow dome complex by Brady and Turner. Conceivably, both intrusive and extrusive rock bodies could be assigned to the unit.

However, if the Dozer Formation on South Ridge is the extrusive flow dome and is overlain by the Lower Bud, then similar rocks higher in the section, such as those north of Wildrose Canyon(?) and at the east end of Rosebud Canyon, must be younger and should be named something else. Correct

Correct. Steve made this point too. Until we see the domes coalesce, we should assign separate name.

8

11. There are no distinctive marker beds in the Rosebud mine area so long-range correlations are difficult. In fact, massive aphyric or weakly porphyritic units, plagioclase-phyric flows or sills, monolithic breccias, lithic tuffs, and flow-banded rocks occur throughout the section. Glauconite Green rocks of the Bud Formation on South Ridge have caught the eye of many workers but there is no guarantee the green color persists laterally or is stratigraphically significant. 7

Bedding is apparently restricted to the Bud and Oscar formations and rocks younger than the Chocolate. Although the presence of bedding may be indicative of the Bud Formation (in the absence of Auld Lang Syne clasts) if between the Dozer and the Chocolate, not all the Bud is bedded. + Gator

9 Brady emphasized the characteristic red silty matrix of the Badger but Massingill saw red matrix in the lower Bud (equivalent to Red-Brown Ugly Unit of Lac and LBT) and single outcrops in the Kamma Mountains show gradations from red to grey matrices.

The Rosetta Stone for Kamma Mountains stratigraphy has not yet been found. If the various primary volcanic units are geochemically distinctive, whole-rock analyses of major, minor, and trace elements may help.

NEWMONT GOLD COMPANY
ROSEBUD J.V.

To: Whomever Date: November 23, 1998

From: George Langstaff

Subject: **GL's Descriptive Rock Nomenclature for Rosebud Logging**

Rocks are identified as felsic volcanic rock (F), mafic volcanic rock (M), tuff (T), breccia (B), or sedimentary rock (S) as follows:

A. **Volcanic Rocks** (dominantly aphanitic)

1. Root Name – Composition
   - **F** – felsic, few mafic minerals (e.g., trachyte, dacite)
   - **M** – mafic, more mafic minerals (e.g., andesite, trachyte)
2. Prefix - Structure
   - **b** – brecciated (includes flow breccia as well as strongly fractured rock)
   - **s** – pseudobreccia (formed by alteration along fractures)
3. 1st Suffix – Texture
   - **a** – aphyric (no phenocrysts >=1 mm)
   - **p** – porphyritic
     - distinctive varieties:
     - **sp** – sparsely porphyritic (=<1% phenocrysts)
     - **cp** – coarsely porphyritic (some phenocrysts >4 mm)

   a. 2nd Suffix – Minerals (precede with dash; if more than one, list from least to most abundant, left to right, e.g., Fp-q,p,k)

q – quartz	**b** - biotite
f – feldspar	**h** - hornblende
p – plagioclase	**y** - pyroxene
k - K-feldspar	**o** - olivine

4. Parentheses – Descriptive Features

am – amygdaloidal	**sp** - spherulitic
bd – banded	**ve** - vesicular
gl - glassy	
lm – laminated (planar features =<2 mm)	
mmb – contains mafic magma blobs	

Examples: Mcp-y,p – coarsely porphyritic pyroxene < plagioclase-phyric basalt
bFa – brecciated, aphyric rhyolite
Fsp-f(mmb) – sparsely porphyritic, feldspar(can't be identified)-phyric latite with mafic magma blobs

Note: Alteration can eliminate mafic phenocrysts, can make K-feldspar and plagioclase indistinguishable, and can make porphyritic rocks appear to be aphyric.

The abundance of phenocrysts can vary within the same unit and some types of phenocrysts (e.g., quartz) may not be present everywhere.

B. **Pyroclastic Rocks**

1. Root Name
   T - Tuff
2. 1st Suffix – Fragment Type (if more than one, list from least to most abundant left to right and separate by slashes, e.g., Tv/c)
   a – ash (=<2 mm by definition but more useful to identify pyroclasts >=1 mm as lithic, vitric, or crystal)
   b - blocks ± lapilli ± ash (>6.4 cm)
   l - lithic lapilli ± ash
   v - vitric lapilli ± ash (icludes shards and pumice)
   c - crystal lapilli ± ash
   a. 2nd Suffix – Minerals
   see A.3.a. above
3. Parentheses – Descriptive Features
   lp - lithophysal
   sw - strongly welded
   ww - weakly welded
   and see A.4. above

Examples: Ta – ash tuff
Tl/c-q,k – lithic < crystal lapilli-ash tuff with quartz < sanidine phenocrysts

C. **Breccias** – if extrusive, pyroclastic, or sedimentary origin is uncertain; otherwise use protolith root name; can include fault breccias if protolith is uncertain

1. Root Name
   B - Breccia
2. 1st Suffix – Number of Clast Types
   m – monomict
   p - polymict
3. 2nd Suffix – Support
   c – clast-supported
   x – matrix-supported
4. 3rd Suffix – Rounding of Clasts
   r – rounded
   s – subrounded to subangular
   a – angular

Examples: Bmca – monomict, clast-supported breccia with dominantly angular clasts
Bpxa/s – polymict, matrix-supported breccia with subrounded clasts more abundant than angular clasts

D. Sedimentary Rocks

1. Root Name

   S – clastic sedimentary rock

2. 1st Suffix – Dominant Clast Size

   c – conglomerate (>2 mm)

   a. Prefix – Support

      c – clast-supported

      x – matrix-supported

   s – sandstone (.0625 to 2 mm)

   m – mudstone (<.0625 mm, includes silt and clay)

3. 2nd Suffix – Secondary Clast Size (if more than one, list from least to most abundant and separate by slashes, e.g., Sst/p)

   p – pebbly, conglomeratic

   n - sandy

   d - muddy

   t - tuffaceous

4. 3rd Suffix – Structure

   1 - massive (beds >10 m thick)

   2 - thick-bedded (.05-10 m thick)

   3 - medium-bedded (.01-.05 m thick)

   4 - thin-bedded (1-10 cm thick)

   5 - laminated (<1 cm thick)

5. Parentheses – Descriptive Features

   bt - bioturbated

   cs - cross stratification

   fs - fossils

   gn - normally graded bedding

   gr - reversely graded bedding

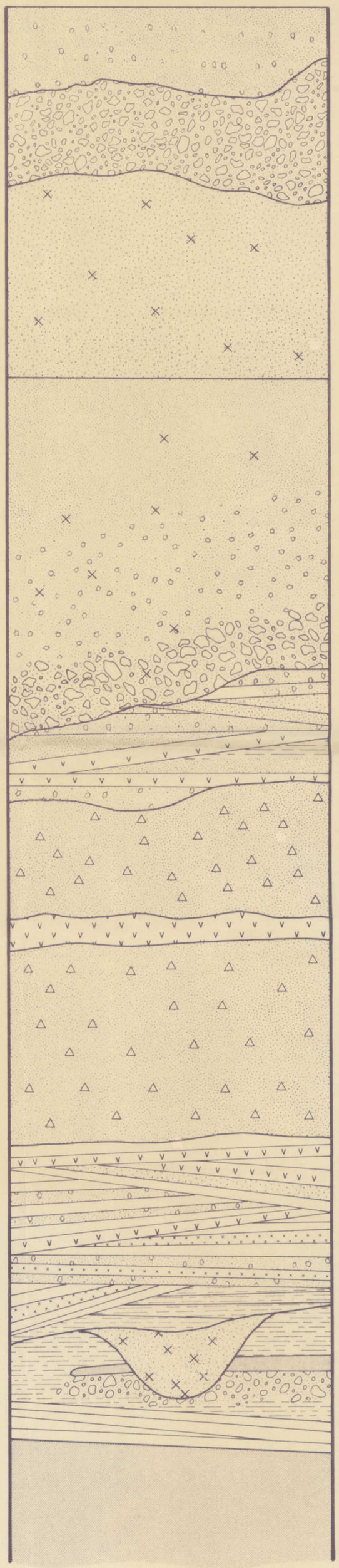
   sf - syn-sedimentary folds

Examples: xSct1 – tuffaceous, matrix-supported conglomerate without apparent bedding

Ssd4(gn) – thin-bedded, muddy sandstone with normally graded bedding

Sm – massive mudstone

FORMATION	MEMBER	SYMBOL	THICKNESS	
	BADGER		0'-200'	
CHOCOLATE FORMATION	GATOR		200'-300'	
	CHOCOLATE TUFF	Tct	400'+	SILICEOUS WELDED TUFF. SPARSE PHENOCRYSTS OF BIOTITE AND SANIDINE, MAROON TO GRAY TO CHOCOLATE BROWN. RESISTANT. MAROON LITHICS-LAPILLI-SIZE.
	CHOCOLATE PYROCLASTICS	Tcp	0'-800'	COARSE, UNBEDDED PYROCLASTICS. TUFFACEOUS MATRIX. BLOCK-SIZED LITHICS NEAR BASE. GRAY TO RED.
	BUD BEDDED PYROCLASTICS	Tcb_2	200'	WELL BEDDED, MODERATE TO WELL SORTED PYROCLASTICS. RED TO BROWN TO PALE GREEN
	FELSITE SILL	Ts	250'	MAROON, FINE GRAINED EQUIGRANULAR.
	BUD GRAY TUFF	Tcb_2	50'-100'	GRAY CRYSTAL-LITHIC TUFF
	FELSITE SILL	Ts	400'	MAROON, FINE GRAINED EQUIGRANULAR.
	BUD BEDDED PYROCLASTICS	Tcb_2		WELL BEDDED, MODERATE TO WELL SORTED PYROCLASTICS. RED TO BROWN TO PALE GREEN.
	BUD CRYSTAL-LITHIC TUFF	Tcb_2		Tcb_1 - CHANNEL- FILLING HETERO-LITHIC TUFF.
DOZER TUFF	LAMINATED MEMBER	Td	~200'	LAMINATED WELDED TUFF, VITROPHYRIC, VITROPHERE PARTLY GONE TO SPHERULITES.
	GRANULAR MEMBER	Td	VERY THICK	GRANULAR, TAN-COLORED TUFF.



EXPLANATION

UNCONFORMITY

	EXTRUSIVE		INTRUSIVE	
TERTIARY / MIOCENE	Tb	- BADGER FORMATION	Tid	- DIKES
			Ts	- SILLS
CHOCOLATE FORMATION	Tcg	- GATOR MEMBER		
	Tct	- CHOCOLATE TUFF MEMBER		
	Tcp	- CHOCOLATE PYROCLASTICS MEMBER		
	Tcb_2	- BUD BEDDED PYROCLASTICS MEMBER		
	Tcb_1	- BUD PYROCLASTICS MEMBER		

ANGULAR UNCONFORMITY

	Td	- DOZER TUFF	

ANGULAR UNCONFORMITY

400' 200' 0 200' 400'
SCALE

LAC MINERALS U.S.A. INC.
1395 Greg St. • Sparks, Nevada 89431

AREA & TYPE OF MAP

ROSEBUD PROJECT
ROSEBUD STRAT. COLUMN
AS SEEN ON SOUTH RIDGE

STATE NEVADA	COUNTY PERSHING	SCALE	CON. INT.
DATA BY S.R. MAYNARD	DRAWN BY J.A. MUELLER	DATE 1/90	NO.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		STRATIGRAPHY OR THE ROSEBUD MINE AREA	heavy	lines represent unconformities																		
2				South Ridge		Dozer Hill Area						South Ridge				Rosebud Canyon				South & North Zones		East Zone
3		Massingill (1988)		LAC (1990) -Maynard		LAC (1991)		Mueller (1991)		Brady (1995)		SFPG (1996)		S. Ridge, Dozer, N of RShear, Black Knob HMS/CPK (1997)		Turner (1997)		Dirt Biker (1993)		Muerhoff & Holmes (1995)		Allen (1997)
4																						
5																						
6																						
7									Tf	Tertiary fanglomerate-angular to subrounded frags of volcanic and pre-Tertiary												
8										basement; thickens to E in SW area; flooded with opaline cement that												
9										intercalates along range-bounding faultin east; probably correlative												
10	Tb	basalt								with lower Camel Conglomerate												
11	Tbs	Barrel Springs-volcaniclastic conglomerate, sand, siltstone and mudstone, sparse Mz clasts,							Ts	Lake sediments-volcanic ash deposited in local lakes along margins of												
12		abundant volcanic clasts; interbedded unwelded pyroclastic/airfall tuffs								Kamma Mtns; incompletely lithified air tuff and fine volcanic ash debris												
13	Tpl	Pansy Lee-conglomerate, sand, sltst &mdst, abundant Mz clasts (no volcanic clasts); clast size,								deposited in thin horizontal layers												
14		abundance and rounding decreases upward through unit																				
15	Tbf	Badger-conglomerate, clay, silt, sand, airfall tuffs, bedded clay matrix conglomerate interbedded	Tb	Badger					Tb	Badger-epiclastic breccia & fanglomerate												
16		with lacustrine/floodplain finer grained beds; lahartic in part																				
17	Tgb	Gator Breccia-pyroclastic breccia, matrix of welded, flow-banded, crystal- and lithic-rich rhyolitic	Tog	Gator					Tbr	rhyolite flows												
18		tuff; clasts up to bomb size of mostly fl-bnd tuff, possibly intrusive vent facies in places, massive											Tg	Gator Fm-breccia member(?) imbricated, locally well rounded								
19	Tcf	Chocolate-pyroclastic, crystal-rich (sanidine and biotite), welded, rhyolitic-quartz latitic,	Tcf	Chocolate Formation	CT	Chocolate Tuff-maroon and gray moderately	Tcf	Chocolate volcanics-rhyolite flows & pyroclastics	Tc	Chocolate Tuff	Tc	Chocolate		conglomerate with volcanic clasts and silty matrix								
20		flow-banded tuff; lithic rich in places; multiple cooling units	Tcb	tuff-siliceous, welded tuff, sparse phenos		welded, fine grained sanidine-bearing tuff,	Tcf	fg rhyolite flows, 2-5% plag phenos+-bt, purple-brown		consists of volcanic lahars (Tcbx), welded and flow banded ash	Tcp	porphyritic lava-med gray, dense, flow-banded, sparsely	Tcbl	Chocolate								
21				of biotite and sanidine, maroon to gray to		lithic tuff and volcanic breccia (CIC, TCrP), locally	Tcf	fg rhyolite flows, 5-15% plag phenos		flows (Tvl), vapor-phase altered flows (Tcp), vitrophyres as well as		porphyritic andesite; flow foliation discordant with bedding		Black Knob member-blk to gray, dense, flow-banded, andesitic;								
22				chocolate brown; resistant; maroon lithics -		includes green, glauconite-rich, lithic lapilli				extensive areas of non-welded ash flow tuffs (Tc) all of probable	Tcsa			stubby, locally glomropor plag; may be correlative with Big Choc flow								
23				lapilli size		tuff horizons especially near its base (C2C);				quartz latite comp; 4-10% 1-3.5 mm plag, 1-3% .2-1 mm bi,		AAA member-dusky purple, amph-phyric, aphanitic andesite; amph										
24						alteration typically consists of bleaching and				gmass composed of feldspar, clay, quartz and hematite		to 3 mm >> stubby plag phenos; locally resembles Brady Andesite										
25			Top	pyroclastics-coarse, unbedded pyroclastics;		moderate to strong argillization	Top	pyroclastic and debris flow breccias			Tcl	tuffs-nonwelded lithic tuffs w/Choc frags		though more porphyritic and less flow banded								
26				tuffaceous matrix; block-sized lithics near							Tcsu			surge tuffs-well bedded, non-welded lithic tuffs w/Choc frags								
27				base; gray to red			Top	pyroclastics, 5-15% plag phenos			Tcl			lithic breccia-massively bedded, non-welded lithic bx, lahars(?), etc.								
28							Top	intermediate flows (andesite, dacite)			Tcmp	Marker Porphyries-glomeroporphyritic lava flows		Marker Porphyries-5-30 ft thick glomeroporphyritic lava flows;								
29														at least 3 in bottom 150 ft of Chocolate								
30																						
31																						
32																						
33							Tcl	rhyolite with dark lithics, locally possible ash flow tuff														
34							Tcs	epiclastic breccia or sediment, Bud-like	Tbf	Brown Rhyolite Flow-massive, fine-grained, rhyolite flows that appear to interfinger			Tcsl	surge tuff-includes 3 ft welded lithic ash flow tuff w/clasts								
35										of the Choc Tuff; 1% .02-2.5 mm plag; 1-2% .1-1 mm biotite, gmass of				of Choc; gradational contact with Bud Surge Tuff								
36										feldspar, limonite, quartz, and biotite												
37	Tbtx	Bud Breccia	Tcb2	Bud bedded pyroclastics	BudBx	Bud Breccia	Tbv	Bud volcanics-epiclastic breccia, cgl, sdst & debris flow	Tbs	Base Surge Deposits												
38				well bedded,moderate to well sorted				deposits with interbedded rhyolite flows; epiclastics		unstratified, horizontal layers of well sorted epiclastic; layers may	UpBud	Upper Bud Tuff-tan, brown, white, and red.										
39				pyroclastics; red to brown to pale green				green and purple		aggregate 1-3 ft thick showing graded bedding and encompass volcanic		poorly sorted lithic tuff breccias										
40	Tbb	upper pyroclastic member-pyroclastic breccia of welded, flow-banded, crystal- and lithic-rich,			upper	green to locally brown, crudely bedded,	Tbx	epiclastic deposits, bedded	Tbs4	debris of similar composition; at least four groupings within individual stratigraphic												
41		quartz latitic tuff; clasts up to bomb size of mostly flow-banded tuff				poorly sorted lithic lapilli tuff and volcanic breccia;				horizons numbered from 1 at base , interfinger with andesite flows												
42						variably glauconitic; bleached when altered																
43																						
44																						
45																						
46																						
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52																						
53																						
54																						
55			Ts	felsite sill-maroon, fine-grained, equigranular	TMB	grey to locally brown, fg porpyritic tuff marker bed;	Tbc	Choc-like rhyolite intertwidded with Tbx; sparse bi	Ta	thin andesite flows, most very fg; 1-3% .02-.2 mm plag; 1-3% .05-.5 mm bi	UpBrand	Upper Brady Andesite-same as lower											
56			Tcb2	Bud Gray Tuff-gray, crystal-lithic tuff		3-5% euhedral feldspar phenos (up to 3mm) which		to several % phenos; includes TMB	Tbs3	same as Tbs4, above	Brtuf	Brady Tuff-mottled, crystal-lithic tuff										
57			Ts	felsite sill-maroon, fine-grained, equigranular		are commonly replaced by clay or pyrite when	Tbw	Wildrose-like rhyolite intertwidded with Tbx; aphyric	Ta	same as Ta, above	LwBrand	Lower Brady Andesite-pale green to dark purple vfg										
58						altered						andesite; flow-banded on cm to mm; 5% amphibole to 2 mm										
59	Tcb2	bedded member-medium to thick bedded, epiclastic and pyroclastic breccia, weak to strong	Tcb2	Bud bedded pyroclastics, as above	lower	usually green, well bedded, lithic lapilli tuff and	Tbx?	same as above	Tbs2	same as Tbs4, above	LwBud	Lower Bud Tuff-heterolithic, non-welded tuffs; dominantly										
60		weld/cementation; clasts mostly pebble size or smaller, individual beds may display inverse	Tcb2	Bud crystal-lithic tuff		epiclastic rocks with abundant green glauconite						pink rhyolite clasts, locally rhyolite chips from basement;										
61		grading										locally medium brown, pumice-rich, moderately										
62	Tbb1	lower epiclastic member-epiclastic breccia, pale red matrix, weak to moderate consolidation,	Tcbl	channel-filling hetero-lithic tuff	LBT	Lower Bud Tuff-red-brown(RBUR), tan and	TwrLBT	Wildrose Rhyolite-fine-grained, aphyric, rhyolite flows,	Tbs1	same as Tbs4, above		welded ash flow tuff; coarse lithic tuffs contain										
63		erosional cross-cutting relationships, cross bedding, thin silt and clay interbeds with pebble				grey lithic tuff and fine-grained to banded		red-brown or purple, typically flow-foliated or				pink flow-banded rhy clasts; tuffs are										
64		to cobble size massive breccia				tuff; when mineralized, it is typically bleached		laminated; includes LBT				deformed near contact										
65						and argillized with a distinctive flesh and/or																
66						pale green gray appearance																
67																						
68							Twl	intrusive or flow domes														
69																						
70							Twf?	intermediate flows, porphyritic														
71																						
72							Twd	same as above														
73																						
74																						
75																						
76																						
77																						
78																						
79	Tdt	Dozer Tuff-pyroclastic, bedded, poorly welded, crystal poor, rhyodacitic tuff, crystal- and	Td	Dozer Tuff	DT	Dozer Tuff-pale green to grey fine-grained	Td	Dozer Rhyolite-fg, aphyric, olive brown to sage green	Tdf	Dozer Formation-probably flow dome complex of rhyolite composition; most is	Tdi	Dozer Rhyolite			Td	Dozer Formation-flow-banded, locally	Tdv	Dozer volcanics-probably an early rhyolite flow dome	Tdt	Dozer Tuff-ranges in thickness from 0 to locally 1000 ft in the project area;				
80		lithic-bearing in places, flow-banded in places+, multiple cooling units, multiple vitrophyres near				locally weathered, lacks visible phenos;		(locally pink, gray or purple) rhy flows, variable foliation		flow-banded, platy rhyolite; 2 specific flow domes identified, one at the	Tdu	upper laminated member-pale tan, white to pinkish, flow				vesicular probably exogenous rhy flow		complex, appears that outcrops topo relief on top		aphanitic, fine-grain, siliceous, weakly flow-laminated, ash flow tuff with	Tdf	Dozer Formation-consists of rhyolitic (felsic? as petrographically described by Ted Pestar),				
81		base of unit				bleached when altered		attitudes; locally includes pyroclastic breccia, undiff		mouth of Rosebud Canyon, one N of Wildrose Canyon; <1% .1-.2mm		banded rhyolite; locally sphaerulitic especially near contact;		dome(s) with significant relief on its upper	Tdb	Flow dome breccia-similar in nature to Dozer flow dome								
82							Tgg	Goblin Gulch Dacite-fg, aphyric, magnetite-bearing		sanidine, gmass of quartz, feldspar, magnetite and glass		well developed monolithic autobreccia within		surface		seq; however, are composed dominantly of monolithic,		local 'ghost', monolithic autobreccia; where mineralized, the Dozer Tuff						
83								dacite flow; blocky to planar jointed; dark brown				100 ft of contact		-upper flow laminated zone		dome-related, breccia bodies and some related near-		is fractured, pervasively silicified (near total replacement is not uncommon),						
84								weathering; dark gray fresh interior			Tdl	lower granular member		(equivalent to "Brown Flow" or Wild Rose		vent flows and flow breccias; best exposures of these		and argillized						
85			Td	granular member-granular, tan-colored			Thg	Knob Gulch Breccia-pyroclastic breccia with clasts						Flow Domes)		rocks occur at the E end of Rosebud Canyon								
86				tuff				of Tgg, Twr, and Td; locally bedded epiclastic breccia														
87								and pebble conglomerate	Tos	Oscar-multiple andesite flows similar to "Ta"; most fine grained, one coarser;					Tos	Oscar Sequence	Tof	Oscar Fm-series of intermediate to mafic but predom						
88										5-8% .2-2 mm plag, 4-5% .05-1 mm altered bi, gmass feldspar and hematite					Tos	Oscar andesite-andesitic flows, generally		andesitic volcanic flows and subordinate interbedded						
89																fine-grained with flow breccias & tuffs		conglomerate (J-T and K clasts) and tuffaceous						
90																		sediment interbeds						
91					Trans	transitional sediments-locally occurring basal T	Tt	transitional sequence-conglomerate, laminated siltstone							Tos	Basal Tertiary Seds-carbonaceous	Ts	Sedimentary rocks-generally consisting of sands, silts,						
92						sediments composed of thinly bedded grey to black		interbedded with basalt flows								sandstone, siltstone, and pebble		grits & sgl which at Dozer Hill directly overlie the J-Tr						
93						siltstone and sandstone derived from Mesozoic										conglomerate		basement rocks and are presumed to be equiv to the						
94						basement rocks												sedimentary portions of the Oscar Formation (Tof)						
95		Jurassic - Triassic Auld Lang Syne Group - carbonaceous phyllite, minor qtz-rich metasandstone and argillaceous metacarbonate, quartz veins																				
96		347 Vs DARK GREY																				
97	INTRUSIVES																					
98	Tia	andesite intrusive	Tid	dikes			Ti	feldspar porphyry intrusions and dikes	Tdi	Rosebud Canyon Rhyolite Dome-intrusive brecccia with weak flow banding;							Til	Latite dikes and plugs [shown younger than the						
99	Tir	felsite intrusive	Tis	sills						5% <.2 mm quartz, 2% hematite (after pyrite?), gmass .01-.05 mm feldspar								Chocolate Formation]						
100	Tib	autoclastic intrusive breccia, rhyolitic(?) matrix and clasts							Tcbx	Chocolate Vent Breccia-vertical flow banding												
101	Tir	intrusive rhyolite, probably vent areas of Chocolate Formation							Tri	small dikes and sills-12% .2-2.5 mm feldspar, 4% .3-2 mm sanidine, 1% .3-1 mm												
102	Tit	intrusive quartz latite, probably vent areas of Chocolate Formation								quartz, 1% biotite altered to chlorite, gmass of feldspar, quartz and glass												
103									Tri	Dreamland Intrusive-crystal-rich rhyolite; 30-35% .02-2.5 mm sanidine and												
104										orthoclase, 20% .5-1.5 mm qtz, 1% .1-.2 mm muscovite, gmass of clay, feld, qtz												
105									Tc vent	Chocolate Fissure Vent-angular fragments of Tia and Tc												
106									Tbf vent	Intrusive Dome for Tbf-intrusive breccia and vertical flow banding												
107									Td/Tdi	Wildrose Canyon Intrusive-flow dome similar to Rosebud Intrusive;												
108										1-2% .2-1.5 mm feldspar, 80-85% lithic fragments composed of Tdi lapilli,												
109										10-15% gmass of quartz and clay												
110																						

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WORK SHEET