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ASSESSMENT REPORT

2001 PROSPECTING PROGRAM (Aug. 6 2001)
AND DATA COMPILATION

BOOMER CLAIMS 1 – 18

YC 18834 - YC 18851

62 19’

133 28’

NTS 105 K / 6

REPORT PREPARED BY BRIAN SCOTT

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SUMMARY

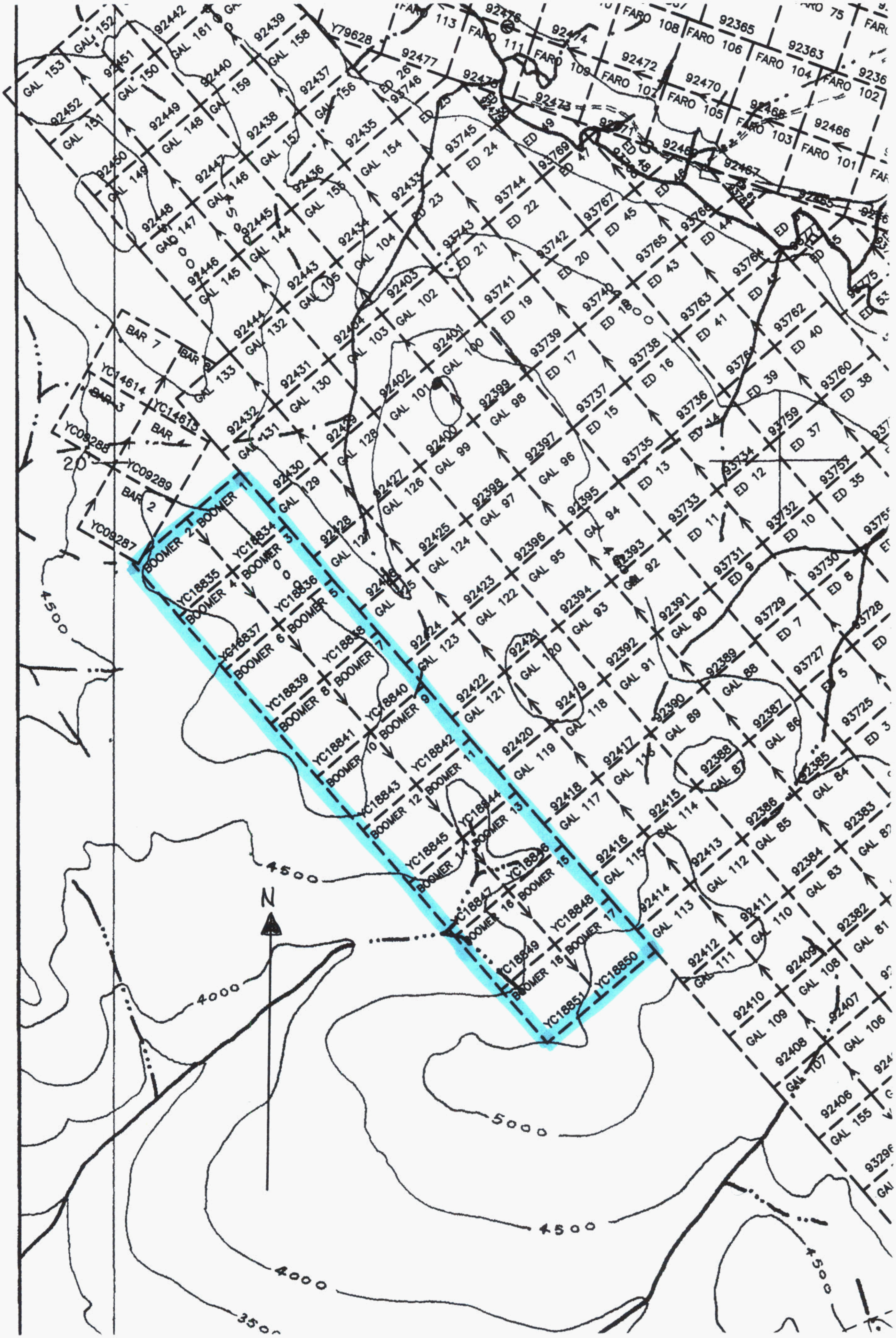
The Boomer 1 – 18 claims were staked in August 2000 to cover several known barite occurrences and a lead – zinc prospect. The area in question is considered to have high mineral potential, mainly due to its proximity (5 km.) to the past producing Faro mine. Fieldwork in 2001 was limited to one day of prospecting and soil sampling, preceded by a compilation of all available pertinent data.

LOCATION AND ACCESS

The Boomer claims are located on the southeast end of Rose Mountain at 62° 19' and 133° 28', 11 km. northwest of the town of Faro in central Yukon. There are several old exploration trails, now heavily overgrown, extending from the Faro mine haul road to within several kilometers of the Boomer claims. Access by helicopter is also readily available from Faro or Ross River. Elevation at the Boomer property varies from 4100 feet to 5200 feet ASL. Treeline occurs at approximately 4500 feet and bedrock exposure above treeline is fairly extensive. Some outcrop is encountoured at lower elevations but till cover varying from thin on slopes and ridges to thick in creek valleys is prevalent.

PROPERTY OWNERSHIP

Ownership of the Boomer 1 – 18 claims (YC 18834 – YC 18851) is held as follows: Rob Hamel-35%, Phil Andrietz-35%, Brian Scott-30%. The claims are in good standing until Aug. 24 2001.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REGIONAL GEOLOGY

The Anvil District, as described by Pigage in Yukon Exploration and Geology – 1998, " is part of the Cordilleran miogeocline, a prism of sedimentary rocks of Precambrian to Jurassic age deposited along the relatively stable continental margin of western North America. Anvil District is immediately east of the Yukon – Tanana Terrane, the eastern-most of the accreted suspect terranes. The Yukon – Tanana Terrane is juxtaposed against Anvil District along the Vangorda fault, interpreted as transpressive suture. Deformation and metamorphism associated with accretion of the suspect terranes was initiated during the Jurassic and culminated in the Cretaceous period. More recently, strike – slip faulting along the Tintina Fault zone immediately southwest of Rose Mountain resulted in 450 – 500 km. of right lateral strike – slip displace-ment during late Cretaceous – early Tertiary time."

LOCAL GEOLOGY

Dr. Pigage in Yukon Exploration and Geology 1998, suggests " that the Rose Mountain stratigraphy represents a structurally concordant succession of stratigraphic units. Several of these units can be correlated with regional North American stratigraphic units, implying that the entire Rose Mountain Stratigraphy has North American affinities.

Pigage's recent mapping (Open File 2001-26) shows the following Rock units on the Boomer claims: (from south to north)

- Yukon Tanana Complex – chloritic phyllite to amphibolite (including eclogite) and serpentinized ultramafics
- Anvil Range Group – basalt or brecciated basalt
- Mount Christie Formation – bedded phyllitic chert
- Earn Group – argillite and bedded chert
- Earn Group – bedded phyllitic chert with barite

DATA COMPILATION

Over the nearly fifty year exploration history of the Anvil District, fairly extensive geological database has been generated. Our compilation program involved collecting all existing geological, geophysical, geochemical reports and surveys. Specifically, we reviewed the following publications:

- Geology and Origin of the Faro, Vangorda, and Swim Concordant Zinc – Lead Deposits – GSC Bulletin 208 – Templeman – Kluit, D. J. 1972
- Assessment Report # 018997 – Taku Claim Group – Shaw, J. C. 1967 – DIAND
- Assessment Report #090345 – Urn Claim Group – Franzen, J. P. 1978 – DIAND
- Assessment Report #091369 – Urn Claim Group – Read, W. S. 1982 – DIAND
- Geology and Sulphide Deposits of Anvil Range, Yukon Jennings, D. and Jilson, G. –CIMM Vol. 37 – 1986 (excerpts included in this report)
- Geology of Mt. Atherton (105 K/4) Rose Mountain (105 K/5) and Mt. Mye (105 K/6) GSC Open File 2250 – Gordey, S. P. 1990
- Yukon Minfile – 105/K – Tay River – DIAND
  Occurrence # 105 K018 – Taku –(included this report)
  Occurrence # 105 K106 – Urn – (included this report)
- Air Photos – Flight line A27522 – photos #94 – 98
- Field Guide to Anvil Pb-Zn-Ag District, Yukon – Pigage, L. GSC Open File 2169 – 1990 – (excerpt included this report)

- Regional Stream Sediment Survey – NTS 105L and 105 K(W1/2) 1989 – GSC Open File 1961 – (excerpts included this report)

- Bouguer Gravity Survey – 105K – Exploration and Geological Services – DIAND – Amerok Geosciences (included this report)

- Aero – Magnetic Survey – 105K – Exploration and Geological Services – DIAND – Amerok Geosciences (included this report)

- Preliminary Geology of Rose Mountain, Anvil District, Central Yukon (105 K/5) – Pigage, L. C. – Yukon Exploration and Geology 1998 – (excerpts included this report)

- The Quaternary History and Till Geochemistry of the Anvil District East – Central Yukon – Bond, J. D. – YEX 1998

- Surficial Geology of Mt. Mye and Faro (105K3 & 6W) Yukon Bond, J. D. – Exploration and Geological Services – DIAND Open File 1999 – 8

- McConnell Ice – Flow Map of the Anvil District (105K) Central Yukon – Bond, J. D. – Exploration and Geological Services Open File 1999 – 14

- Geological Maps of the Anvil District – Pigage,L. C. Exploration and Geological Services – DIAND
    - Open File 2001-4 Rose Mt. (105K/5SE)
    - Open File 2001-26 Faro (105K/3NW) Mount Mye (105K/6SW) – included in this report
    - Open File 2001-28 Mount Mye (105K6/W)
    - Open File 2001-31 Anvil District (105K/2,3,5,6,7,11)

DATA INTERPRETATION

The gravity survey shows a distinct gravity high centered over the southeast end of the Boomer property, which could indicate an intrusive body. The aero-mag survey shows a very distinct contact running from SE to NW, coincident to the Boomer claim block, which appears to correspond with the Vangorda Fault as mapped by Pigage (Open File 2001-26). Air photos show what appears to be a "kill zone" in the area covered by Boomer 16. Assessment report #018997 (J. C. Shaw – 1967- Taku claim group) discusses anomalous zinc (1000 ppm) and copper (250 ppm) values returned for soil samples collected on ground now covered by Boomer 13, as well as a coincident 1967 mag high. The regional stream sediment survey (GSC Open File 1961) shows anomalous values for copper, gold, nickel, barium, lead, tungsten and mercury in the immediate area surrounding the Boomer claim group.

2001 FIELD PROGRAM

Due to time and budget constraints, field work in 2001 was limited to a one day property visit on August 6. Claimholder Rob Hamel was accompanied by Hudson Bay Mining exploration geologists Rick ~~Diment~~ Zuran and Mark Kruse. Access was by helicopter from Ross River. Prospecting and soil sampling was conducted on Boomer 13 in an attempt to duplicate anomalous zinc and copper values reported by Shaw in 1967 (Ass. Report #018997). However, three soil samples collected at UTM coordinates 580461 E and 6908631 N sample MDCS45917, 580542 E and 6908579 N sample MDCS 45918, and 580621 E and 6908526 N sample MDCS 45919, failed to return any anomalous values.

CONCLUSIONS AND RECOMMENDATIONS

The attempt to duplicate anomalous zinc and copper values reported by Shaw in 1967 may have been hampered by mapping inconsistencies. Future fieldwork should focus on prospecting and soil sampling on the kill zone believed to be located on Boomer 16. Perhaps till sampling (as described by J.D. Bond – Quaternary history and till geochemistry of the Anvil District – Yukon Exploration and Geology – 1998) would be more appropriate. In this procedure, samples are taken from the 'C' horizon rather than the 'B' horizon as in conventional soil sampling. Also, the ultramafics (Pigage's Pz unit – Open File 2001-26) on the southwest end of the Boomer claim block should be investigated for Ni – PGM mineralization, in light of the anomalous nickel values reported in the regional stream sediment program (GSC Open File 1961).

SOIL SAMPLES – BOOMER 13 – YC 18846

PROPERTY	Sample	SAMPLER	DATE	X	Y	ZONE	NTS
BOOMER	MDCS45917	RZ	6-Aug-01	580461	6908631	08V	105 K/5
BOOMER	MDCS45918	RZ	6-Aug-01	580542	6908579	08V	105 K/5
BOOMER	MDCS45919	RZ	6-Aug-01	580621	6908526	08V	105 K/5

Note: All values ppm unless otherwise stated.

NAD	Batch	Batch_No	Analytical	Wt__grams	Lab_ID	Ag_ppb	Al %	As
27	102759soil	A102759	83	30	ACME	195	1.48	13.1
27	102759soil	A102759	64	30	ACME	83	1.06	11.2
27	102759soil	A102759	74	30	ACME	111	1.3	8.6

Au ppb	B	Ba	Be	Bi	Ca %	Cd	Ce	Co
26	1	487.8	0.5	0.22	0.23	0.21	28.5	16.5
2	1	242.8	0.2	0.18	0.14	0.21	30	17
0.6	1	713.4	0.3	0.23	0.2	0.36	30.2	14.1

Cr	Cs	Cu	Fe %	Ga	Ge	Hf	Hg ppb	In
120.6	1.92	38.46	2.92	4.9	0.1	0.01	33	0.03
146.8	1.18	28.63	2.78	4.2	0.05	0.01	31	0.02
96	1.36	29.91	2.73	5.8	0.1	0.01	36	0.03

K %	La	Li	LOI %	Mg %	Mn	Mo	Na %	Nb
0.09	14.3	13.3	10.4	0.69	1350	1.73	0.009	0.65
0.08	14.3	15	7.9	0.91	1189	2.12	0.004	0.59
0.08	15.8	16.6	10.4	0.6	641	1.27	0.006	0.89

Ni	P %	Pb	Pd ppb	Pt ppb	Rb	Re ppb	S %	Sb
88.7	0.049	15.3	5	1	10.4	0.5	0.05	1.21
85.5	0.041	11.79	5	1	7.7	0.5	0.02	1.02
50.9	0.047	15.19	5	1	9.7	0.5	0.03	0.63

Sc	Se	Sn	Sr	Ta	Te	Th	Ti %	Tl
2.7	0.4	0.6	19.8	0.025	0.04	2	0.02	0.09
1.9	0.4	0.5	12.9	0.025	0.02	1.8	0.035	0.07
1.8	0.3	0.7	22.2	0.025	0.03	0.9	0.036	0.09

U	V	W	Yt	Zn	Zr
0.7	49	0.1	5.28	79.3	0.5
0.5	43	0.1	3.31	70.9	0.5
0.5	63	0.1	3.47	63.2	0.2

STATEMENT OF EXPENSES - 2001 Program

Data compilation and interpretation	3.5 days	...........$775
Travel - by truck Whitehorse to Ross River return - helicopter Ross River to property		............$600
Prospecting and soil sampling - Aug. 6		....................$300
Assaying - 3 soils – multi element ICP		.......................$150
Report preparation		....$600
	TOTAL	......$2425

STATEMENT OF QUALIFICATIONS

Rob Hamel successfully completed the Advanced Prospecting Course in 1988 and the Petrology for Prospectors short course in 1993. He has been involved in mineral exploration in the Yukon since the early 80's.

Brian Scott completed the Advanced Prospecting course in 1988 and the Petrology short course in 1993. He has been active in mineral exploration in the Yukon and northern B.C. since 1978.

APPENDICES

Geology and sulphide deposits of Anvil Range, Yukon

D.S. JENNINGS
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Vancouver, British Columbia
and
G.A. JILSON
Curragh Resources
Whitehorse, Yukon

ABSTRACT

Anvil District is underlain by 5 km of polydeformed, late Precambrian to upper Paleozoic, metasedimentary and metavolcanic rocks intruded by a Cretaceous granitic plutonic suite. Most rocks of the district are almost certainly North American and have strong affinities with well-known Selwyn Basin stratigraphy representing the most southwestern (outboard) present-day examples. The uppermost unit, however, is suspect and may be allochthonous. The southwestern margin of the district is defined by two major faults separating it from adjoining terranes.

The Late Proterozoic and (?) Lower Cambrian Mt. Mye formation, monotonous, non-calcareous pelites at least 2 km thick, forms the basal stratigraphic unit in the district. Mt. Mye strata are correlated with unnamed, lithologically similar assemblages beneath Rabbitkettle Formation toward Mackenzie Platform northeast of the district. Calcareous phyllites and lesser basaltic extrusive and intrusive rocks of the Cambrian and Ordovician(?) Vangorda formation overlie the Mt. Mye with narrowly gradational contact. An important carbonaceous phyllite member occurs at the base of the formation. The 1 km thick Vangorda sequence is correlated with the more calcareous Rabbitkettle Formation eastwards toward Mackenzie Platform. A 1 km thick basaltic metavolcanic sequence named Menzie Creek formation overlies and is interleaved with Vangorda formation. Carbonaceous phyllites, slates and siltstones containing lower Ordovician to lower Silurian graptolite fauna are interbanded with the diverse Menzie Creek volcanic facies and overlie them. These metasediments are lithologically and faunally similar to strata of Road River Group with which the Menzie Creek is correlated. This lower portion of the Anvil district stratigraphic sequence represents deep marine sediments which accumulated on a trailing continental margin subject to episodic extensional tectonism resulting in the emplacement of the basaltic component of the section.

A thick (1 km) Devonian(?) to Permian(?) sequence of varicoloured, phyllitic cherts, chert conglomerate, and local stratiform barite capped by massive alkaline basalts occurs along the southwest edge of the district. This chert-rich sequence is in part similar to Earn Group, but the upper portion of this chert package and overlying basalts comprise the type section of Anvil Range Group. A distinct structural discontinuity between these sequences is not locally recognized, but regional relationships outside the district suggest Anvil Range Group, at least, formed in an oceanic basin outboard of North America and is allochthonous.

Anvil District has a complex polydeformational/polymetamorphic history. Two overlapping Mesozoic regional metamorphic and folding events are recognized in low pressure, Buchan-type facies series ranging from greenschist to amphibolite facies grade. Metamorphic zones decrease in grade radially outward and stratigraphically upward from a granite-cored central metamorphic/plutonic culmination termed Anvil Arch which domes the entire stratigraphic sequence into an open, doubly-plunging antiform. Subsequent events are regionally non-penetrative, brittle folding and faulting episodes superimposed on earlier fabrics. An episode of major extensional faulting may record the final stages of uprise of the plutonic core of the district.

Five stratifrom, pyritic lead-zinc-silver-(barite) deposits associated with anomalous thicknesses of graphitic phyllite are developed in a 150 m thick interval straddling the contact of Mt. Mye and Vangorda formations. The bulk of this mineralization occurs in uppermost Mt. Mye formation, but the highest horizons in multi-layered deposits are hosted by basal Vangorda formation. A pre-mining geological reserve of 120 000 000 tonnes of 3.7% lead, 5.6% zinc and approximately 45 - 50 g/tonne silver applies to the aggregated five deposits.

A cyclic arrangement of sulphide lithofacies is common in deposits of the district. Graphitic to non-carbonaceous, disseminated sulphide-bearing quartzites form the basal and/or marginal facies of a deposit which are succeeded upwardly and inwardly by massive pyritic sulphides, then baritic massive pyritic sulphides. This recurring facies arrangement may occur on the scale of an entire deposit cross section to a 1 m length of drill core. This idealized arrangement is commonly interrupted, truncated or imperfectly developed.

Sulphide deposits have a variably developed, white mica-dominant alteration envelope, commonly best developed in a deposit footwall. This alteration may represent hot ore fluid/wallrock interaction along the ore fluid pathway; a metamorphic reaction envelope between the sulphides and enclosing sediments or a combination of these origins. Demonstrable feeder zones for Anvil deposits are absent.

In plan, the known sulhpide deposits of Anvil district describe a northwest-southeast trending curvilinear array. Graphitic phyllites associated with the Mt. Mye/Vangorda contact thicken abnormally southwest of this deposit line. Additionally, the first major pulse of basaltic volcanism in the Anvil pile is recognized near this contact. These features taken together are consistent with a genetic model involving extensional tectonism, rifting and passive basaltic volcanism with episodic focussed exhalation of evolved, metalliferous, basinal brines along synsedimentary growth faults into local, reduced basins. Sulphide facies cyclicity may result from repetitively occurring physicochemical factors at the site of sulphide deposition, at the site of ore fluid evolution, or in the manner of ore fluid escape.

Introduction

The Anvil Range lead-zinc-silver district is located 200 km northeast of Whitehorse, Yukon (Fig. 1). There are five deposits with defined reserves in the district. Open-pit mining from Cyprus Anvil Mining Corporation's Faro deposit at rates up to 10 000 tonnes per day began in late 1969; this is the only deposit that has yet sustained production. The Anvil Mine constitutes

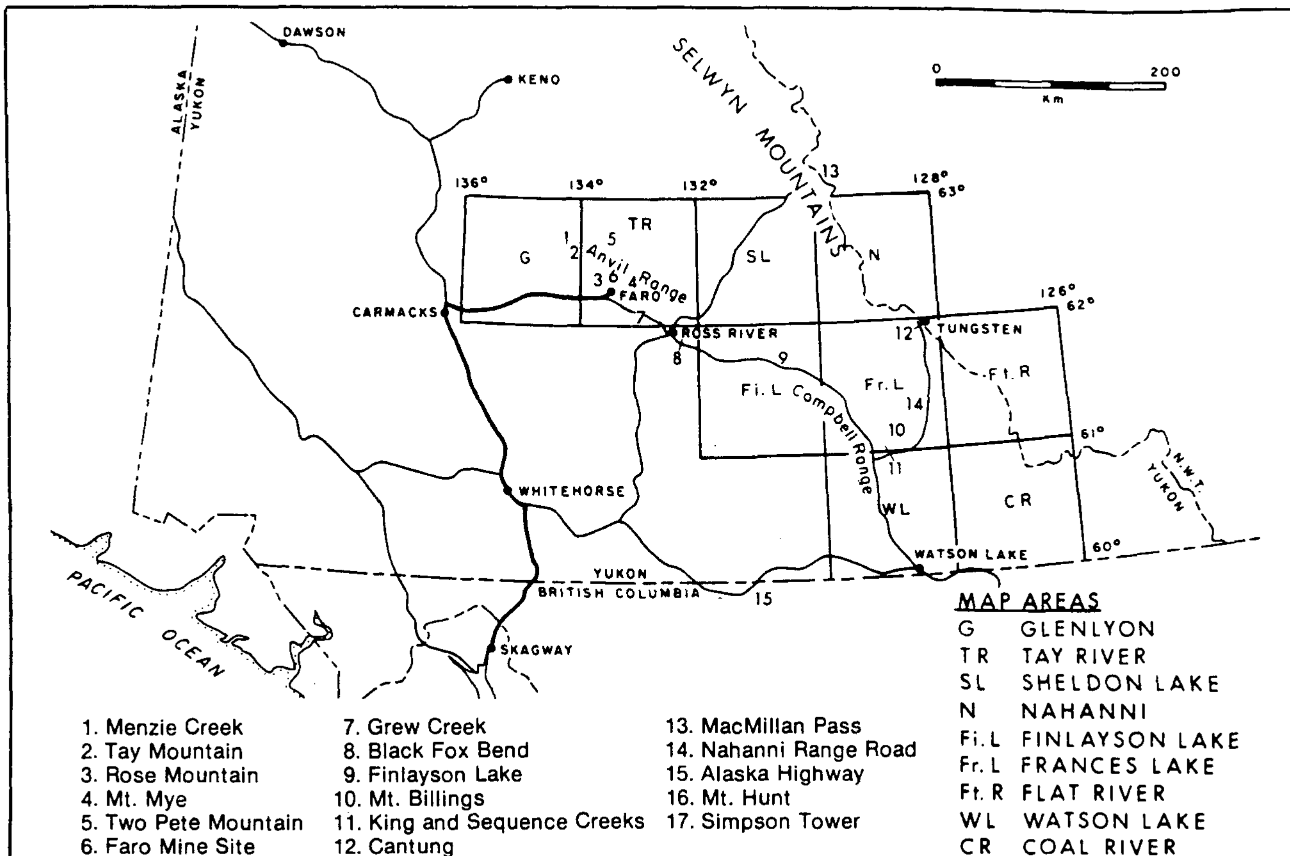


FIGURE 1. The southern Yukon showing the location of the Anvil Range and Anvil Mine (location 6) in relation to the Yukon highway system. The heavy line shows the route of concentrate shipment from the mine to tide water at Skagway, Alaska. Also shown are various localities and map sheets cited in the test.

Yukon's largest mining operation and is one of the largest lead-zinc-silver mines in Canada. Present remaining geological reserves for all five deposits in the district total 96 million tonnes of 8.9% combined lead-zinc with 51 g/tonne silver. In the district, there is an estimated total of 225 million tonnes of sulphide-bearing rock if all sulphide lithofacies are considered irrespective of grade.

These stratiform, stratabound, pyritic, massive sulphide deposits occur in a well defined curvilinear trend within a restricted 150 m thick upper Proterozoic to Cambrian stratigraphic interval straddling the boundary of the underlying Mt. Mye and overlying Vangorda formations. Discussion of the deposits is given in the context of a stratigraphic and structural analysis of the Anvil District. A synsedimentary, exhalative, genetic model consistent with Selwyn Basin evolution and lead isotope systematics is presented.

The first systematic geological mapping in the Anvil District was that of Roddick and Green (1961). After discovery of the Faro and Swim deposits in 1964-65, a more detailed geological study was undertaken by Tempelman-Kluit (1972). This work includes some descriptive detail on the Faro, Vangorda and Swim deposits.

Exploration methods in the District are discussed by Aho (1966, 1969), Brock (1973), Chisholm (1957) and Morton (1973).

Work on ore deposits of the district has not been extensive. An early study on the Faro deposit is that of Campbell and Ethier (1974). The Grum Deposit, particlarly the sulphide isotopes of the ores, has been studied by Modene (1982).

Several studies have included Anvil District ores within a larger context: Le Couteur (1973), Kuo (1976), Kuo and Folinsbee (1974), Godwin and Sinclair (1982) and most recently, McClay and Ellis (1983).

This study is the result of work in the district by the authors and many co-workers during the period 1971-1983.

Regional Geology

The ore deposits of the Anvil District formed in the shale-rich, outboard, portion of the early Paleozoic - late Proterozoic North American miogeocline. The local basin of interest is Selwyn Basin (Fig. 2), a major northeasterly convex embayment in the present-day distribution of peri-cratonic platformal carbonate and orthoquartzite strata of Mackenzie Platform, coeval with the basinal shales. Selwyn Basin passed through several evolutionary stages which are reflected in the basin filling sediments as large-scale compositional sequences.

The basin appears to have been initiated by complex Proterozoic rifting which formed the ancient continental margin (Eisbacher, 1981). The oldest unit exposed (in the basin) is the late Proterozoic to early Cambrian "Grit Unit" (Gabrielse *et al.*, 1973). This unit consists of turbidites (Gordey, 1979) and can be viewed as a huge fining upward sequence of coarse, poorly sorted, quartz + feldspar, sandstone and pebble conglomerate with interbedded shales. Locally important interbedded limestone and dolomite is developed in the upper part of the unit, and minor mafic volcanics occur locally. The shale component is commonly drab olive green, but a belt of red and green shale near the top of the unit runs the length of the southern part of the basin (Fig. 2). The varicoloured shales are co-extensive with, but largely younger than, a belt of the largest limestone and dolomite bodies. The shales of the red and green belt change gradually through maroon and green into dark grey shales (largely the Phyllite Unit of Gabrielse *et al.*, 1973) to the northeast and the uppermost shales intertongue with the sandstones of the Backbone Ranges Formation (Gabrielse *et al.*, 1973). To the southwest of the red belt, the shales appear also to grade laterally through maroon into grey colours but there is little exposure of this interval.

The shales at the top of the "Grit Unit" pass upwards into early and middle Cambrian drab brown and black shales (Gordey,

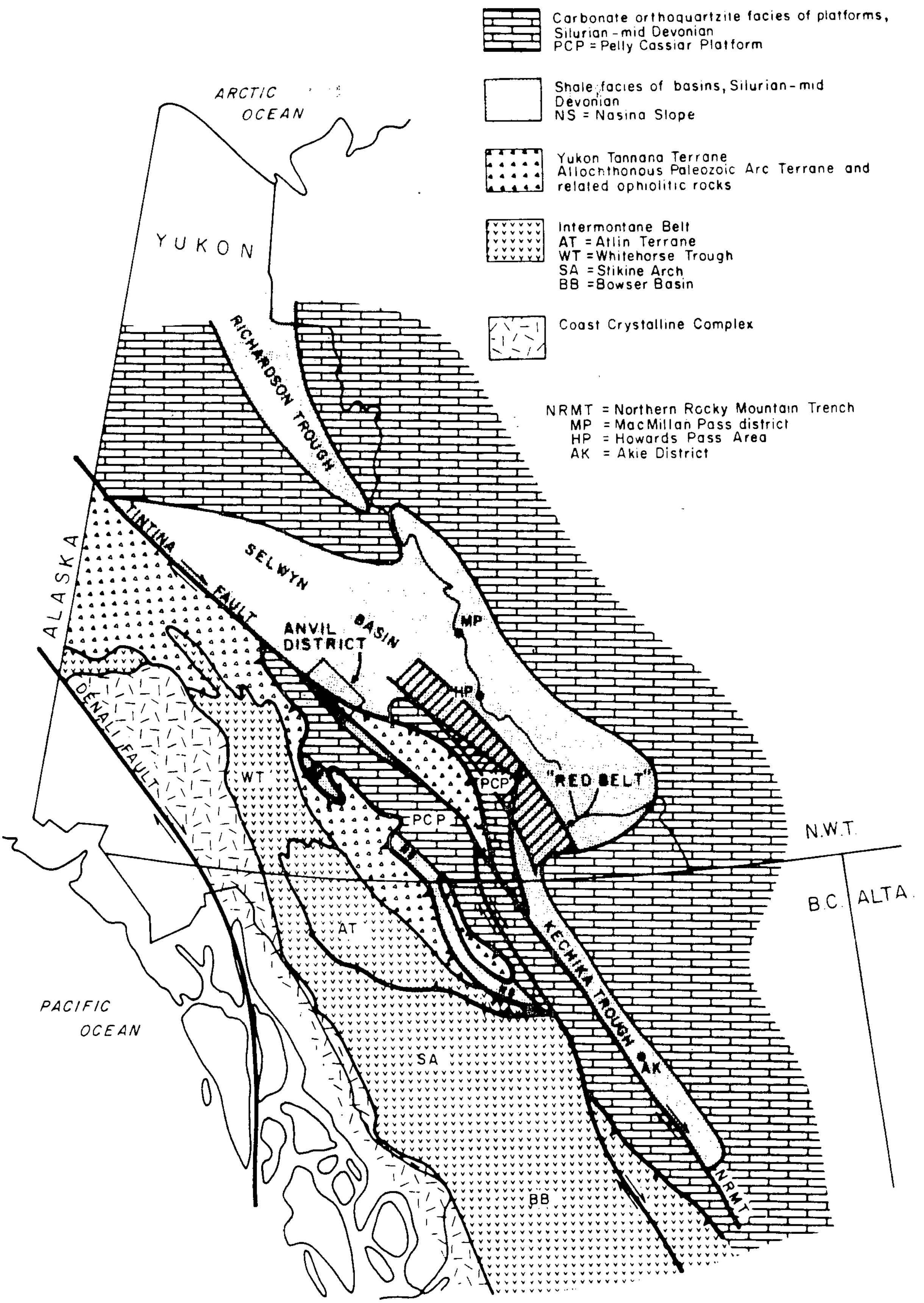


FIGURE 2. The Anvil District in relation to the Selwyn Basin and other major tectonic features outboard of platformal carbonates and basinal shales of strong North American affinity. The "red belt" shows the distribution of red shales and large carbonate bodies in the upper Grit Unit based largely on mapping by the authors and co-workers.

Legend

Tertiary – Paleocene?

Tsv	basalt, quartz feldspar porphyry, sandstone, conglomerate, shale
Ts	conglomerate, sandstone
Tv	rhyolite plug

Cretaceous

Ki	Anvil Dyke Suite: diorite, quartz diorite, quartz feldspar porphyry
Kgr	Anvil Plutonic Suite: granodiorite, quartz monzonite

Triassic (and younger?)

Tr	polymict conglomerate, micaceous quartz sandstone, greywacke, black shale, limestone (Tr? may be younger and uncomforably overlie Tr)

Permian and older

uYTT	undifferentiated rocks of Yukon Tanana Terrane: micaceous quartzite, gritty micaceous quartzite, black phyllite, marble, metabasite, felsic metavolcanics, phyllitic chert

Pennsylvanian and Permian (and older?)

PPc	calcitic and dolomitic marble, limestone

age unknown: upper Paleozoic? (associated with PPa)

mi	mafic intrusive rocks: gabbro, diabase
um	ultramafic rocks: serpentinite, harzburgite, rodingite, quartz carbonate fuchite altered ultramafics

Pennsylvanian and lower Permian?

PPav	Anvil Range Group: basalt
PPat	Anvil Range Group: red and green chert, tuffaceous chert

Devonian and Mississippian

Mk	Kalsas Formation: limestone
uDM	Earn Group: chert, siltstone, shale, chert pebble conglomerate, barite (uDM+: probably includes older rocks and some younger)

Ordovician to Devonian?

S q	quartzite (age unknown, could belong to uDM locally)
SD a	laminated dolomitic quartz siltstone, dolomite, quartzite, dark grey shale (resembles basal Askin Group and lower Earn Group)
SD s	black phyllite with middle Devonian limestone lenses (may belong entirely in lower Earn Group)
OSrr	black and grey slate, quartzite, minor dolomite (may equate partly to Road River and older rocks - probably partly equivalent to SDs and SDa

lower Ordovician (and younger?)

Omc	Menzie Creek formation : basalt, black phyllite

Cambrian to lower Ordovician (?)

€Ov	Vangorda formation: calcareous phyllite, metabasite, calc-silicate (€Ov+ includes H€mm locally or Omc locally)

lower Cambrian and Hadrynian (?)

H€mm	Mt Mye formation: noncalcareous phyllite and schist

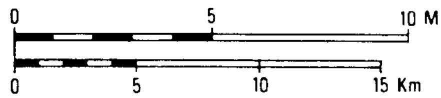
FIGURE 3. Geological map of the Anvil District. The major sulphide deposits are indicated in black. Section C-D is Figure 19. See Figure 20 for location of additional cross sections.

GENERALIZED G

MAPPED BY: D.S. JENNINGS & G.A. JILSON 1971-1979, 1980, 1983; L.C. PIGAGE 1979, 1980; J.B. HESLOP 1971, 1972; P.F. LEWIS 1972-1974; D.J. HANSEN 1977-1978; J.P. FRANZEN 1978;

Symbols

- contact
- sulphide deposit
- strike slip fault
- normal fault, ball on downthrown side
- moderately or shallowly dipping fault of unknown sense of displacement
- thrust fault
- form line of S_2 foliation, or in uYTT form line of flaser fabric; (former dip mostly less than 45°, latter mostly more than 45°)
- bedding strike and dip direction (mostly 45° or less)
- axis of antiform
- e eclogite locality

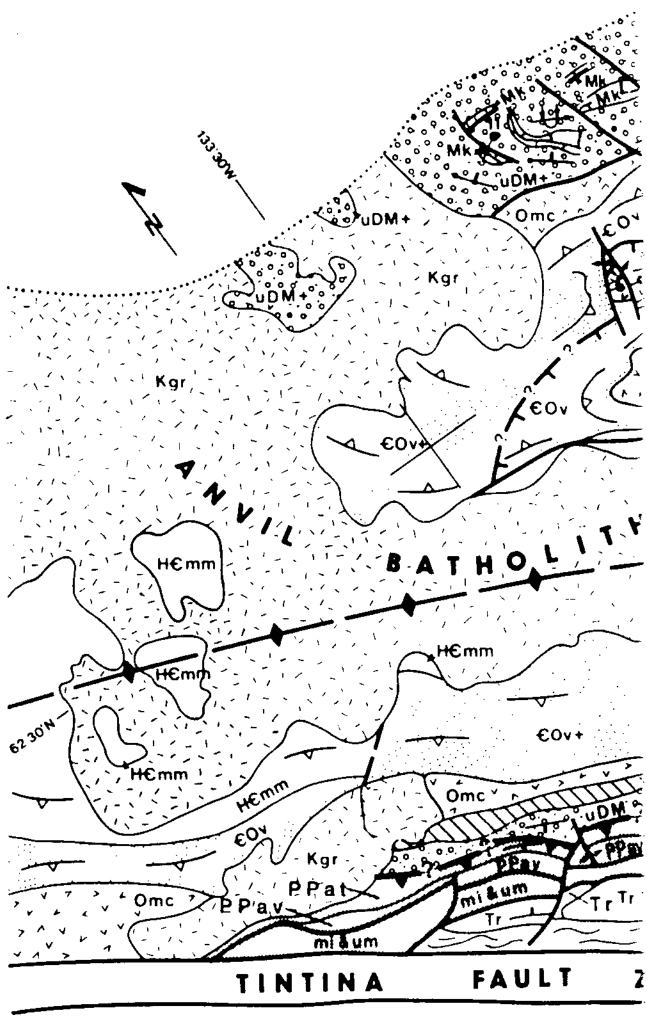


Faults

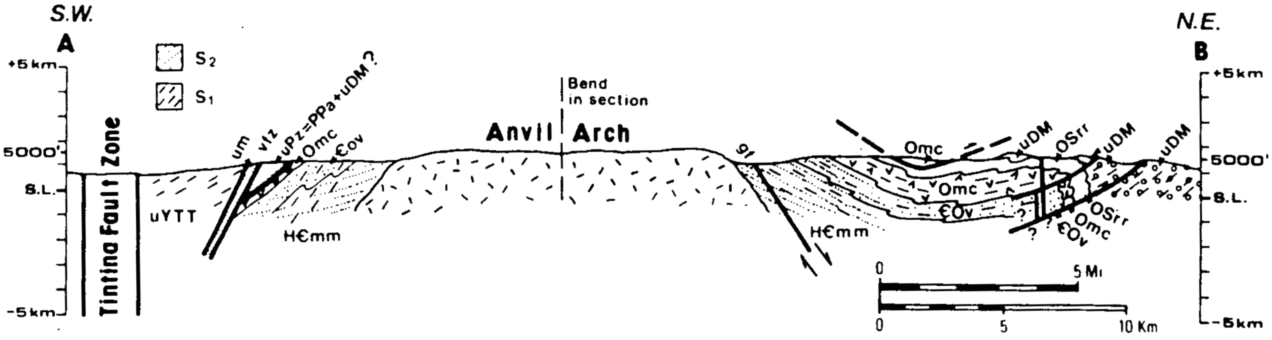
vfz :	Vangorda Fault zone	
tf :	Tie Fault	
blcf :	Blind Creek Fault	
mcf :	Mye Creek Fault	
gf :	Graphite Fault	
kcf :	Klunk Creek Fault	
lrf :	Lapie River Fault	Strands of Tintina Fault
bucf :	Buttle Creek Fault	Strands of Tintina Fault
gcf :	Grew Creek Fault	Strands of Tintina Fault
dcf :	Danger Creek Fault	Strands of Tintina Fault
rrf :	Ross River Fault	Strands of Tintina Fault

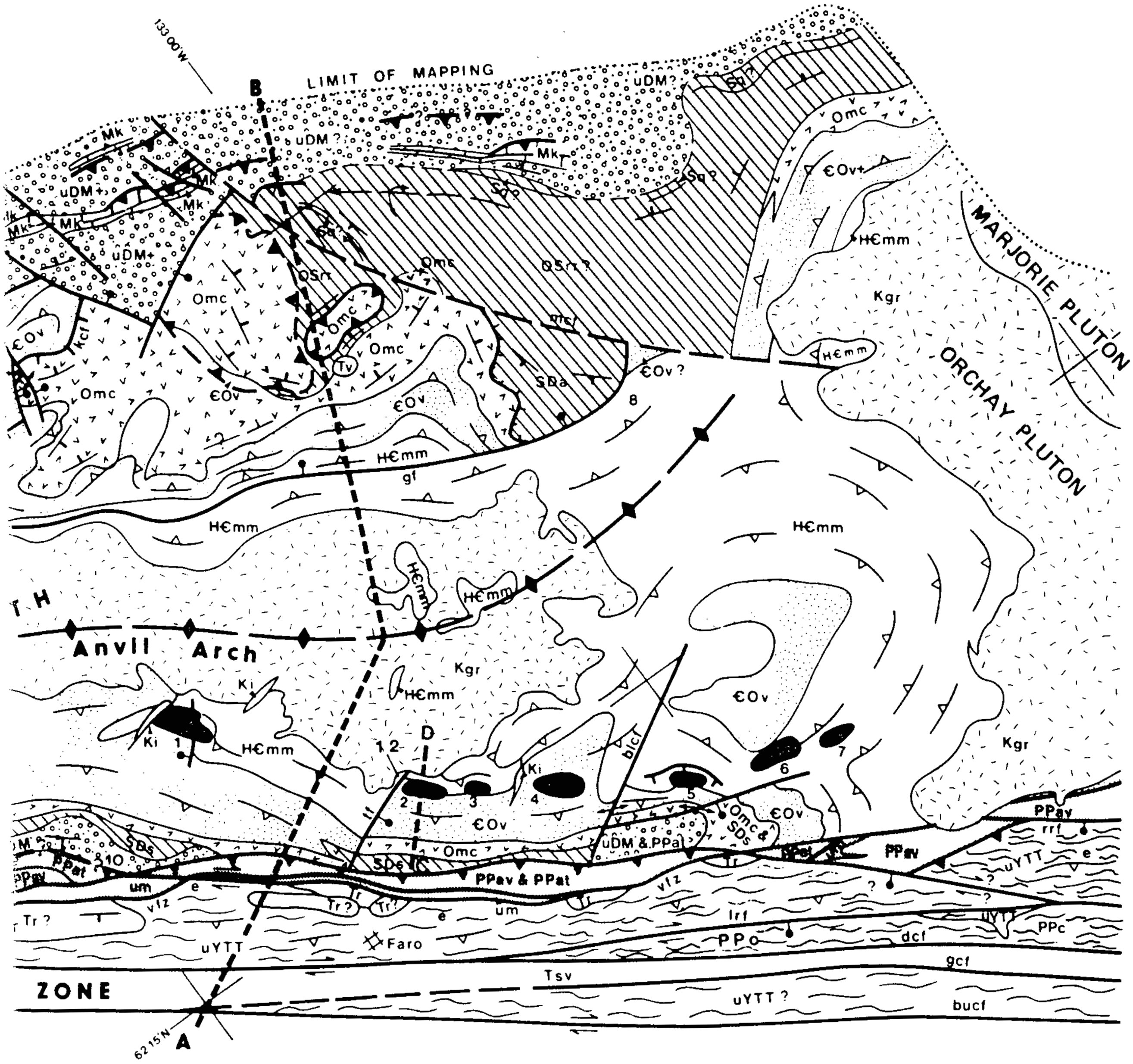
Mineral Occurrences & Sulphide Deposits

1.	Faro	Zn, Pb, Ag, Au, Cu; stratiform
2.	Grum	" "
3.	Vangorda	" "
4.	Dy	" "
5.	Swim	" "
6.	SB	Cu, Zn, Fe; stratiform
7.	Sea	Cu, Zn, Fe; stratiform?
8.	Ace	Cu, Zn, Fe; stratiform
9.	KD	Zn, Cu; volcanogenic stringer?
10.	Urn	barite, stratiform
11.	Dana	Zn, Pb, Cu, Ag; replacement?
12	FIRTH	ZnPb, modified stratiform



GEOLOGICAL MAP OF THE ANVIL LEAD-ZINC DISTRICT CENTRAL YUKON TERRITORY





1978 and 1979; Blusson, 1966). This sequence appears to thin over the red belt and is easily distinguished from the underlying "Grit Unit" shales in that area, but to the southwest and northeast, the sequence is thick and difficult to separate from the "Grit Unit". A widespread archeocyathid-bearing limestone conglomerate (Gordey, 1978) apparently derived from the earliest Paleozoic shallow water carbonates of the Mackenzie Platform occurs in this sequence.

In southeastern Selwyn Basin, the next major compositional unit is the thin banded, medium grey, silty argillaceous limestone of the upper Cambrian to lower Ordovician Rabbitkettle Formation (Gabrielse *et al.*, 1973). This sequence is best developed east of the red belt of the "Grit Unit" where it is very thick and dominantly limestone. Over the red belt, the sequence is thin and to the southwest, it is shale-rich and recessive; it is commonly represented there by calcareous phyllite. An important unconformity is present at the base of this sequence east of (Gabrielse *et al.*, 1973; Gordey, 1979) and probably above the red belt of the "Grit Unit" but there is no evidence of the unconformity to the southwest where exposure is poor.

In middle Ordovician, episodes of mafic volcanism occurred locally around and within Selwyn Basin (Gabrielse *et al.*, 1973; Cecile, 1982), accumulating to considerable thickness at several places. At about the same time, the basin filling sediments became black and chert rich. This carbonaceous sequence characterizes the basin until mid-Devonian and is largely known as the Ordovician and Silurian Road River Group and early and middle Devonian Basal Earn Group (Gordey *et al.*, 1982).

From late early Silurian to middle Devonian, a belt of shallow water limestone, dolomite and quartz sandstone accumulated along the present southwest edge of Selwyn Basin just outboard of and sub-parallel to the former red belt of the "Grit Unit". These are the sediments that characterize the Pelly-Cassiar Platform (Fig. 2). Between this platform and the Mackenzie Platform facies equivalent dark shale and chert and lesser dolomitic siltstone continued to be deposited in Selwyn Basin (Gordey, 1979).

In late Devonian and Mississippian, an episode of extensional tectonism disrupted this segmented basin and intrabasinal or westerly derived chert and quartz-rich coarse clastics accumulated interbedded with black shale and chert (Gordey, 1979). These sediments form the upper part of the Earn Group (Gordey *et al.*, 1982).

A Mississippian through Triassic sequence including shale, sandstone, siltstone and chert succeeded the Earn Group. These sediments are not conspicuously dark coloured and mark the return of aerated conditions to the basin (Gordey *et al.*, 1982 and Gordey, pers. comm., 1984).

The Anvil deposits are associated with carbonaceous phyllites within a transition from strata of the second and third sequences outlined above. In the Anvil District, strata of the second sequence are represented by the Mt. Mye formation, largely non-calcareous phyllite and schist, and the third sequence by the Vangorda formation, largely calcareous phyllite and metabasite. Basalt and carbonaceous phyllite of the Menzie Creek formation represents one of the largest centres of mafic volcanism associated with the fourth sequence. Other major lead-zinc deposits in the vicinity (Howards Pass and Macmillan Pass, Fig. 2) occur within the younger, black, shale-rich sequences.

The district is part of the Omineca Crystalline Belt, the easterly of two major granitic and metamorphic welts that run the length of the Canadian Cordillera (Monger *et al.*, 1982). In the area, the Omineca Belt is a series of uplifts exposing polydeformed and metamorphosed equivalents of the older parts of the stratigraphy outlined above. The uplifts are cored by 100 Ma, late to syn-kinematic granites and are commonly partly bounded by extensional faults. The Anvil Batholith (Fig. 3) is one of the larger of these granitic bodies. The complex structural and metamorphic history of the district has had a profound effect on textures and structures of its ore deposits.

The Anvil District is just inboard of one of the larger suspect terranes of the Yukon, the Yukon Tanana Terrane, (Coney *et al.*, 1980) and because of its complex tectonic history, should be considered as a possible suspect terrane itself. The strong similarities between the lower parts of the structural/stratigraphic sequence of the district and well known Selwyn Basin stratigraphy argues against this possibility. Although rocks of the district may be allochthonous (Gordey, 1983) or displaced, such translation is probably not large. The uppermost unit of the district, basalt and chert of the Anvil Range Group (Tempelman-Kluit, 1972), however, does not fit well into Selwyn Basin stratigraphy and appears to be an allochthonous exotic oceanic assemblage. The Yukon Tanana Terrane is faulted against the Anvil District sequence along the Vangorda Fault (Fig. 3). This structure is thought to be part of a transpressive suture developed during oblique collision of the Yukon Tanana Terrane with the North American continental margin (Mortensen and Jilson, 1985) which initiated the metamorphism and deformation of the district and culminated in intrusion of the Anvil Batholith (Tempelman-Kluit, 1979).

One of the most prominent of the longitudinal lineaments of the Canadian Cordillera, the Tintina Trench, passes just southwest of the district. The Trench is the locus of the late Cretaceous or early Tertiary right lateral strike-slip fault with 450 km to 500 km displacement (Tempelman-Kluit, 1970a). The association of this lineament with the district is thought to be a consequence of it having been controlled by a major crustal weakness that has repeatedly exerted its influence over the evolution of the district. We speculate below that the oldest example is the control over ancient faults that bounded sub-basins, channeled ore fluids and resulted in the linear array of ore deposits we see today.

Stratigraphy

Introduction

The stratigraphic sequence of the Anvil District ranges from latest Precambrian to Permian. The ore deposits occur within a 150 m thick section of the pre-Ordovician part of that sequence. This study consequently focusses on the lower portion of the sequence.

Three informal formational names are used to describe the Ordovician or older strata of the district (Fig. 4).

Mt. Mye Formation

Introduction

The Mt. Mye formation is the oldest map unit in the district. Drilled intersections and cross sections suggest an approximate thickness of at least 2 km. Excellent exposures of Mt. Mye formation are found on the south slopes of Mt. Mye northeast of the Vangorda and Dy deposits and between the Grum and Faro deposits along the access road to the Anvil Mine (Fig. 5). Lower portions of the formation occur in the core of Anvil Arch northeast of Blind Creek (Fig. 5). The formation crops out widely near Tay Mountain (Fig. 1).

Lithology

The two dominant rock types of the formation are non-calcareous biotite, muscovite, quartz, plagioclase, ± garnet, ± staurolite schist in areas of amphibolite facies metamorphism and non-calcareous muscovite, chlorite, quartz, plagioclase phyllite in areas of lower grade metamorphism. Important interlayered rock types are: (a) carbonaceous, muscovite, quartz phyllite; (b) calcitic marble and limestone; (c) thinly banded diopside, quartz, plagioclase, biotite ± calcite calc-silicates; and (d) weakly to strongly foliated actinolite, chlorite ± calcite schists and amphibolites or metabasites.

The typical non-calcareous phyllite of the Mt. Mye is medium to dark medium grey and weathers rusty brown with a rust flecked foliation surface. The rocks are commonly banded with dark grey micaceous folia 1 mm to 10 mm thick separating lighter grey finely crystalline quartz-rich layers two to five times thicker. In general, the unit has smaller and less well developed lithon structure than the overlying Vangorda formation. Soft, homogeneous, mica-rich phyllites are also widespread in the unit.

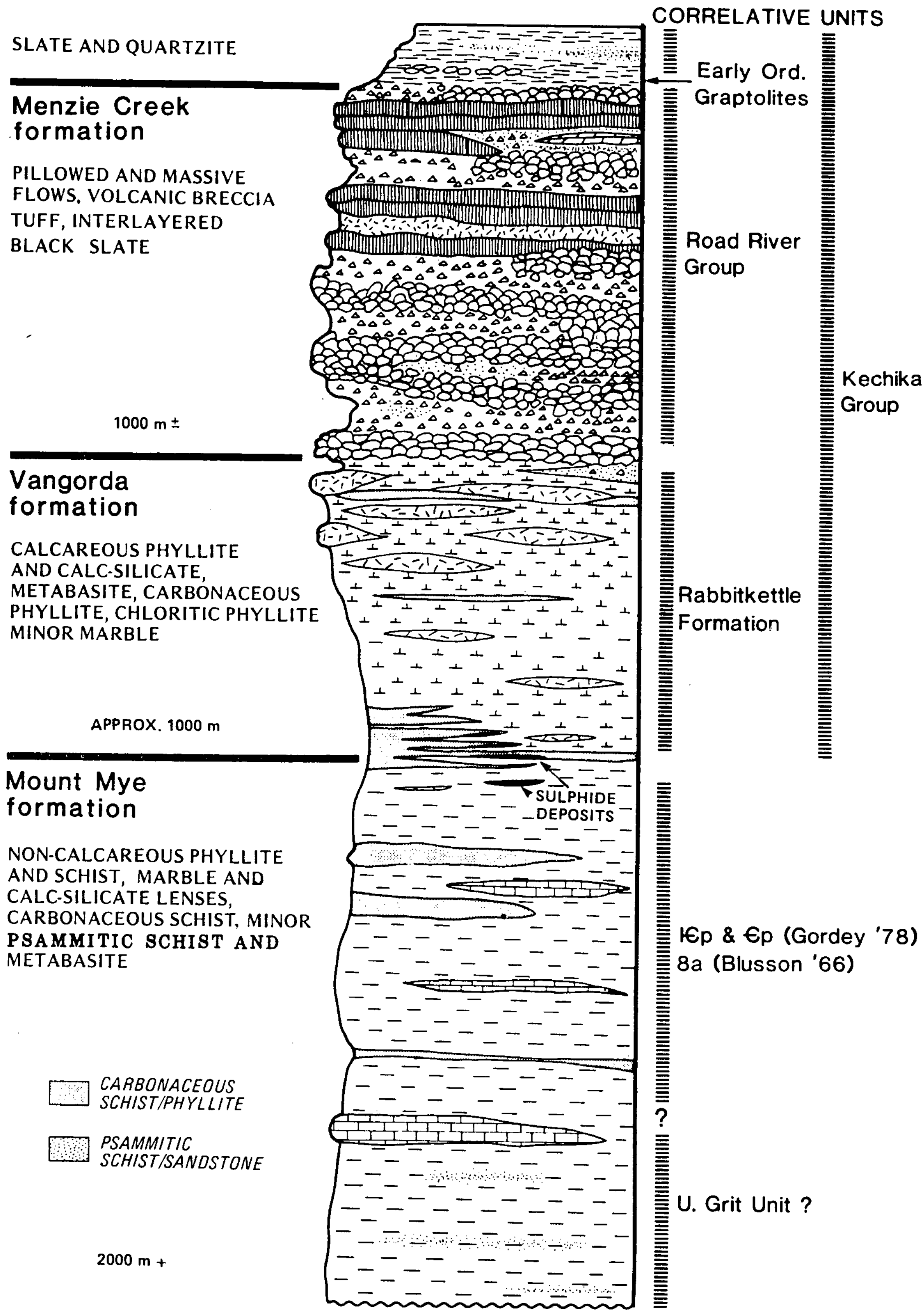


FIGURE 4. A schematic column of the older portion of the stratigraphy of the Anvil District. The sulphide deposits consist of several horizons in the upper Mt. Mye and lower Vangorda formations. The thickening of carbonaceous phyllite near the ore deposits is represented as if viewed looking northwest. The over-all section is rich in mafic volcanic and subvolcanic material but most is younger than the ore deposits.

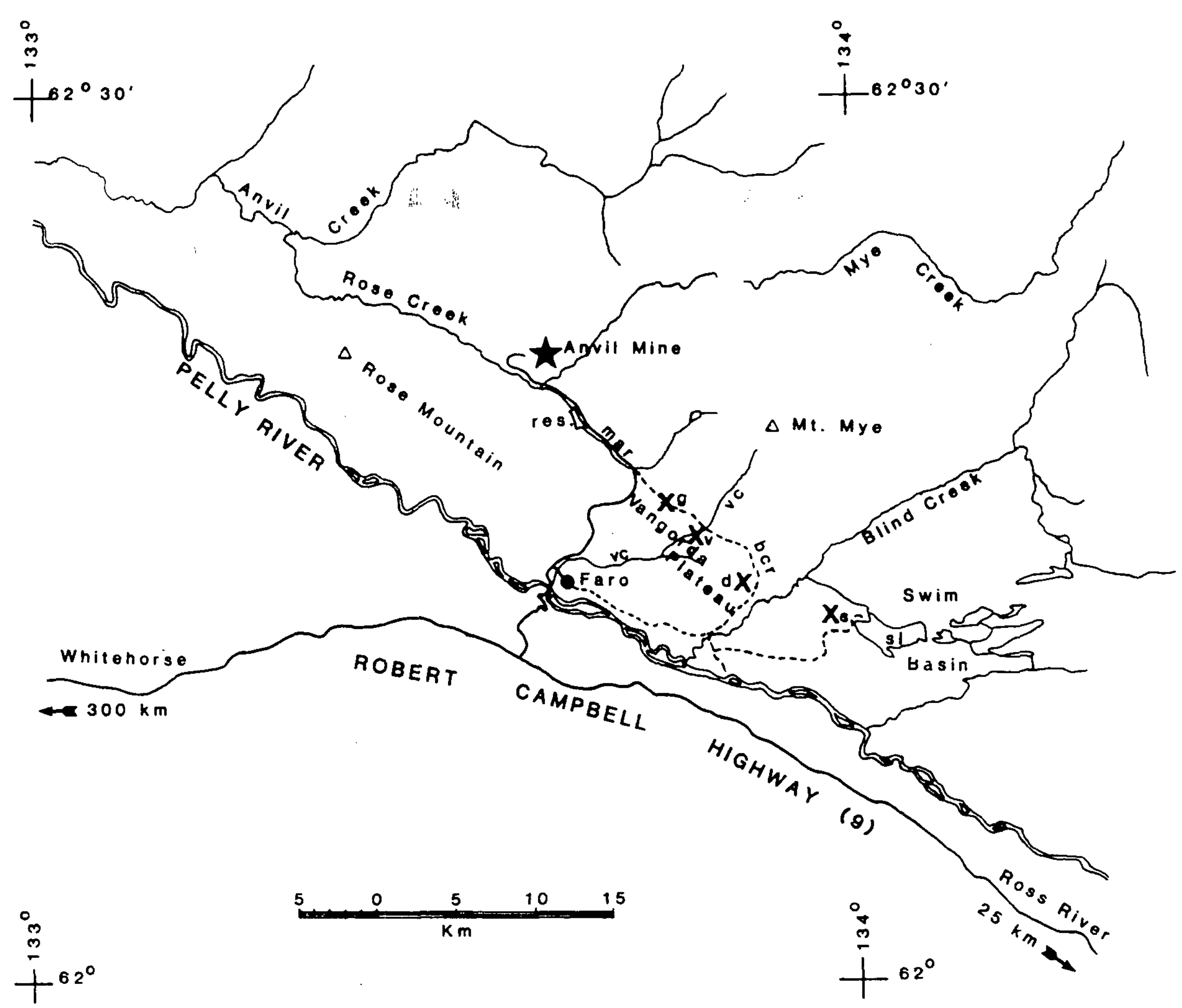


FIGURE 5. The southwest quarter of Tay River map sheet (Fig. 1) showing the location of the major Pb-Zn-Ag-bearing sulphide deposits (g = Grum, v = Vangorda, d = Dy, s = Swim) and other localities cited in the text (sl = Swim Lake, vc = Vangorda Creek, bcr = Blind Creek road, mar = mine access road, res. = mine water supply reservoir). Heavy solid lines are all-weather gravel highways, dashed lines are secondary roads. Swim Basin is a structural basin between the Blind Creek Fault and the Orchay Batholith (Fig. 3). Vangorda Plateau is defined as the area between the Tie Fault and Blind Creek Fault (Fig. 3).

Mineralogically, the Mt. Mye phyllites average 60% quartz, 30% muscovite, the rest being chlorite, biotite, and plagioclase or dolomite. The average bulk composition of 18 examples of this phyllite is shown in Table 1, Col. A. Its composition is closer to the average shales of Shaw (1956) and Clarke (1924) than to greywacke composition (Middleton, 1960 and Pettijohn, 1963), a protolith with which it might be confused (Table 1, Col. H and I).

In areas of higher grade metamorphism, the pelite of the Mt. Mye is a fine to coarse, medium grey-brown to purplish brown schist with colour depending on relative proportions of carbonaceous material and biotite. Its weathering colour, a reddish to purplish brown, is similar to the fine-grained phyllites. The schists are generally pervasively foliated with lithon structure seen only in thin section. Quartzo-feldspathic and micaceous compositional banding parallel to foliation is increasingly developed at higher metamorphic grade.

There are two major schist variants. The first is a fine-grained, medium dark brownish grey schist (Table 1, Col. B) composed dominantly of quartz, muscovite and biotite with lesser garnet and andalusite. Pseudomorphs (after andalusite?) are conspicuous on the foliation surface as dark greenish grey, irregular, feather-like chloritic patches, 1 cm to 20 cm in length. The second major variant is a non-carbonaceous, coarse, well banded schist composed of quartz, muscovite and biotite with garnet and staurolite porphyroblasts and andalusite clots. The composition of these variants and an intermediate schist unit is shown on Table 1 where it is seen that the schist variants are similar to one another and to the phyllites. The schists and phyllites represent the same pelite package at various metamorphic grades.

Dark grey to black carbonaceous quartz, muscovite and chiastolite phyllites and schists are interlayered with and grade into less carbonaceous Mt. Mye pelites. These darker coloured rocks comprise only about 10% of the formation but are important because of their association with sulphide deposits and their electromagnetic response. Carbonaceous interbands appear to be more abundant in the upper 200 m of the formation where the background pelite also appears slightly more carbonaceous.

Marble and calc-silicate schist are interlayered with pelite of the formation and comprise about 10% of the unit. The most commonly occurring lithologies are: (a) light grey, medium crystalline, calcitic marble with boudins of biotite schist and calc-silicate, and; (b) thinly banded light green, cream and brown quartz, tremolite, biotite ± diopside ± garnet ± calcite ± epidote calc-silicates. The marble bodies may be up to about 75 m thick but generally are only a few tens of metres thick. The largest bodies can be traced several kilometres. Smaller bodies are less continuous. Some thickness variation may be due to unmapped isoclinal folds. The calc-silicates are spatially

TABLE 1. Comparison of Mt. Mye formation average composition with average pelites and greywackes

	Average - this study								
	A phyllite (N = 18)	B coarse biotite - muscovite - andalusite schist ± garnet ± staurolite (N = 32)	C biotite-muscovite-andalusite schist (N = 47)	D grey biotite - muscovite - andalusite schist (N = 65)	E weighted[1] average of Mt. Mye formation (A—D) (N = 162)	F average pelite (Shaw, 1956)	G average shale (Clarke, 1924)	H average greywackes (Pettijohn, 1963)	I average eugeosynclinal greywackes (Middleton, (1960)
SiO_2	56.89	56.82	55.57	57.33	56.67	61.54	58.38	66.75	65.67
TiO_2	0.78	0.69	0.70	0.54	0.64	0.82	0.65	0.63	—
Al_2O_3	20.53	19.39	20.29	19.99	20.02	16.95	15.47	13.54	12.73
Fe_2O_3	9.08	9.57	9.02	8.30	8.85	2.56	4.03	5.53	5.09
FeO	—	—	—	—	—	3.90	2.46	—	—
MnO	0.08	0.07	0.10	0.08	0.08	—	—	0.05	—
MgO	2.29	2.29	2.11	2.06	2.15	2.52	2.45	2.15	2.40
CaO	1.19	0.66	0.99	0.88	0.90	1.76	3.12	2.54	4.20
Na_2O	1.17	0.64	0.88	0.70	0.79	1.84	1.31	2.93	3.04
K_2O	4.37	4.07	4.07	3.77	3.98	3.45	3.25	1.99	1.87
P_2O_5	0.15	0.14	0.12	0.17	0.15	—	—	0.16	—
H_2O	—	—	—	—	—	3.47	5.02	—	—
CO_2	—	—	—	—	—	1.67	2.64	—	—
S	0.04	0.79	0.28	0.40	0.40	—	—	—	—
LOI	3.44	4.98	5.87	5.78	5.38	—	—	—	—
Total	100.01	100.11	100.00	100.00	100.01	100.48	98.78	96.34	95.00

1 Weighting on the basis of number of samples, N = number of samples.
2 LOI = loss on ignition.
3 A—D are averages of analyses by Bondar-Clegg, Vancouver, British Columbia, using XRF.

TABLE 2. Mt. Mye formation metabasites

Sample Number	812	1025	1907	1552	788	1863	Average
SiO_2	50.80	49.40	48.80	51.60	54.10	48.10	50.47
TiO_2	2.58	1.81	2.66	1.09	1.31	1.00	1.74
Al_2O_3	13.30	15.50	15.00	15.50	15.00	15.90	15.03
Fe_2O_3*	13.80	11.70	13.80	11.30	11.70	12.10	12.40
MnO	0.17	0.15	0.17	0.17	0.13	0.16	0.16
MgO	6.70	6.20	5.60	7.10	6.20	6.30	6.35
CaO	10.00	9.80	10.60	10.50	7.30	9.90	9.68
Na_2O	1.10	3.50	1.70	2.70	3.55	2.75	2.55
K_2O	0.15	0.40	0.25	0.15	0.10	0.40	0.24
P_2O_5	0.27	0.23	0.34	0.09	0.15	0.25	0.22
S	0.18	0.01	0.26	0.01	0.02	0.59	0.18
LOI	0.62	1.19	0.44	—	0.38	1.41	0.80
Total	99.67	99.89	99.02	100.21	99.94	98.86	
Zr ppm	153	95	170	43	82	109	109
Y ppm	17	14	20	17	16	16	17
Normalized for total = 100% and LOI + S = 0%							
SiO_2	51.38	50.06	49.33	51.50	54.35	49.66	51.05
TiO_2	2.61	1.83	2.69	1.09	1.32	1.03	1.76
Al_2O_3	13.45	15.71	15.16	15.47	15.07	16.42	15.21
Fe_2O_3*	13.96	11.86	13.95	11.28	11.75	12.49	12.55
MnO	0.17	0.15	0.17	0.17	0.13	0.17	0.16
MgO	6.78	6.28	5.66	7.09	6.23	6.50	6.42
CaO	10.11	9.93	10.72	10.48	7.33	10.22	9.80
Na_2O	1.11	3.55	1.72	2.69	3.57	2.84	2.58
K_2O	0.15	0.41	0.25	0.15	0.10	0.41	0.25
P_2O_5	0.27	0.23	0.34	0.09	0.15	0.26	0.22
Total	99.99	100.01	99.99	100.01	100.00	100.00	

* Includes FeO calculated as Fe_2O_3.
LOI = loss on ignition.
Analyses by Bondar-Clegg using XRF with Y checked by neutron activation.
All values are weight per cent unless otherwise noted.

associated with the marbles and are one to three times more voluminous. The most widespread marble/calc-silicate horizon is about 200 m to 400 m below the top of the formation and may correlate with the widespread Early Cambrian limestone conglomerate of Selwyn Basin (Gordey, 1978). Minor carbonaceous finely crystalline mable is interlayered with carbonaceous pelite above this unit.

Metabasites interpreted as either flows or sills occur in the Mt. Mye but are volumetrically significant only near its top where they comprise a few per cent of the unit. These rocks are generally strongly foliated, dark green amphibole, plagioclase, quartz schists lacking relict igneous texture. Metabasite bodies are generally only a few metres to tens of metres thick and have small to moderate lateral dimensions (up to a few hundred metres). Thin (10 cm to 1 m), variably calcareous, green, amphibole-rich schists, possibly derived from tuffs, occur interlayered with pelites near the top of the formation. The composition of Mt. Mye metabasites (6 analyses, Table 2) is that of a sub-alkaline basalt (Figs. 6-9). These metabasites are compositionally similar to, though less alkaline than, the more altered but less metamorphosed mafic rocks of the Vangorda formation and Menzie Creek formation to which they may be related as subvcolcanic feeders.

Little unequivocal data on the depositional environment of the Mt. Mye is found in Anvil District. The fine-grained, thinly banded monotonous nature of the metapelites and their regional setting is felt to be consistent with accumulation in relatively deep water on or at the foot of a continental rise.

Age and Correlation

Mt. Mye formation is similar to Cambrian strata mapped by Gordey (1978—units €p and l€p) in Selwyn Mountains (Fig. 1) near Howards Pass. Early Cambrian strata similar to the upper portion of the Mt. Mye have also been mapped by Blusson, (1966—Unit 8a) near Cantung (Fig. 1). Grey to brown phyllites of Early Cambrian or Hadrynian age below these units and

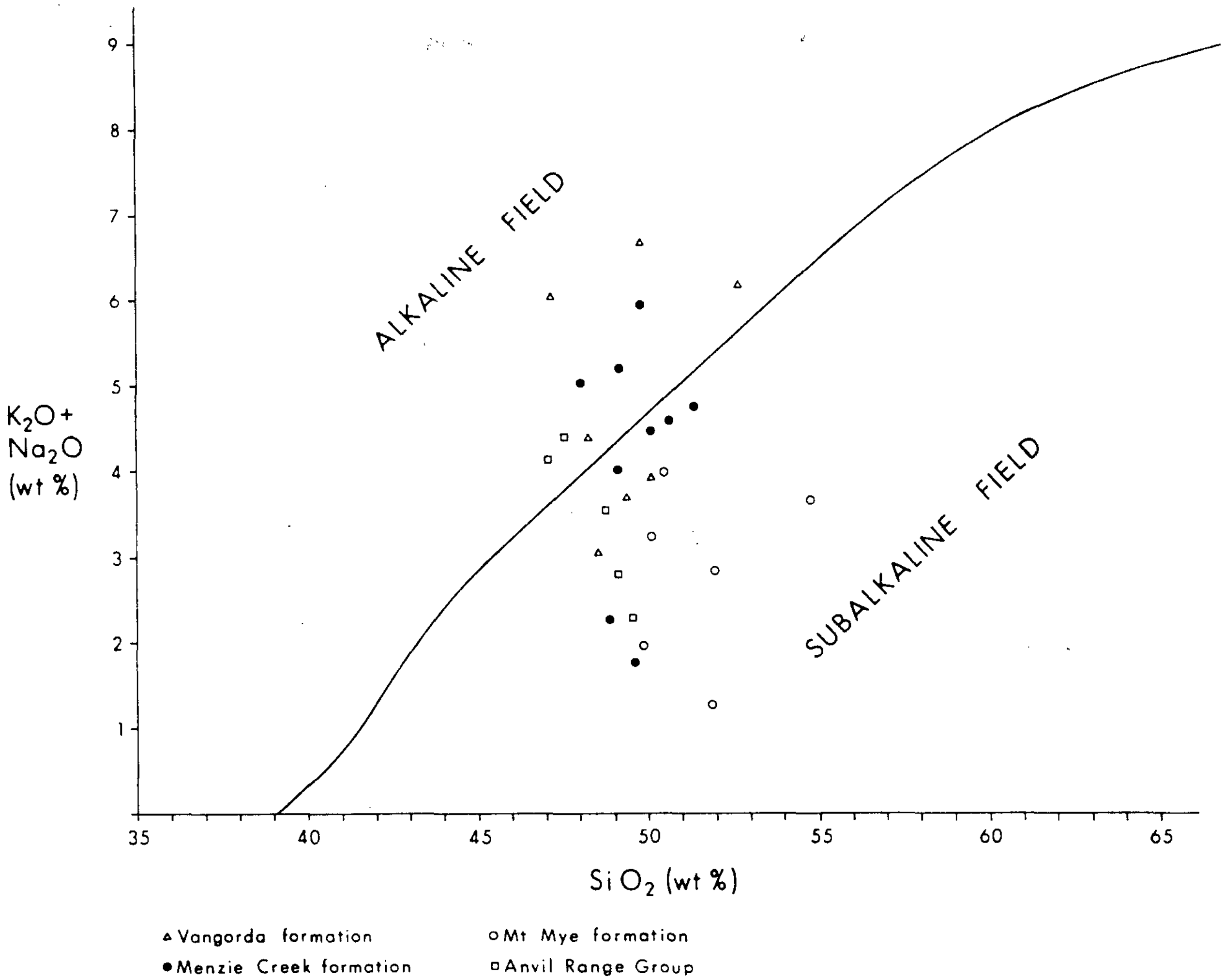


FIGURE 6. Alkali-silica diagram showing analyses of various mafic lithologies given in Tables 2, 3, 5 and 6. The alkaline-subalkaline field boundary is after Irvine and Baragar (1966). The metabasites of the Mt. Mye formation are least carbonated and tend to plot in the subalkaline field. The more strongly carbonated Vangorda and Menzie Creek formation metabasites plot toward the alkaline field.

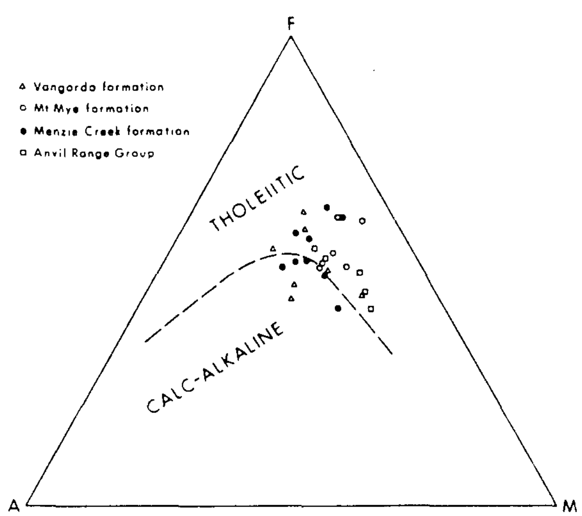


FIGURE 7. AFM plot of same analyses as Figure 6 definition of A, F and M as well as field boundary is after Irvine and Baragar (1966). With the exception of the Anvil Range Group basalts, all rocks are sufficiently strongly altered to carbonate-bearing assemblages to render inferences from this diagram and Figure 6 highly suspect.

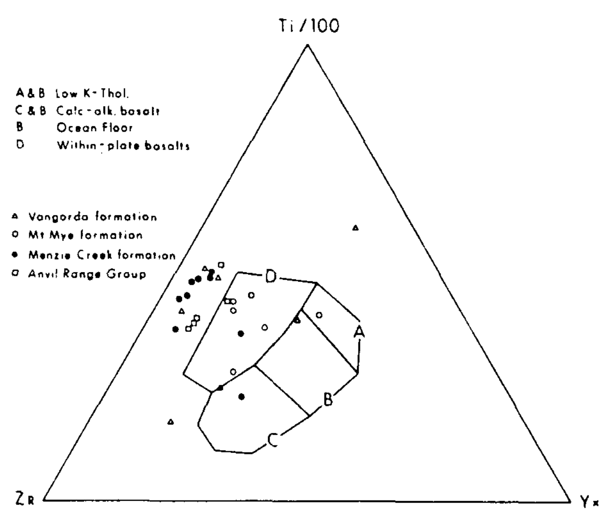


FIGURE 8. A Ti-Zr-Y discriminant diagram after Pearce and Cann (1973). The tendency of the least carbonate altered metabasites (of Mt. Mye formation) to plot in the within plate basalt field may be meaningful but the over-all scatter of analyses casts doubt on the general applicability of the inference to other formations.

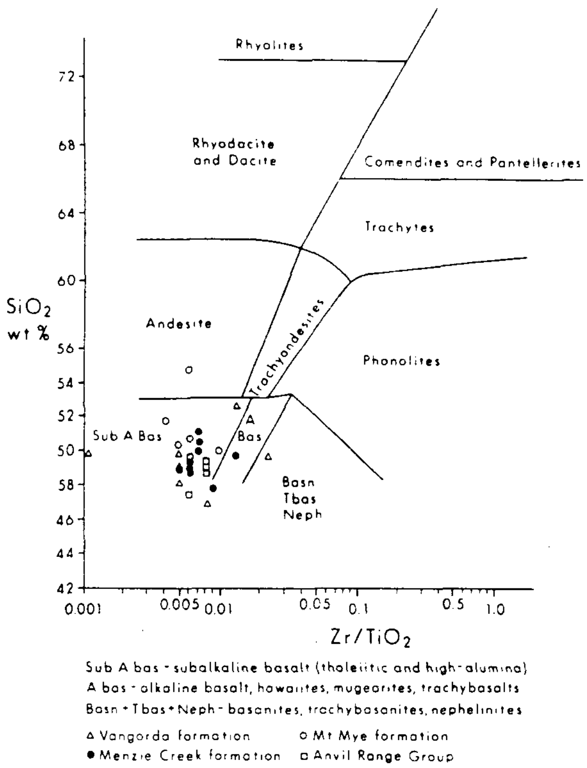


FIGURE 9. An SiO_2-Zr/TiO_2 discriminant plot after Floyd and Winchester (1977). Most analyses plot in the subalkaline basalt field but probable silica mobility renders the plot ambiguous.

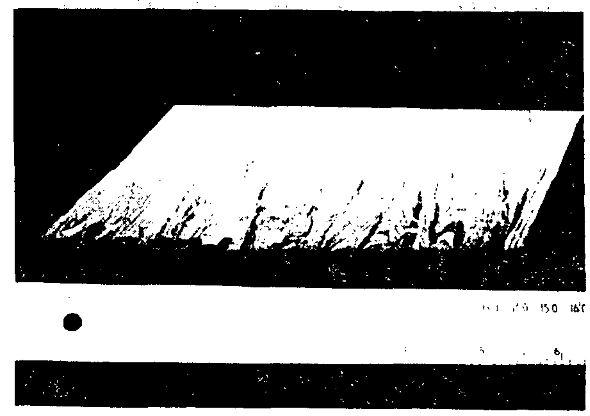


FIGURE 10. Calcite-rich Vangorda formation phyllite in drill core. S_2 (Table 7) is at about 80 degrees to the core axis. The thin compositional banding parallel to S_1 and the typical lithon structure of the phyllites is evident. The light-coloured bands are the quartz- and calcite-rich recrystallized siltstone bands; the darker micaceous bands are non-calcareous.

FIGURE 11. Green, laminarly banded phyllite (possible metatuffs or hornfelsed calcareous pelite) found adjacent to metabasites (just out of photo to the right) of the Vangorda formation. S_2 is inclined gently from left to right. S_0 and S_1 are parallel and steeply dipping (Table 7 for clarification of structural terminology).

similar rocks in Flat River map area (Fig. 1, part of phyllite unit of Gabrielse *et al.*, 1973) also resemble Mt. Mye formation and may be equivalent. On the basis of lithologic similarity to these better dated units, the Mt. Mye formation is thought to be lower (perhaps middle) Cambrian and possibly late Hadrynian.

The Mt. Mye formation includes the lower quartz-rich division of unit 3 and all of unit 3b of Tempelman-Kluit (1972). Most of unit 2 (*op. cit.*) is also part of the Mt. Mye, though amphibolite facies Vangorda formation is also included.

Vangorda Formation

Introduction

Vangorda formation is a thick sequence of recessive, generally calcareous phyllite, intercalated with lesser, basic, meta-igneous rock. The calcareous phyllites are locally metamorphosed to calc-silicate assemblages. A carbonaceous member occurs at the base of the formation. The existence of a mappable upper calcareous division in the phyllites of the Anvil District was first clearly demonstrated by Roberts (Brock and Roberts, 1971).

Strong internal deformation in the district adds great uncertainty to estimates of thickness of the formation. The thickness indicated from cross sections is about 1000 m, but this can vary considerably depending on the treatment of local structural detail.

The best readily accessible exposures of Vangorda formation are found along the road paralleling Blind Creek in the vicinity of the Dy deposit (Fig. 5), where both phyllite and metabasite can be examined. Good exposures of phyllite can also be seen southeast of the Firth showing (Fig. 12, Mineral Occurrence No. 12). Calc-silicates of Vangorda formation are best examined in the walls of the Faro pit (Anvil Mine) and in surface exposures northwest of the Faro deposit. Excellent exposures of the basal carbonaceous unit can be seen in the Faro pit and on the road to Swim Lake south of the Swim deposit (Fig. 5).

Weathering of the unit is distinctive and generally aids mapping the formations, especially from the air. Most outcrops are covered with a light grey druse and are light brownish grey or tan with conspicuous lustrous grey phyllite chips nearby. The formation is easily distinguished from rusty brown weathering Mt. Mye formation.

Lithology

Phyllites

Vangorda formation is characterized by medium grey phyllite very thinly interlayered with light grey quartz- and calcite-rich bands thought to be derived from siltstone beds and laminae (Fig. 10). The phyllitic bands are one-half cm to 1 cm thick and the quartz and calcite bands are 1 cm to several cm thick. The phyllitic bands are generally non-calcareous and homogeneous though internal colour gradations in shades of grey occur. The quartz-calcite bands are usually parallel laminated; grading occurs rarely; cross lamination is also rare and is generally preserved only in lower grade equivalents outside the district. The thin bands that form this rock are usually intricately folded on a hand specimen scale with an axial planar crenulation cleavage forming the dominant plane of fissility of the phyllites.

This rock type has many variants due to variations in the composition of the constituent bands. The over-all colour of the muscovite-chlorite phyllitic bands ranges from light olive, greenish-grey to medium grey (the dominant colour) to black

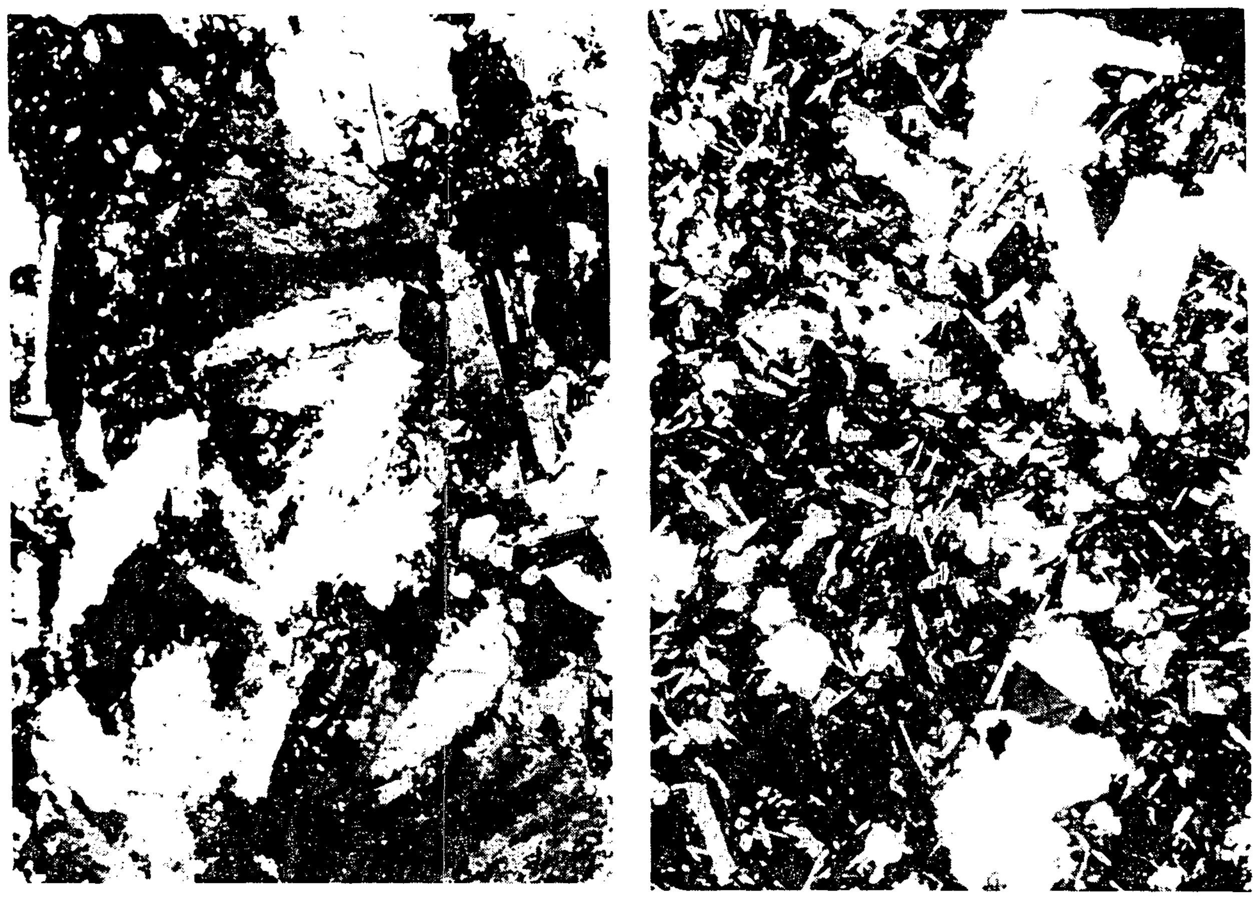


FIGURE 12. Comparison of thin sections of a typical specimen of metabasite from Vangorda formation—(A) crossed nicols—and a *metavolcanic from* Menzie Creek volcanic unit—(B) crossed nicols. Clear volcanic textures which typify the Menzie Creek are not found in Vangorda metabasites. Rather, they are coarser and more equigranular. Each view is 2 mm by 3 mm.

depending essentially on the amount of carbonaceous material. The siltstone bands, though always quartz-bearing, can have calcite and/or dolomite contents varying from 0% to 70%.

The most important Vangorda phyllite variants are (a) black, variably calcareous and commonly dolomitic, thinly layered, quartzose phyllite; (b) soft, medium grey to black, homogeneous, non-calcareous phyllite (lacking in quartz siltstone layers); (c) medium grey, non-calcareous phyllite thinly interlayered with quartz siltstone similar to the dominant Mt. Mye lithology; and (d) medium grey phyllite with thin quartz dolomite layers. None of these variants comprise more than 10% to 15% of the unit and they are clearly subordinate to the medium grey calcareous version which forms about 50% of the volume of the formation.

In addition to the black phyllite variant noted above, pervasively foliated, homogeneous, variably siliceous, hard, fine-grained black phyllites with minor (1%) disseminated pyrite and pyrrhotite are also developed, particularly near the base of the formation. Near ore deposits, these rocks are harder, more siliceous, more sulphide-rich and more abundant than elsewhere. They appear to be derived from black, siliceous shales laterally equivalent to black, sulphide-bearing, ribbon-banded, graphitic quartzite ore facies (see deposits section).

Dimensions of the carbonaceous members of Vangorda formation are poorly known. The thickest and most extensive member is at the base of the formation and can be traced discontinuously through the district and beyond as far as correlative exposures near the Nahanni Range Road on the west flank of Mt. Billings Batholith, 300 km southeast (Fig. 1). It is typically only a few tens of metres thick but near ore deposits can be up to 100 m thick. Electromagnetic conductors that define this unit can be followed continuously for several kilometres to a few tens of kilometres. It is not certain whether the lack of continuity of this member is caused by unappreciated structural complications or is depositional. Carbonaceous phyllite is developed as a subordinate lithology through the remainder of the formation where it is less areally extensive and thinner than the basal member.

Relatively pure marble is a very minor lithology in Vangorda formation. These marbles are mostly calcitic, medium bluish grey and the fine to medium crystalline; they are generally thin interbands and tend to occur in association with abundant and very calcite-rich siltstone bands. Rare, rusty orange weathering, medium crystalline, dolomitic marbles also occur locally. Black, slightly fetid, finely crystalline, calcitic marble is a minor constituent particularly in association with the basal carbonaceous member of the formation.

Green phyllitic rocks are common in Vangorda formation. These green phyllites are of considerable importance because of their implications for the extent to which volcanic rocks are present in the formation. Of particular interest is a striking, thinly laminated green and white, generally calcareous, phyllite that resembles a bedded tuff (Fig. 11). Locally, these rocks appear to be cherty and are hard. These green, laminated phyllites are rarely seen except adjacent to metabasites (described below) and most metabasites have them associated. In many instances, these phyllites grade outward from the metabasites into green or greenish grey, texturally normal Vangorda formation calcaerous phyllites. These greenish grey phyllites may result from a volcanic admixture to normal Vangorda formation pelites or from a weak bleaching (due to oxidation of background carbon in the normal pelites?) and/or chlorite alteration superimposed on the formation during intrusion of the spatially associated metabasites. The strongly laminated green rocks may thus be an

TABLE 3. Vangorda formation metabasites

Sample Number	5531	692	1402	1497	1487	5564	5596	Average
SiO_2	46.80	50.40	47.00	46.80	47.40	44.40	47.00	47.11
TiO_2	4.70	2.28	2.38	1.58	1.84	2.20	3.20	2.60
Al_2O_3	15.40	16.80	14.40	14.90	19.90	18.50	13.00	16.12
Fe_2O_3*	5.00	11.70	10.60	10.80	11.50	3.60	4.70	12.76
FeO	9.50	—	—	—	—	8.90	9.90	—
MnO	0.21	0.08	0.13	0.15	0.04	0.16	0.19	0.14
MgO	5.60	6.10	8.60	6.20	6.40	4.20	4.80	5.99
CaO	4.80	2.65	11.00	11.40	1.80	6.20	7.00	6.41
Na_2O	4.00	4.70	2.90	3.45	4.35	5.35	3.50	4.47
K_2O	0.25	1.20	0.10	0.05	2.05	0.40	0.20	0.61
P_2O_5	0.58	0.56	0.32	0.21	0.70	0.45	0.47	0.47
S	—	0.04	0.03	0.07	0.01	—	—	0.04
LOI	3.30	3.26	2.37	4.43	3.79	5.15	6.55	4.12
Total	100.14	99.77	99.83	100.04	99.78	99.81	100.51	
Zr ppm	260	317	26	80	430	175	175	209
Y ppm	16	41	24	23	32	(5)	6	21
Normalized for total = 100% and LOI + S = 0%								
SiO_2	48.33	52.24	48.24	48.98	49.39	47.22	50.02	49.20
TiO_2	4.85	2.36	2.44	1.65	1.92	2.32	3.41	2.71
Al_2O_3	15.90	17.41	14.78	15.60	20.73	19.54	13.84	16.83
Fe_2O_3*	5.16	12.13	10.88	11.30	11.98	3.80	5.00	13.33
FeO	9.81	—	—	—	—	9.40	10.54	—
MnO	0.22	0.08	0.13	0.16	0.04	0.17	0.20	0.14
MgO	5.78	6.32	8.83	6.49	6.67	4.44	5.11	6.23
CaO	4.96	2.75	11.29	11.93	1.88	6.55	7.45	6.69
Na_2O	4.13	4.87	2.98	3.61	4.53	5.65	3.72	4.21
K_2O	0.26	1.24	0.10	0.05	2.14	0.42	0.21	0.63
P_2O_5	0.60	0.58	0.33	0.22	0.73	0.48	0.50	0.49
Total	100.00	99.98	100.00	99.99	100.01	99.99	100.00	

* Includes FeO calculated as Fe_2O_3 if FeO not given separately.
LOI = loss on ignition.
Analyses by Bondar-Clegg using XRF with Y checked by neutron activation.
( ) indicates less than the detection limit within parentheses.
All values are weight per cent unless otherwise noted.

altered facies of normal Vangorda pelites rather than tuffs. A second type of distinct, green, calcareous phyllite is described below with the metabasites to which it is more directly related.

Metabasites and Derived Rocks

The most abundant subordinate lithology of Vangorda formation is mafic meta-igneous rock: metabasite or greenstone. Even though this sub-unit accounts for only about 15% to 20% of the formation, it is particularly conspicuous because it is resistant. Thus it, and its associated green phyllite, make up a high proportion of outcrops. Metabasites occur throughout the formation but are most abundant in its upper part where they may amount to 50% of the unit. Metabasite occurs in lens-shaped bodies with massive interiors commonly preserving relict diabasic or medium-grained, ophitic texture (Fig. 12). The margins of metabasites are pervasively recrystallized and strongly foliated. Metabasite bodies are 1 m to 100 m in thickness and can be as much as several kilometres in length. Most are smaller, commonly foliated and appear to parallel original compositional layering in Vangorda formation but are locally crosscutting in detail. Whole rock analyses show that metabasites are of basaltic composition (Table 3, Figs. 6-9).

A commonly occurring, widespread but volumetrically minor lithology of Vangorda formation related to the metabasites is olive green, calcareous, chlorite-rich phyllite. These rocks are more homogeneous than the green, laminated phyllites noted above. They commonly contain 0.1 cm to 5 cm thick, foliaform, white, quartz ± calcite bands of more irregular thickness than quartz ± calcite bands in normal Vangorda pelites and these bands are considerably more coarsely grained. These bands are more akin to vein material and merge locally with foliaform veins. The remainder of the rock is a homogeneous or a weakly, thickly colour laminated, fine-grained aggregate of chlorite + quartz + calcite + plagioclase + muscovite. Locally, relict feldspars and or pyroxenes and/or amygdules have been identified. Some specimens show an indeterminate mottled texture that could be clastic. These chloritic phyllites are very similar to the fine-grained margins of metabasites and to chloritic phyllites found in the overlying Menzie Creek formation (see below). They have mafic igneous compositions and may be small, fine-grained, metabasite bodies that are pervasively foliated throughout. However, some appear to have been tuffs or mafic flows. The dimensions of individual chloritic phyllite units is not well known. They are generally not more than a few metres thick and many examples are only a few centimetres thick. Some bodies have been traced for several hundred metres at approximately the same stratigraphic interval. These chloritic phyllites are generally readily distinguished from the medium grey, calcareous, pelitic phyllites that typify Vangorda formation but the two rock types become very difficult to separate where they are intimately interlayered and the pelites are highly altered. A large complex of these green phyllites of diverse origin occurs with metabasites at the northeast edge of the Dy and Grum deposits.

Two significant variants of the metabasic rocks in the district deserve mention. The first is variably serpentinized pyroxenite that occurs locally associated with otherwise normal metabasites. These appear to be pyroxene cumulates related to the metabasites, and like them have foliated margins showing their pre-D_1 age. The second is a rusty weathering, light tan quartz-sericite-dolomite or ankerite rock commonly bearing minor amounts of a bright green possible serpentine or clay mineral (Modene, 1982) resembling fuchsite. These rocks are common in the Grum deposit and are found more rarely in other deposits. They are heavily carbonated metabasites resembling quartz-carbonate altered, metabasic rocks described worldwide. Black, carbonaceous ore types are commonly bleached off-white adjacent to these rocks. Less intensely altered, carbonated metabasites that retain a green colour occur widely in the district. Indeed, most metabasites in the Vangorda formation are carbonated to some degree, a fact that adds considerable ambiguity to interpretation of whole rock geochemical data in Table 3.

The origin of the metabasites and allied green rocks is controversial. In hand specimen and in thin section, most metabasites are texturally like fine-grained intrusive rocks (Fig. 12). Local, crosscutting, contact relationships also support an intrusive origin. Pillows have not been observed in the metabasites and fine-grained, amygdaloidal texture that typify the overlying

TABLE 4. Comparison of average whole rock analytical data for calcareous phyllite and all calc-silicates of Vangorda formation

	A[3] calcareous phyllite (N = 8)	B[3] "ordinary" calc-silicate (N = 9)	C[3] "cherty" calc-silicate (N = 3)	D average calc-silicate B and C (N = 12)	E A normalized for LOI = 0	F B normalized to LOI = 0	G C normalized to LOI = 0	H D normalized to LOI = 0
SiO_2	49.86	51.27	52.11	51.48	55.06	53.90	53.32	53.77
TiO_2	0.29	0.46	0.47	0.46	0.31	0.48	0.47	0.48
Al_2O_3	16.34	17.14	15.87	16.83	17.99	18.01	16.23	17.57
[1]Fe_2O_3	6.75	7.04	6.54	6.92	7.39	7.38	6.67	7.21
MnO	0.09	0.09	0.06	0.08	0.10	0.09	0.06	0.08
MgO	3.21	3.54	3.89	3.63	3.52	3.71	3.96	3.77
CaO	9.51	10.96	13.34	11.56	10.63	11.50	13.76	12.06
Na_2O	1.70	1.38	1.33	1.37	1.87	1.44	1.35	1.42
K_2O	2.69	3.13	3.87	3.32	2.97	3.30	3.95	3.46
P_2O_5	0.16	0.18	0.20	0.19	0.17	0.19	0.20	0.19
[2]LOI	9.42	4.80	2.32	4.18	—	—	—	—

1 Total iron as Fe_2O_3.
2 LOI = loss on ignition.
3 Averages of analyses by Bondar-Clegg, Vancouver, British Columbia, using XRF (N = number of samples).

Menzie Creek flows are restricted to the margins of larger equigranular bodies. The metabasites are texturally identical to dykes and plugs intrusive into the overlying Menzie Creek volcanics. The above considerations suggest that the metabasites are derived from basaltic sills, perhaps subvolcanic feeders to the Menzie Creek volcanic unit. On the other hand, since metabasites are spatially associated with green, possibly tuffaceous phyllites, some may be flows that accumulated in local flow and fine-grained hyaloclasite complexes.

Despite this ambiguity, there is no doubt volcanism did occur at times during the accumulation of Vangorda formation. The evidence is particularly clear in the Grum deposit where thin (1 mm to 1 cm), green, unmineralized, chloritic phyllites occur interlayered with sharp contacts in black, carbonaceous, sulphide-bearing quartzites. These chloritic rocks faithfully follow the layering in the ore and almost certainly were originally thin tuffs. The best evidence for the presence of tuffs is found in rare, green, chloritic phyllite interlayers found both in the ore and in other metasediments. These particular layers are a few to 10 cm thick and show rapid vertical colour gradation from dull, olive green to medium or dark grey more typical of the surrounding sediments.

Calc-silicates

One of the major problems in tracing Vangorda formation through the district is its variable metamorphic overprint. In areas of higher grade metamorphism, as near the Faro deposit, the dominant lithology is thinly and discontinuously banded, pervasively foliated, green, cream and purplish brown, hard calc-silicates. Typical mineral assemblages are quartz, tremolite-actinolite, plagioclase, biotite ± diopside ± calcite ± epidote. Calc-silicate outcrops are commonly druse covered, blocky and weather medium to light grey similar to the phyllites.

Table 4 compares the average bulk composition of representative calc-silicates and calcareous phyllite. When recast on a volatile-free basis, their compositions are essentially identical. The loss of CO_2 from the consumption of calcite during formation of calc-silicate minerals presumably accounts for the difference in volatiles (L.O.I.) between the two rock types.

A peculiar variant of calc-silicated Vangorda is found at several localities on the northeast flank of Anvil Range. These rocks are very fine-grained, thinly layered, pervasively foliated and have a characteristic cherty aspect. Despite their cherty appearance, these calc-silicates are no more siliceous than ordinary Vangorda calc-silicates (see Table 4, Col. B and C) and in thin section they are similar to other calc-silicates but so fine grained that their mineralogy is difficult to determine. These rocks are part of unit 4 of Gordey (1983) and crop out widely south of Two Pete Mountain (Fig. 1).

Depositional Environment

Like the underlying Mt. Mye formation, the depositional environment of Vangorda formation is equivocal. Its fine-grained, monotonous nature, more argillaceous character than its presumed equivalents to the east and southeast, and its paleogeographic setting suggest deposition in relatively deep water.

The thin bedding and lamination as well as grading and cross lamination within rare examples of Bouma cycles in equivalent strata outside the district is suggestive of some sediment transport by turbidity currents.

Contact Relationships and Internal Variation

The basal contact of the formation appears sharp, but is rarely exposed. At both Grum and Faro where the structure is reasonably well understood, the contact appears to be relatively sharp and occurs across the basal carbonaceous member within which there is a rapid downward transition of interlayered lithology from rocks typical of the Vangorda formation to those typical of the Mt. Mye.

At Faro, the basal carbonaceous member is a few to over 30 m thick and contains interlayers of transitional calc-silicates, amphibole-rich metabasic rocks, chloritic schists, marbles and pelites typical of Mt. Mye formation. The base of the formation is arbitrarily placed at the point where Mt. Mye formation schists with a normal grey colour are encountered. At Grum, there is also a basal carbonaceous member approximately 30 m thick which is variably dolomitic (presumably the protolith of the Faro transitional calc-silicates) and some chloritic metabasic rocks also occur. This basal unit at Grum is abruptly overlain by normal medium grey calcareous phyllite, but the base of the unit, unlike Faro, is the locus of one of the major ore lenses thus obscuring the normal formational contact relationship. Immediately beneath the ore layers are normal Mt. Mye phyllites.

Based on relationships at the Dy deposit, we have previously proposed a gradual, interlayered transition between the Mt. Mye and Vangorda formations over as much as 300 m vertically (Jennings *et al.*, 1980). We now suspect some of the apparent interlayering of calcareous and non-calcareous phyllite may be an artifact of the poorly understood structure there.

Geographic variation in the character of the formation occurs within the district. Compared to the area of the sulphide deposits on the south flank of the Anvil Arch (Fig. 3), the formation on the northeast flank is less calcareous and metabasites are less abundant and smaller; exhalative base metal-rich sulphide bodies are also conspicuously absent there though a small occurrence is known in Mye Creek (Fig. 5).

Age and Correlation

The formation crops out widely between the Anvil district and Coal River 500 km southeast (Fig. 1). Outside the Anvil district, the best accessible exposures are along the Nahanni Range Road west of the Mt. Billings Batholith between King and Sequence Creeks in Frances Lake map area (105 H) (Fig. 1). Metabasites are very minor in the formation everywhere outside the Anvil district northeast of the Tintina Fault.

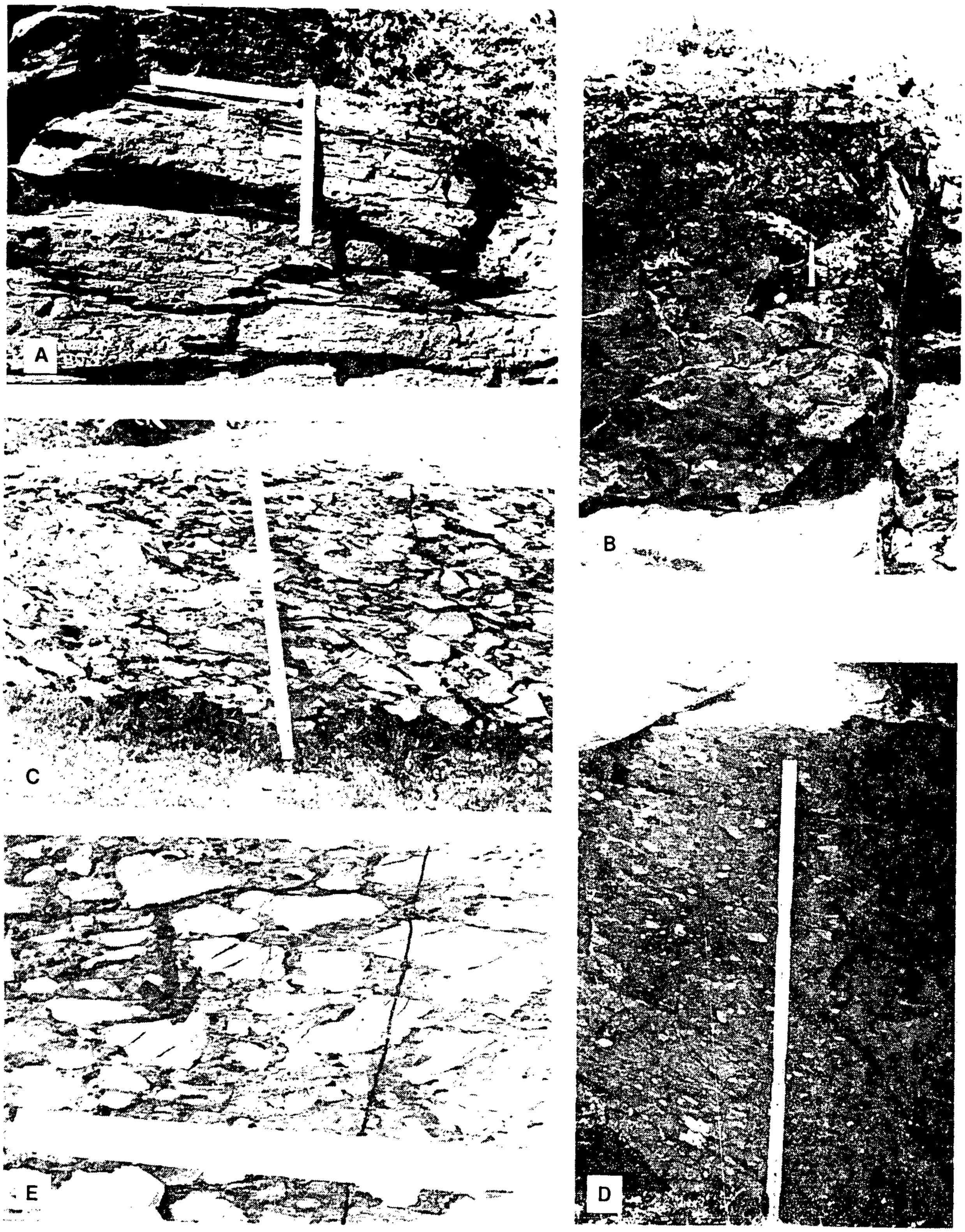


FIGURE 13. Typical Menzie Creek formation pillowed flows, (A) and (B), and breccias (C), (D) and (E). (B) shows unfoliated pillows. (A) shows more typical pillows toward the base of the unit where they are strongly flattened (into S_1): in (A), S_1 is horizontal and pillow margins are marked by zones of concentrated, crudely radial amygdules. (Rule is 20 cm on edge.) (C) shows the typical relief weathering of Menzie Creek breccias due to the strongly calcareous matrix; S_1 is horizontal with moderate flattening of clasts. (Rule is 40 cm long.) (D) is an example of less clast rich matrix support breccia; S_1 is gently inclined from left to right. (Rule is 60 cm long.) (E) is a close-up of a breccia in which some clasts have broken, dark rinds, possibly derived from non-amygdaloidal pillows; S_1 is horizontal. (Rule graduated in cm.) See Table 7 for explanation of structural terminology.

Similar rocks occur north of Mt. Hunt (unit 10 of Blusson, 1966) and on Simpson Tower in Frances Lake Map area; in southwestern Coal River Map area (unit 8a of Gabrielse and Blusson, 1969); and in northeastern Finlayson Lake map area (Fig. 1, unit u€Osl of Tempelman-Kluit, 1977). The Cambrian-Ordovician Kechika Group south of the Tintina Fault has long been noted to be similar to phyllites of the Anvil Range (Tempelman-Kluit, 1972) and the Vangorda formation presumably correlates with its lower portion at least in part (see also Gordey, 1981, p. 9).

The Rabbitkettle Formation (Gabrielse *et al.*, 1973) of Cambro-Ordovician age is similar to the Vangorda formation in its thinly layered, calcareous and silty nature, but is far less argillaceous.

On the basis of lithologic similarity to these better dated units, the Vangorda formation is thought to be, at least in part, upper Cambrian possibly extending to lowest Ordovician. We have found no evidence in the Anvil district for the pronounced, sub-upper Cambrian, regional unconformity at the base of the Rabbitkettle Formation (Gabrielse *et al.*, 1973) to the east. Strata as old as lower Cambrian, may thus be included in the Vangorda formation: specifically equivalents of part of unit €c of Gordey (1978) or the Hess River formation (Cecile, 1982).

Unit 3 of Tempelman-Kluit (1972) includes the Vangorda formation. Specifically, the upper member and the abundant graphitic rocks (*op. cit.* p. 6) appear to belong to the formation. The statement that thinly laminated silty limestone is abundant in the upper part of unit 3 (*op. cit.* p. 7) is a reflection of the more calcareous nature of the upper Vangorda formation. Some amphibolite facies portions of the Vangorda formation are included in unit 2 (*op. cit.*) particularly calc-silicates northwest of the Faro deposit.

Menzie Creek Formation

Introduction

Menzie Creek formation is a thick unit of resistant, grey weathering, dominantly basaltic metavolcanic rocks with intercalated black phyllite and slate. Major rock types present in subequal amounts are pillow lava, volcanic breccia and massive, amygdaloidal, commonly porphyritic flows.

A maximum thickness of 1.5 km seems likely. Locally, the formation is thin and appears to nearly lens out into a black shale package.

The best exposures of Menzie Creek formation are northeast of Anvil Batholith most easily accessed by helicopter. On the south flank of Anvil Arch, the unit is recessive with small outcrops within 1 or 2 km of the mine access road and the Blind Creek road northeast of Vangorda Fault zone.

Lithology

Well developed pillow lavas are common in the Menzie Creek formation (Fig. 13 A and B). Typically, they are 0.5 m in diameter and have 0.5 cm to 1 cm dark rinds. Radially elongated, calcite- and chlorite-filled anygdules 0.5 cm in diameter are developed around the periphery. The pillow core is finely to non-amygdaloidal, aphanitic, and non-porphyritic to porphyritic (feldspar and/or augite). Interpillow matrix is generally fine-grained, highly foliated, and chloritic. Fine breccia and minor red chert also occur. Pillow breccia is interlayered with or beneath pillow lavas at many localities. In the lower portions of the formation, pillows are highly flattened into the S_1 foliation. Well formed, undeformed pillows are the rule, higher in the formation.

The massive flows range from medium olive green to grey green to dark green to almost black and rarely, purple or red. They commonly contain 5 mm diameter calcite- and/or chlorite-filled amygdules and may be aphanitic or have feldspar or augite phenocrysts. The flows range from unfoliated and blocky to strongly foliated and fissile. A few exposures show individual flows with amygdule trains along their upper and lower contacts and massive or columnar jointed interiors. Rarely, massive flows have rubbly, flow-brecciated tops. Massive flows grade into flow breccias whose large angular fragments have matching margins separated by fine breccia with a nearly identical appearance. Massive flows are more abundant than pillow lavas in the upper part of the formation. Calcite amygdules are commonly much larger in flows from the upper part of the formation than in the lower.

Breccias of diverse and often obscure origin are widely developed in Menzie Creek formation (Fig. 13 C to D). Most breccias are homolithic, massive, ungraded and unstratified. Fragments are angular, usually equant and one to several centimetres across, although fragments to several metres are known. The weathering colour, amygdule or phenocryst content of the fragments vary, but most appear basaltic. Identifiable pillow fragments occur sparsely and in some cases, the fragments have broken across possible pre-brecciation weathering rinds. The matrix is fine fragmental basaltic material, now calcite- or dolomite-rich, typically weathering to a distinctive, rough, high relief surface (Fig. 13C). Both clast and matrix supported breccias appear to occur (discounting effects of metamorphic flattening). Where the basal contact of a breccia unit crops out, there is locally evidence of scour of interbreccia tuffs(?) and one example of a 0.5 m reverse graded zone was encountered. The thickness of individual breccia layers is difficult to determine because of lack of bedding. Individual units 30 m thick are defined and 5 m to 10 m high outcrops of homogeneous breccias are common.

Age and Correlation

The only direct evidence of the age of the Menzie Creek formation is provided by fossils from unit OSrr. This unit overlies the Menzie Creek with a poorly exposed, probably interdigitating contact. These fossils indicate that the Menzie Creek is early Ordovician or older. Lower Paleozoic, particularly Ordovician, mafic volcanic rocks have been described at several localities in and around eastern Selwyn Basin as recently summarized by Cecile (1982). From published descriptions, many of these occurrences are similar to Menzie Creek formation e.g.: unit 5 of Tempelman-Kluit (1970a) and the upper part of Gordey's (1981) Cambro-Ordovician assemblage.

The formation in Glenlyon map area to the northwest is more abundantly porphyritic; massive flows appear to predominate over breccia and pillowed basalt. Furthermore, Menzie Creek and Vangorda equivalents are more clearly interlayered. Vangorda and Menzie Creek formations (and minor Mt. Mye formation near Tay Mountain) in this area are equivalent to Campbell's (1967) Anvil Range Group.

Unit 8b? and all Anvil Range Group basalts outside the strip in Rose Mountain (Fig. 5) along Tintina Trench (G.S.C. Map 1261A, Tempelman-Kluit, 1972) are mainly Menzie Creek basalts. Analyses IIA-IID in Table II (*op. cit.*) are properly referred to Menzie Creek formation.

A comparable, thick accumulation of volcanic rocks in southwestern Selwyn Basin has not been recognized. The presence of Ordovician volcanic rocks and of large metabasite bodies in the Vangorda formation may be indicative of massive sulphide potential in underlying rocks.

Road River Equivalents and Related Strata

Introduction

Dark coloured metasedimentary rocks thought to be equivalent to the Road River Group (Cecile, 1982; Gordey *et al.*, 1983) are included in four separate map units in Figure 3. None of these areas have been studied in any detail.

Unit SDs

Unit SDs occurs in a narrow strip southwest of the belt of Menzie Creek formation on the southwest flank of Anvil Arch. The unit is very poorly exposed but its distribution is relatively well known due to its distinctive anomalous electromagnetic signature.

The few outcrops examined by the writers are recessive black, generally featureless, non-calcareous phyllite. Locally, thin bedding striping in shades of grey is developed on foliation surfaces.

TABLE 5. Menzie Creek formation metavolcanics

Sample Number	5535	5009	4505	4648	4506	4663	4198	1458	1617	Average
SiO_2	47.50	47.00	47.40	46.50	48.00	46.50	48.30	44.80	49.40	47.27
TiO_2	3.90	2.80	2.40	1.50	3.40	2.65	2.30	1.04	2.58	2.51
Al_2O_3	14.20	15.00	14.80	15.40	14.70	15.10	14.20	14.30	12.60	14.48
Fe_2O_3*	4.70	5.45	3.15	1.70	1.80	4.90	2.45	11.50	12.60	13.02
FeO	8.60	7.20	9.50	8.75	10.00	9.00	9.00	—	—	—
MnO	0.15	0.18	0.11	0.15	0.15	0.18	0.20	0.08	0.15	0.15
MgO	5.60	5.60	4.70	9.20	5.60	5.10	7.40	4.80	6.00	6.00
CaO	7.50	9.50	6.80	8.30	8.40	9.20	7.80	8.60	8.80	8.32
Na_2O	3.00	1.60	4.00	3.30	3.80	2.20	3.85	4.90	4.10	3.41
K_2O	0.95	0.10	0.25	1.60	1.30	0	0.50	0.45	0.50	0.63
P_2O_5	0.50	0.41	0.44	0.27	0.46	0.39	0.37	0.27	0.29	0.38
S	—	—	—	—	—	—	—	0.13	0.02	0.08
LOI	3.30	5.45	6.50	3.40	2.40	4.95	3.25	8.77	2.88	4.54
Total	99.90	100.29	100.25	100.07	100.01	100.17	99.62	99.64	99.92	
Zr ppm	220	180	185	135	190	160	160	156	188	175
Y ppm	12	(5)	5	(5)	10	6	(5)	27	27	11
Normalized for total = 100% and LOI + S = 0%										
SiO_2	49.17	49.56	50.67	48.10	49.18	48.83	50.12	49.37	50.92	49.55
TiO_2	4.04	2.95	2.57	1.55	3.48	2.78	2.39	1.15	2.66	2.62
Al_2O_3	14.70	15.82	15.82	15.93	15.06	15.86	14.73	15.76	12.99	15.19
Fe_2O_3	4.87	5.75	3.37	1.76	1.84	5.15	2.54	12.67	12.99	13.66
FeO	8.90	7.59	10.15	9.05	10.24	9.45	9.43	—	—	—
MnO	0.16	0.19	0.12	0.16	0.15	0.19	0.21	0.09	0.15	0.16
MgO	5.80	5.90	5.02	9.52	5.74	5.36	7.68	5.29	6.18	6.28
CaO	7.76	10.02	7.27	8.59	8.61	9.66	8.09	9.48	9.07	8.73
Na_2O	3.11	1.69	4.28	3.41	3.89	2.31	4.00	5.40	4.23	3.59
K_2O	0.98	0.11	0.27	1.66	1.33	0	0.52	0.50	0.52	0.66
P_2O_5	0.52	0.43	0.47	0.28	0.47	0.41	0.38	0.30	0.30	0.40
Total	100.01	100.01	100.01	100.01	99.99	100.00	100.00	100.01	100.01	

* Includes FeO calculated as Fe_2O_3 if FeO not given separately.
LOI = loss on ignition.
Analyses by Bondar-Clegg using XRF with Y checked by neutron activation.
( ) indicates less than the detection limit within parentheses.
All values are weight per cent unless otherwise noted.

An important, but volumetrically minor lithology is fetid, fine-grained, dark grey to black bioclastic limestone. The limestone occurs in lenses up to a metre thick but with uncertain lateral dimensions. The known localities occur in the lower part of the map unit. The limestone contains abundant crinoid ossicles, some of which have twin axial canals. The limestone has yielded conodonts of eary Middle Devonian age (Orchard, pers. comm. 1982; Cameron, pers. comm. 1977). Near Swim Lake, the unit contains very minor thin tan weathering dolomite similar to that in Unit OSrr (see below).

The upper and lower contacts are not exposed, but both are thought to be gradational. Metavolcanics similar to the Menzie Creek formation occur interlayered with the unit near its base. The upper portion appears to grade into black, grey and beige chert of the Earn Group.

Minor rock types in Menzie Creek formation include thin bedded, commonly graded, tuffs or fine, volcanic fragment-rich, epiclastic rocks with very minor interlayered, fine-grained, stratified breccia. Near the top of the formation, calcite- or dolomite-cemented basaltic sandstone, minor basalt cobble conglomerate and sandy grey limestone or orange weathering dolomite up to 10 m thick are interstratified with the volcanic assemblage. These sedimentary rocks and the abundance of large amygdules in nearby massive flows indicate, at least, local shoaling of the volcanic pile.

This description applies mainly to areas northeast of Anvil Batholith, where the formation is best studied. Southwest of Anvil Batholith, the formation's characteristic lithology is olive green, amygdaloidal, chloritic phyllite. Pillow lavas and breccia with lesser thin bedded tuff also occur, but unlike the northeast area, the Menzie Creek is interlayered with abundant black phyllite. This part of the formation is highly foliated, recessive and has not been studied in detail. The interlayered black phyllite gives a characteristically "busy" EM signature useful in mapping its extent in areas of poor exposure.

Volcanic rocks of Menzie Creek formation show a limited range of basaltic composition and were probably alkalic basalts originally (Table 7). The metabasalts are extensively carbonated to orange weathering quartz ± fuchsite (?) rock in the extreme case. Though the analyses in Table 5 are of least altered material, they sould be approached with caution. Andesite has been reported in Glenlyon map area (Fig. 1, Campbell, 1967) and may be present, but is not suggested in our analyses.

The abundance of breccia, greater thickness of the formation, evidence of shoaling, general lack of thin pelagic sedimentary interlayers and association with large discordant mafic plugs northeast of Anvil Batholith are interpreted to imply a volcanic centre in that area. A large area of pre-metamorphic bleaching (to sericite, quartz, carbonate) enclosing folded or foliaform stringers of quartz and calcite with sphalerite, pyrite, chalcopyrite and minor galena (KD deposit, Fig. 3, Mineral Occurrence No. 9) perhaps coincidentally occurs near this centre. This may be a minor occurrence of volcanogenic, fumarolic-type mineralization.

Unit SDa

Unit SDa occurs in a triangular fault-bounded area 14 km northeast of Mt. Mye. The upper and lower contacts are not exposed.

The lowest portion of the unit exposed is characterized by laminarly bedded, dolomitic siltstone about 100 m of which is present. A zone of poor exposure separates these siltstones from overlying massive orthoquartzite and dolomite. This interval may be underlain by dark shale. Medium-grained, well sorted pure orthoquartzite occurs in a bed or beds 10 m to 20 m thick. The orthoquartzite is overlain by about 30 m of medium crystalline light grey to white, white weathering massive dolomite. The dolomite has yielded Middle Devonian fossils (locality F3; Tempelman-Kluit, 1972).

The dolomite is overlain by an unknown thickness of thin bedded, dark grey to black, non-calcareous shale and siltstone with characteristic thin bedding striping on cleavage surfaces.

The dolomitic siltstone is identical to the basal portion of the late early Silurian to middle Devonian Askin Group (Wheeler, Green and Roddick, 1960) that crops out 150 km southeast of the Anvil district. The dolomite and quartzite are very similar to upper parts of the Askin Group. The Askin Group defines the extent of the Cassiar Platform, and unit SDa contains the only strata in the Anvil District that resemble this important regional unit. The dark coloured sediments overlying the quartzite are very similar to strata of the basal Earn Group (Gordey *et al.*, 1983) examined by the writers southeast of Anvil District and in the Akie District (Jefferson *et al.*, 1983) of northeastern British Columbia (Fig. 2).

Unit OSrr

Unit OSrr occurs in an irregular area 15 km north-northeast of Mt. Mye. Approximately 250 m to 400 m of sequence is exposed there.

The basal two-thirds of the unit at that locality are black, non-calcareous, shale to phyllite. The upper third of the unit is brown weathering, dark grey shale with very minor tan weathering unlaminated dolomitic siltstone. Near the top of the unit is a 1 m to 30 m thick laterally discontinuous bed or beds of orthoquartzite. The quartzite is medium-grained, pure and massively bedded. It is similar to the quartzite of unit SDa, but the laminated dolomitic siltstone characteristic of unit SDa is not present in unit OSrr. The shales and tan weathering dolomitic siltstone of the upper part of the unit contain graptolites at several localities (including localities F1 and F2; Tempelman-Kluit, 1972) of middle Ordovician or early Silurian age. A few kilometres west of these localities, Gordey (1983) has recently discovered lower Ordovician graptolites from near the base of a similar shale sequence also divisible into lower black and upper brown weathering parts. Quartzite is not present there. The younger graptolitic rocks occur very close to the orthoquartzite and probably overlie it but the relative stratigraphic positions of these rocks are not well known due to poor outcrop. The quartzite is very similar to that of unit SDa, however, laminated dolomitic siltstone characteristic of the latter unit is absent. If unit SDa is equivalent to the Askin, as seems likely, then it is not likely that the quartzites correlate, as those of unit OSrr appear to be older.

The lower contact of unit OSrr is not well exposed. The distribution of local shale and volcanic float suggests that the unit is interlayered with the upper part of the Menzie Creek formation. Unit OSrr is also thought to overlie the Menzie Creek because of its northerly sheet dip, the regular asymmetric distribution of colour in the shales and the fact that Menzie Creek bedded tuffs and pillow lavas at many localities south of the belt of OSrr dip north and are north facing. The reader should consult Gordey (1983) for an alternative interpretation of this area.

Southeast of the locality just described, the unit consists of black shale to phyllite and drab black phyllitic chert (unit OSrr ? in Fig. 3). Near the top of this sequence is tan to orange weathering variably dolomitic quartzite (Sq?) and siltstone (locally irregularly laminated) that may be related to unit SDa.

The affinity of the map unit is uncertain in this area. Gordey (1983) considers most of this area to be underlain by rocks older than the graptolitic shales and a facies equivalent of the Menzie Creek and Vangorda formations. North of Orchay Pluton (Fig. 3), the black shale and chert sequence is underlain by calc-silicate and calcareous phyllite similar to Vangorda formation and basalt similar to Menzie Creek formation; thus, we consider the black shale and chert sequence to be younger than these formations.

Earn Group

Rocks tentatively considered equivalent to the Earn Group (Gordey *et al.*, 1983) occur in two belts on the northeast and southwest flanks of Anvil Arch respectively. The sequences in both areas are chert-rich. In the northeast, chert-bearing clastics are minor and a major limestone-bearing unit is present. On the southwest flank of the Anvil Arch, limestone is minor and chert pebble conglomerate is an important rock type.

In the southwestern belt, the Earn Group consists of black, grey, beige and green, thinly interbanded cherts and siliceous phyllite of similar colours. The dominant colour at the base of the unit is dark grey and black. The colour changes gradually up section to grey and beige dominant with increasing proportions of dull olive green chert so that the top of the unit is beige and green chert dominant. The lower half of the unit contains abundant chert pebble conglomerate and grit. Rocks of the Earn Group in this belt are very highly strained and the conglomerate clasts are strongly flattened into the generally layer parallel metamorphic foliation. Since folds in the thinly banded chert sequence are highly attenuated and rootless, it is commonly difficult to distinguish strongly deformed thin-banded chert from chert pebble to cobble conglomerate.

Near the top of the unit, minor grey calcareous phyllite, limestone and orthoquartzite are interlayered with the phyllitic cherts. Several tens of metres beneath the calcareous rocks is the most important of several layers of stratiform barite that occur through the Earn Group sequence on the southwest flank of the Anvil Arch. The barite is finely crystalline and medium to light grey. It is hosted by and interbanded with beige phyllitic cherts and like the cherts, it is strongly foliated. The barite horizons are up to 12 m thick and have been traced for several kilometres. Several other barite horizons of lesser extent occur beneath the major unit including a discontinuous one near the base of the Earn Group.

This chert and chert conglomerate sequence is considered correlative with the Earn Group on the basis of its lithologic similarity. The age of the sequence is perhaps bracketed by the occurrence of Middle Devonian fossils in rocks structurally beneath and Pennsylvanian or Early Permian fossils (see below) in rocks structurally overlying, however, it is yet to be demonstrated that this is a stratigraphic sequence. The upper and lower contacts of the Earn Group here are gradational colour changes.

Anvil Range Group

Our use of the term Anvil Range Group follows the redefinition by Tempelman-Kluit (1972) and his subsequent usage (Tempelman-Kluit, 1979). The Anvil Range Group was originally named by Campbell (1967) for rocks exposed in Glenlyon map area. The sequence to which the name was originally applied, we now consider Mt. Mye, Vangorda and Menzie Creek formations.

The Anvil Range Group consists of two units. An upper volcanic unit characterized by unfoliated but locally sheared, massive, but commonly finely brecciated, dense, fine-grained, dark green, commonly epidotized and hematite-veined basalt (Table 6). The basalt weathers to characteristic reddish brown, rounded, knobby but resistant outcrops. The basalt is underlain by ribbon-bedded green and red chert, tuffaceous chert and minor tuff. The contact between basalt and chert is intercalated as described by Tempelman-Kluit (1972). This sequence is seen only on the Rose Mountain ridge, but similar green cherts lacking associated basalt or significant red chert occur locally on the northeast flank of Anvil Range (not differentiated from uDM in Fig. 3).

The Anvil Range Group and Menzie Creek formation have been previously mapped as one unit. Basalts of the Anvil Range Group are distinguished from those of the Menzie Creek by their lack of appreciable amygdules, lack of diverse volcanic structures and textures, lack of metamorphic foliation, darker colour and distinctive weathering colour. The Anvil Range Group is only exposed on the Rose Mountain ridge. That locality is fairly typical of much of the unit in the belt from Faro to Watson Lake (Fig. 1) and we believe should be the Group's type locality. The basalts to the southeast, however, are quite clearly pillowed and not everywhere associated with red chert, for example in the Campbell Range (Fig. 1).

The Anvil Range Group bears a close spatial relationship to ultramafic rocks, layered and massive gabbro, diabase, locally as dyke complexes, rodingite and orange weathering, carbonated, fuchsitic ultramafics.

The prominent light grey weathering carbonates of Unit 8c of Tempelman-Kluit (1972) (PPc, Fig. 3) occur in Tintina Trench across Vangorda fault zone and may not be related to the Anvil

TABLE 6. Anvil Range Group volcanics

Sample Number	6064	6176	6322	4144	4260	Average
SiO_2	45.20	46.70	47.40	47.00	47.20	46.7
TiO_2	1.50	2.20	1.05	1.50	1.20	1.49
Al_2O_3	16.30	14.00	14.70	15.60	15.60	15.24
Fe_2O_3	13.30	4.85	2.15	2.30	3.30	12.05
FeO	—	9.00	7.85	7.60	6.45	—
MnO	0.15	0.32	0.17	0.15	0.17	0.19
MgO	5.80	7.40	8.70	10.40	7.20	7.90
CaO	10.50	9.20	11.50	8.00	11.80	10.20
Na_2O	3.10	3.50	2.35	3.15	1.90	2.80
K_2O	0.85	.80	0.35	0.25	.30	0.51
P_2O_5	0.10	0.20	0.13	0.20	0.15	0.16
LOI	3.05	1.60	3.50	3.55	4.60	3.26
Total	99.85	99.77	99.85	99.70	99.87	
Zr ppm	—	135	88	120	105	112
Y ppm	—	14	(5)	7	(5)	8
Normalized for total = 100% and LOI + S = 0%						
SiO_2	46.69	47.57	49.20	48.88	49.54	48.38
TiO_2	1.55	2.24	1.09	1.56	1.26	1.54
Al_2O_3	16.84	14.26	15.26	16.22	16.37	15.79
Fe_2O_3*	13.74	4.94	2.23	2.39	3.46	12.48
FeO	—	9.17	8.15	7.90	6.77	—
MnO	0.15	0.33	0.18	0.16	0.18	0.20
MgO	5.99	7.54	9.03	10.82	7.56	8.36
CaO	10.85	9.37	11.94	8.32	12.39	10.57
Na_2O	3.20	3.57	2.44	3.28	1.99	2.90
K_2O	0.88	0.81	0.36	0.26	0.31	0.52
P_2O_5	0.10	0.20	0.13	0.21	0.16	0.16
Total	99.99	100.00	100.01	100.00	99.99	

* Includes FeO calculated as Fe_2O_3 if FeO not given separately.
LOI = loss on ignition.
Analyses by Bondar-Clegg using XRF with Y checked by neutron activation.
( ) indicates less than the detection limit within parentheses.
All values are weight per cent unless otherwise noted.

Range Group. It appears to be part of the Yukon-Tanana Terrane, since at Grew Creek and Blackfox Bend (Fig. 1) on Pelly River it shares interlayered quartz grit with underlying members of the blue quartz grit-bearing Yukon-Tanana sequence.

Intrusive Rocks

Anvil Plutonic Suite

Late- and post-metamorphic intrusive rocks cutting the Anvil metamorphic complex occur as large plutonic bodies or as dykes, sills and plugs. Three major intrusions are recognized, Anvil Batholith, Orchay Pluton and Marjorie Pluton (Fig. 3). Collectively, they are termed the Anvil Plutonic Suite (Pigage and Anderson, 1985) and range in composition from granite to granodiorite with biotite, quartz, plagioclase and K-feldspar as ubiquitous phases. Variable amounts of hornblende and muscovite distinguish discrete intrusive phases (Pigage, pers. comm., 1982), but relationships between the phases are poorly understood. A description of the plutonic suite was first given by Tempelman-Kluit (1972) and a more recent description can be found in Pigage and Anderson (1985).

The Anvil Batholith is typically biotite-muscovite or biotite-hornblende quartz monzonite, either medium crystalline and equigranular or with coarse K-feldspar megacrysts. The vast majority of the batholith shows cross-cutting relationships to the S_2 foliation (see structure section) and post-dates the major deformations. Little, if any, contact metamorphic effects are seen such as hornfelsing or retrogression of regional metamorphic phase assemblages. Contacts of the batholith are sharp and non-migmatitic. These observations suggest a "hot-into-hot" intrusive relationship, implying the heat flow regime responsible for the second regional metamorphic event (see below) is related to the batholith. Very locally, margins of Anvil Batholith are weakly to moderately foliated by a relatively shallowly dipping foliation.

Orchay Pluton is smaller than Anvil Batholith but may be connected to it at depth beneath the crest of Anvil Arch. It is biotite-hornblende quartz monzonite texturally similar to Anvil Batholith and shows post-metamorphic, non-migmatitic intrusive contacts.

The Marjorie Pluton (Fig. 3) is mapped only in reconnaissance fashion. It includes hornblende-biotite quartz monzonite showing both medium-grained equigranular and coarsely porphyritic textures. Hornblende phenocrysts are locally coarsely crystalline, seived and irregular. Poikilitic, K-feldspar megacrysts are also common. Quartz phenocrysts characterize this suite and are commonly smoky. Cross-cutting relationships between the Marjorie and Orchay Plutons are uncertain because the contact area is very poorly exposed. Roddick and Green (1961) considered the Marjorie Pluton to be a subvolcanic equivalent of the South Fork Volcanics.

Anvil Dyke Suite

The Anvil Dyke suite has been studied in detail only near the Faro deposit. This discussion focuses mainly on that area, but most dykes in the district fall into one of the following categories. The members of the dyke suite are more abundant with depth or proximity to Anvil Batholith and may be related to it. All members of the dyke suite are post metamorphic and cut the Batholith, but their relative ages are poorly known.

The most voluminous members of the dyke suite are northeast-trending, porphyritic, medium to dark green hornblende diorite dykes which cut megacrystic quartz monzonites of the Batholith. The diorite body in the north end of the Faro open pit and the body immediately northeast of Faro deposit, zone 2, are among the largest examples (Fig. 29). Several diorite dyke sets cut the Faro deposit with a prominent set developed along the fault between zones 1 and 3 (Figs. 30 and 32). Elsewhere, hornblende diorite dykes commonly follow northeast-trending faults and fractures.

Intrusion of hornblende diorite dykes and sills in the calc-silicated Vangorda formation above zone 3 produced extensive brecciation locally involving the sulphide deposit (Fig. 21). This

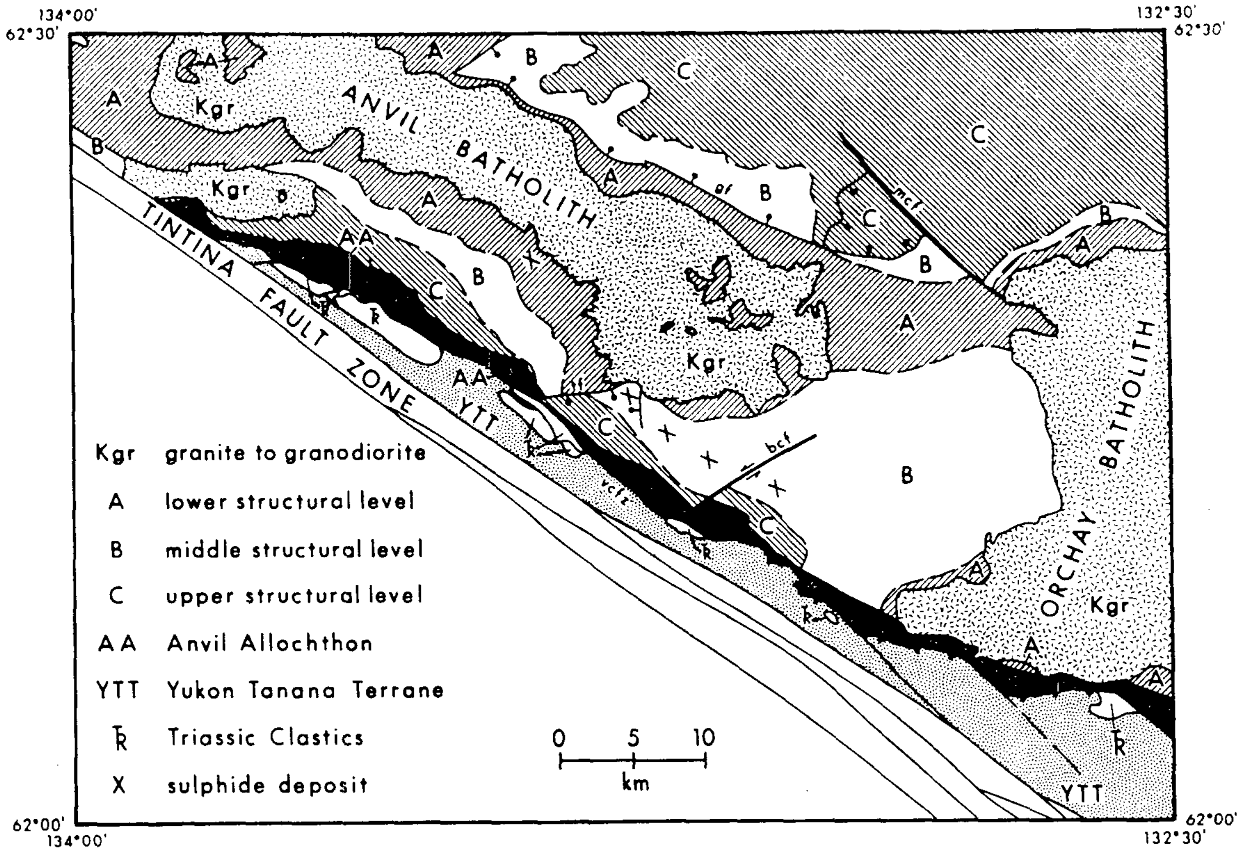


FIGURE 14. Distribution of the three structural levels of the Anvil District. AA is possibly allochthonous Anvil Range Group basalt and chert (Anvil Allochthon of Tempelman-Kluit, 1979). Black represents sheared mafic and ultramafic rocks of Vangorda Creek Fault zone. Triassic clastics are polymict conglomerates, shales and limestone found adjacent to Vangorda Creek Fault zone, see Tempelman-Kluit (1972) for descriptions. tf = Tie Fault, vcfz = Vangorda Creek Fault zone, bcf = Blind Creek Fault, mcf = Mye Creek Fault, gf = Graphite Fault.

brecciation presumably resulted from vapour pressure of the melt having exceeded confining pressure of the superincumbent strata and resulted in a coarse, angular, clast supported breccia with a rock flour and minor, devitrified, altered, chloritized diorite glass matrix. The age of the brecciation is at least post D_3 (see below). This breccia body is the only example known in the district; it occurs immediately adjacent to the Faro orebody and in cross section, the deposit can be interpreted to be zoned with respect to the centre of brecciation. The post-metamorphic age of the breccia shows the breccia forming event cannot be related to the ore-forming event since the ores are clearly pre-metamorphic. Rare diorite fragments occur in the breccia. However, unbrecciated diorite and minor medium-grained, equigranular, dark pink monzonite intrude the breccia, apparently following joint surfaces and post-dating the main stage of brecciation.

Intrusion of quartz-feldspar porphyry dykes, minor sills, and irregular intrusive masses and leucocratic tourmaline-garnet pegmatite dykes mark the last intrusive event. Both rock types crosscut hornblende diorite dykes northeast of the Faro deposit, but their relative ages are not known.

Quartz-feldspar porphyry also cuts quartz monzonite of Anvil Batholith north of the Dy deposit. The porphyry consists of smoky, grey or clear, euhedral and subhedral, locally doubly terminated and/or embayed quartz, subhedral feldspar and commonly biotite in a light coloured, generally aphanitic matrix. The smoky quartz-bearing character of these rocks and rocks of Marjorie Pluton may imply a genetic relationship and suggest the Marjorie Pluton is younger than Orchay Pluton. A similar, possibly younger quartz-feldspar porphyry plug occurs northeast of Anvil Batholith (unit TV in Fig. 3).

Well-foliated, garnet-bearing granitic sills up to a few metres thick occur in schists near the contact of Anvil Batholith. The occurrence of garnet and tourmaline in the late stage dykes as well as in the batholith itself reinforces the probable relationship between the plutonic and dyke suites.

The best and most recent K/Ar ages on rocks of the Anvil Batholith fall in the range 95 to 100 Ma (Pigage, pers. comm., 1982), an age range, in general confirmed and extended to other members of the plutonic suite by Rb/Sr work (Pigage and Anderson, 1985), though one sample of the Orchay phase yielded a single, questionable Rb/Sr isochron age of 61 Ma.

Structure

Introduction

The Anvil District is a structurally complex polymetamorphic and polydeformational terrane. Metasediments of the district contain evidence for at least five phases of deformation of which the first two are the most significant in that they are penetrative, regionally developed and accompanied by regional metamorphism. They are further of great importance in that they significantly affect the shape and character of the orebodies.

The metasediments are domed to form a northwest-trending structural culmination, Anvil Arch, cored by Cretaceous granitic rocks of the Anvil plutonic suite (Fig. 3). Grade of metamorphism decreases in intensity radially outward and upward from the granitic rocks in the core of the arch. Middle amphibolite facies rocks occur near the plutonic core, but much of the district is greenschist facies.

The most prominent and characteristic fabric element of the metasediments of the Anvil District is a shallowly dipping foliation commonly sub-parallel to compositional layering. This foliation varies in its manifestation depending on depth in the structural sequence. Other deformational features likewise vary

TABLE 7. Summary of nomenclature and manifestation of structural features

Nomenclature			Manifestation			Orientation				
Event	**Fabric Element**	**Definition**	**Lower Structural Level**	**Middle Structural Level**	**Upper Structural Level**	**SW Flank of Anvil Arch**	**NE Flank of Anvil Arch**	**Associated Faulting**	**Associated Intrusive Activity**	**Associated Metamorphism**
pre D_1	S_0	bedding	not preserved, transposed into S_2	rarely preserved, largely transposed into S_1 and intensely crenulated into D_2 folds	widely preserved bedding	over-all sheet dip of compositional units moderately to shallowly SW	over-all sheet dip of compositional units moderately to shallowly NE	possible syn-depositional growth faults •	mafic sill emplacement	none
D_1	S_1	planar structures formed during D_1	schistosity locally preserved in lithons and small D_2 folds (mostly) microscopic preservation	phyllitic axial planar cleavage intensely crenulated by F_2	slaty to phyllitic cleavage axial planar to F_1 folds	moderately to steeply SW dipping in high levels	dips shallowly in higher levels, poorly known in deeper levels	small NE directed thrusts on N flank of range and possible large scale overthrusting on south flank emplacing Anvil Range Group	none identified	regional metamorphism greenschist to amphibolite facies
	F_1*	folds formed during D_1	not well preserved on outcrop scale but inferred on larger scale	rarely preserved, generally tight to isoclinal folds S_0. Northeasterly vergent.	well developed close to tight folds in S_0	axial planes dip moderately SW, axes trend NW-SE subparallel to L_2	poorly known			
	L_1	linear structures formed during D_1	not preserved due to D_2 overprinting	rarely preserved as compositional striping on S_1, largely overprinted by D_2	compositional stripping in S_1 ($S_0 x S_1$)	NW-SE subparallel to L_2	poorly known in lower levels · Trend NW-SE in upper levels			
D_2	S_2	planar structures formed during D_2	nearly pervasive schistosity axial planar to isoclinal folds in S_1 and compositional layering ubiquitous development	strongly developed crenulation cleavage axial planar to F_2 folds	weak crenulation cleavage not well developed in highest levels	shallow SW sheet dip	shallow NE sheet dip	none conclusively identified	possible intrusion of Anvil Batholith during waning stages	regional metamorphism greenschist to amphibolite Buchan facies series
	F_2	folds formed during D_2	small isoclinal rootless folds in compositional layering and S_1, common rootless isoclines in quartz veins. Larger scale folds probably present but not well documented.	intensely developed small scale folds in S_1 and compositional layering	not widely developed except as microscopic folds in S_1 related to L_2 crenulation lineation	axial planes parallel S_2, axes parallel L_2, commonly SW vergent	axial planes parallel S_2, axes L_2, vergence unknown			
	L_2	lineations formed during D_2	poorly preserved lineation due to (1) hinges of microlithons,(2) waviness on S_2 caused by hinges of quartzose layers in microlithons, and (3) onlap lineation	ubiquitous development of wrinkle lineation on S_1 in noses of F_2 and widely developed onlap lineation	weak wrinkle lineation on S_1	shallowly doubly plunging in direction 135° on average	shallowly doubly plunging in direction 135° on average			
D_3	S_3	planar structures formed during D_3	generally weak crenulation cleavage but more strongly developed locally in vicinity of larger folds	locally developed weak to moderate crenulation cleavage	not identified with certainty	moderate to steep SW sheet dip	not well known	none conclusively identified	possibly related to late stages of intrusion of Anvil Batholith	waning stages of D_2 metamorphism in lower levels, none in middle and upper levels
	F_3	folds formed during D_3	locally developed, close, flexural slip folds in S_2 with wave-length and amplitude of several cm. Larger folds near FARO deposit	mesoscopic folds not generally developed but broad regional warps in S_2 appear to be genetically related	not identified with certainty	axial planes parallel S_3, axes parallel L_3, generally NE vergent	not well known			
	L_3	lineations formed during D_3	coarse** wrinkle lineation in S_2 parallel to F_3 axes	fine** wrinkle (crenulation) lineation on S_2	not identified with certainty	shallowly doubly plunging in direction 155°	shallowly doubly plunging in direction 155°			

TABLE 7. Summary of nomenclature and manifestation of structural features

Nomenclature			Manifestation			Orientation				
Event	Fabric Element	Definition	Lower Structural Level	Middle Structural Level	Upper Structural Level	SW Flank of Anvil Arch	NE Flank of Anvil Arch	Associated Faulting	Associated Intrusive Activity	Associated Metamorphism
	S_4	planar structures formed during D_4	similar to S_3	similar to S_3	weak crenulation cleavage only locally developed	strike 110°-120° dip moderately SW to subvertical	not well known			
D_4	F_4	folds formed during D_4	similar to F_3	similar to F_3	broad warps in S_1 and S_0 appear geometrically related	axial planes parallel S_4, axes parallel L_4, generally NE vergent	not well known	small northeast directed thrusts	possibly related to late stages of intrusion of Anvil Batholith and formation of Anvil Arch	as above
	L_4	lineations formed during D_4	coarse wrinkle lineation on S_2	coarse wrinkle lineation on S_2	coarse wrinkle lineation on S_1 developed locally in lower parts of level	shallowly doubly plunging in direction of 110°-120°	shallowly doubly plunging in direction 110°-120°			
	S_5	planar structures formed during D_5	fracture cleavage axial planar to small folds in S_2	fracture cleavage to close spaced jointing	not identified	strike 60° - 80°, subvertical *dip*	strike 60° - 80°, subvertical *dip*			
D_5	F_5	folds formed during D_5	open chevron-style folds with amplitudes up to several tens of centimetres	not widely developed, local open, low amplitude folds on outcrop scale. Weakly developed chevron-style folding	not identified	axial planes parallel S_5, axes parallel L_5	unknown	*normal* faults trending 60°, possibly related to Tie Fault and other extensional faults	possibly Anvil Dyke Suite, especially 60° trending dykes	none
	L_5	lineations formed during D_5	weak coarse wrinkle lineation on L_2	very wide spread crenulation lineation on S_2 locally but generally only intersection of S_5 and S_2	not identified	doubly plunging in direction 60°-80°	doubly plunging in direction 60°-80°			

* F is also used to refer to the axial plane and axis of the fold depending on context.

** Coarse wrinkle (or crenulation) lineation (see Fig. 18B) crests spaced about 0.5 cm, fine wrinkle lineations spaced about 1 mm or less.

according to depth in the pile. Structural position thereby provides a convenient framework for discussion of the fabric of rocks of the district. We divide the district into three gradational and somewhat arbitrary regimes: lower, middle and upper structural levels (Fig. 14).

In the lower level, amphibolite facies metamorphic rocks contain an intensely developed schistosity into which compositional banding is transposed on most observable scales. Development of features characteristic of this level is generally confined to the lower Mt. Mye formation, however, strata as high as the Menzie Creek formation are locally affected.

The middle level's rocks are generally in the greenschist facies with characteristic intensely developed crenulation cleavage. In many outcrops, banding is transposed into the dominant foliation but exceptions are numerous and there are many examples where the over-all dip of layering is at strong angles to the foliation over large areas. The middle level is best developed in the upper Mt. Mye formation and throughout the Vangorda formation.

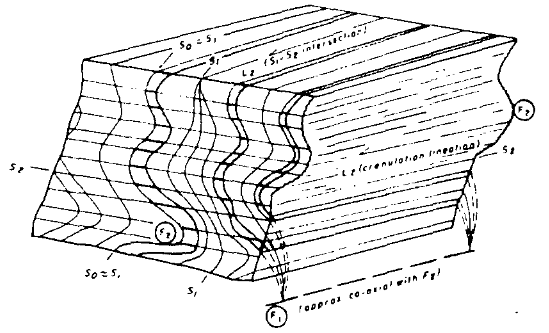
In the upper structural levels, rocks were deformed at low or sub-greenschist facies and they commonly have a well developed phyllitic to slaty cleavage which can be found at high angles to well preserved bedding. In the upper levels, the characteristic low-angle cleavage noted above is present but very weakly developed and an earlier foliation is dominant. This structural level is best developed in the Menzie Creek and younger units.

Table 7 summarizes the nomenclature applied to various elements of the fabric of Anvil District rocks and the manifestation of these elements at the three structural levels referred to above. Figure 15 summarizes the geometric relationships of the fabric elements of rocks of the lower and middle structural levels.

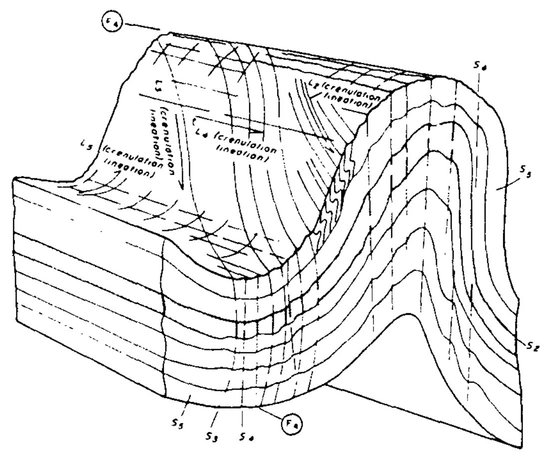
The structure of the district has only been studied in detail on the southwest flank of the Anvil Arch where extensive drill control and aritificial exposures supplement the meager outcrop of the district. Reconnaissance work elsewhere demonstrates that the remainder of the district shows a similar structural style, but the specific geometry of these areas is known only in a most general way.

Lower Structural Level

The lower structural levels of the metamorphic pile are best exemplified by the area of the Faro deposit (Fig. 16). Here, S_2 is a penetrative schistosity axial planar to close to isoclinal folds in an earlier foliation (S_1) and compositional banding. S_1 and banding are largely transposed into S_2 with preservation only in the hinges of F_2 folds and particularly in lithons which are commonly only noticeable on a microscopic scale (Fig. 17). F_2 fold axes and the parallel L_2 crenulation lineation trend 300 degrees to 330 degrees plunging shallowly to the northwest. The L_2 direction is sub-parallel to the elongation of the Faro deposit. S_2 dips about 20 degrees to the southwest away from the core of the Anvil Arch and the batholith. The majority of F_2 folds verge southwest. Though mesoscopic D_2 folds are developed in ores of the Faro deposit and mesoscopic to microscopic folds are not uncommon in the host rocks, there is no evidence in the results of deep drilling near the deposit of any large-scale folds of that generation that could repeat the deposit or the stratigraphy of the host rocks. The over-all shape of the deposit may be the result of large intrafolial D_2 folds but the internal geometry is not well known. Like S_2, large-scale compositional layering also dips shallowly southwest but tends to dip more shallowly than S_2. This may be the result of unmapped northeast vergent F_1 folds that are expected from relations elsewhere in the district (see below) and would be parasitic to a larger first-phase fold postulated to explain the local map pattern north of the Faro deposit. Small-scale F_1 folds are not, however, widely preserved



A Schematic post-D_2 geometry



B Schematic post-D_5 geometry (F_3 and F_5 omitted)

FIGURE 15. Summary diagrams showing the fabric elements in rocks of the Anvil District:

$D_{1\text{-}5}$ refers to deformations 1-5.

$S_{1\text{-}5}$ refers to foliations (surfaces) formed during D_1 through D_5. S_0 is bedding.

$L_{1\text{-}5}$ refers to lineations formed during D_1 through D_5.

$F_{1\text{-}5}$ refers to folds and fold axes formed during D_1 through D_5.

See Table 7 for details of structural terminology.

(A) summarizes the post D_2 geometry and is an idealization of the greenschist facies phyllites of the middle structural level. (B) shows the post D_2 deformations, superimposed on near pervasive S_2 where parallel to compositional layering, and is an idealization of the amphibolite facies schists of the lower structural level.

in the Faro deposit area, nor are they anywhere in the deeper parts of the sequence.

Three temporally and geometrically distinct post D_2 deformations are recognized in the Faro deposit area.

D_3 deformation and metamorphism produced a weak, non-penetrative metamorphic foliation, S_3 axial planar to F_3 folds in S_2 and compositional banding. S_3 strikes 150 degrees to 160 degrees and has a sub-vertical dip. F_3 fold axes plunge shallowly southwest parallel to a penetrative crenulation lineation, L_3. F_3 folds are close, parallel flexural slip folds in S_2 whose amplitudes vary from 10 cm to 10 m and wavelengths are up to 15 m.

D_4 deformation features include a non-penetrative, axial planar, metamorphic foliation, S_4, striking 110 degrees to 120 degrees and dipping sub-vertically to moderately southwest and a non-penetrative crenulation lineation parallel to F_4 fold axes. F_4 folds are open to close with doubly plunging axes trending 110 degrees to 120 degrees. Folds of this generation (Fig. 18A) are the largest recognized in the Faro deposit and complicate the over-all shape of the deposit (Figs. 30 and 31). Folds with amplitudes of 15 m to 40 m and wavelengths of 75 m have been recognized but their size varies laterally through the deposit. These fold amplitudes decrease rapidly with depth in the deposit, suggesting that significantly different mechanical properties between sulphides and host rocks controlled the folding. Small-scale northeast directed thrust faulting along pre-existing S_2 surfaces occurred during D_4. Northeast and north of the Faro Deposit, F_4 folds with amplitudes of over 100 m occur (Figs. 16 and 30).

Features developed during the D_5 event occur only locally in the Faro deposit area. S_5 is a weak non-penetrative foliation axial planar to small folds in S_2. A weak crenulation lineation, L_5, parallels the fold axes and represents the intersection of S_5 with S_2. S_5 strikes 60 degrees to 80 degrees and dips sub-vertically. D_5 was associated with normal faults which cut the above thrusts.

Middle Structural Level

A partial cross section through the southwest flank of the Anvil Arch (Fig. 19) illustrates the features of the middle structural level of the terrane. The area of the Grum, Vangorda and Dy deposits (the Vangorda Plateau) is the best studied portion of this structural level and an appreciation of the over-all style of this area was essential to the discovery of the deeply buried Dy deposit and will be to its continuing delineation.

The most prominent feature of the cross section is the gross right way up panel of stratigraphic units forming the flanks of the Anvil Arch. Superimposed on this panel are several Z symmetry, northeast vergent, first-phase folds (F_1) in the over-all compositional layering (S_0) with amplitudes in excess of 500 m. Axes of these folds trend northwest-southeast and are shallowly doubly plunging. The axial surface of this fold generation is paralleled by a steeply southwest dipping foliation (S_1) which is cut and crenulated by a shallow southwest dipping, close spaced, younger foliation (S_2). This younger crenulation foliation is axial planar to ubiquitous, dominantly S symmetry, southwest vergent, folds (F_2) in S_1. These second generation folds are of significantly smaller wavelength and amplitude than the first generation folds and impart a macrolithon fabric to the rocks. The F_2 folds are approximately coaxial with F_1. F_2 axes are parallel to the L_2 crenulation which trends about 330 degrees on the average and plunges most commonly shallowly to the northwest but is doubly plunging over-all. L_2 is parallel to the elongation of each of the ore deposits and on a district scale follows the curvilinear trend of the deposits (Fig. 20).

A closer view of the same geometry and the structural style is provided by a representative cross section through the Grum deposit (Fig. 33). S_1 is axial planar to a megascopic, Z symmetry, tight to isoclinal, first phase antiform synform pair outlined by the contact of the Mt. Mye and Vangorda formations and the ore layers. Compositional layering (S_0) as well as S_1 are folded into close to tight, S symmetry folds whose axial plane parallels a younger shallow southwest dipping crenulation cleavage, S_2. The failure to recognize such a large-scale F_1 fold would lead to a quite different picture of the Grum deposit probably involving facies changes. Conversely, the inherent difficulty of convincingly demonstrating the presence of F_1 folds through the D_2 overprint greatly limits the ability to deduce the original geometry of these deposits.

Geometric relationships characteristic of the outcrop or mesoscopic scale at this structural level are illustrated in Figure 21. Figure 21A is one of the best examples of a refolded F_1 fold in the district. This is from an outcrop of laminarly banded metatuffs or altered green phyllite adjacent to a metabasite of the Vangorda formation. A phase one antiform-synform pair is refolded along shallow dipping axial planes paralleled by the S_2 crenulation cleavage producing an over-all structure very similar to the previous Grum section. This outcrop demonstrates the importance of a detailed appreciation of small-scale structures as a guide to the interpretation of the expected shapes of unexposed sulphide deposits known only through widely spaced drill holes.

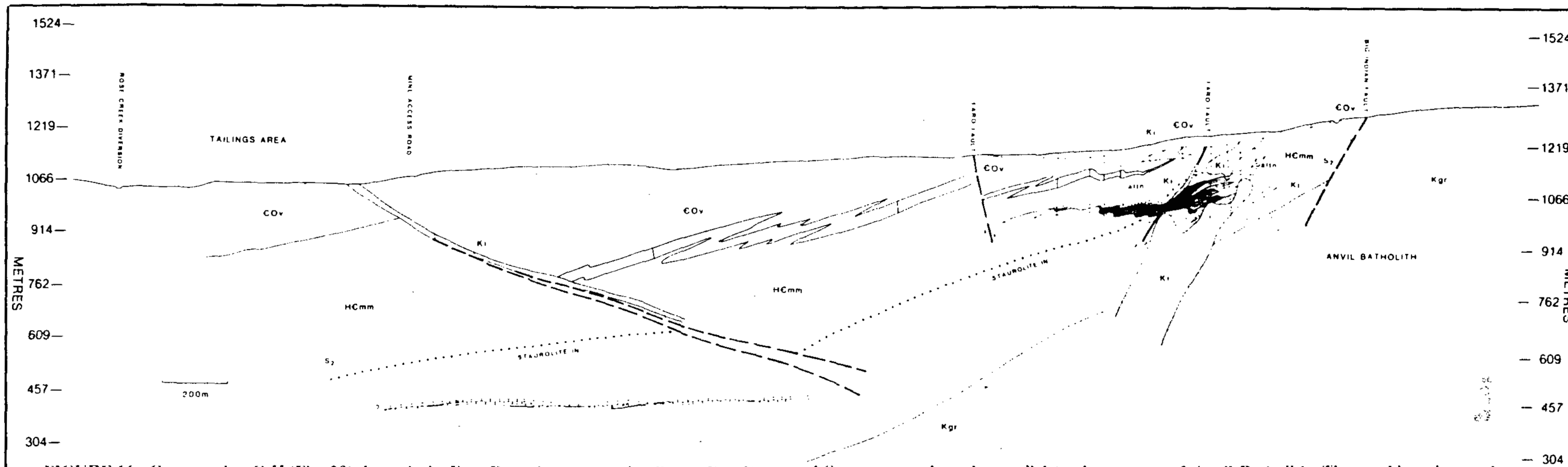


FIGURE 16. Cross section G-H (Fig. 20) through the Faro Deposit (same section line as Fig. 30) illustrates the large scale structural relations of the lower structural level. Note approximate parallelism of unit boundaries to S_2. Most Vangorda formation on this section is calc-silicate with the exception of the structurally highest portion near the mine access road. The dotted line shows the first appearance of staurolite in Mt. Mye schists. The metamorphic reaction surface and S_2 are approximately parallel to the contact of Anvil Batholith. The marble unit may be equivalent to the lower Cambrian archaeocyathid limestone of Selwyn Basin. In drill holes that intersect the marble near the Batholith it is altered to tactite and contains minor scheelite. The low dip of the fault in the southwest half of the section is apparent. Note the large scale post D_2 folds northeast of the Faro deposit.

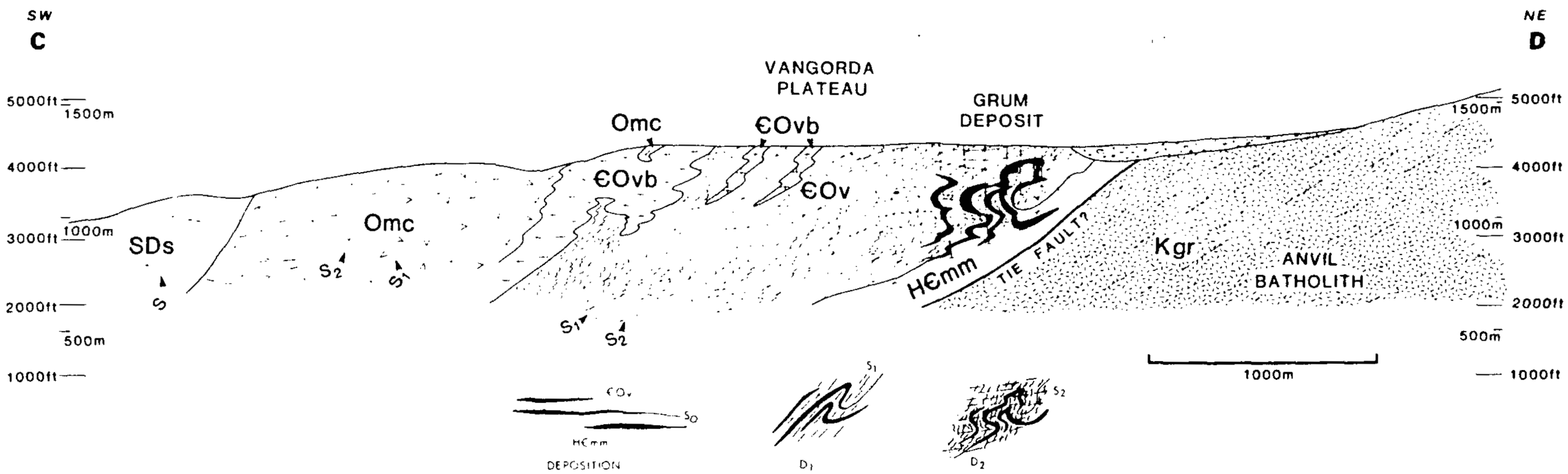


FIGURE 19. Cross section through the Vangorda plateau and the Grum deposit along line C-D on Figure 3, looking northwest. Steeply to moderately southwest dipping S_1 crenulated by shallowly dipping S_2 is typical of the structural relations of the middle structural level on the Vangorda plateau where greenschist facies rocks dominate. Post D_2 folds gently warp the S_2 foliation near Grum. The Grum deposit provides the best example of the F_1/F_2 interference pattern in the district. The deposit is involved in a large "Z" (or "N") shaped D_1 fold, refolded by "S" shaped D_2 folds. The inserts show the sequential development of Grum from a sequence of stacked en echelon ore layers parallel to S_0 through D_1 and D_2 to produce the geometry observed today.

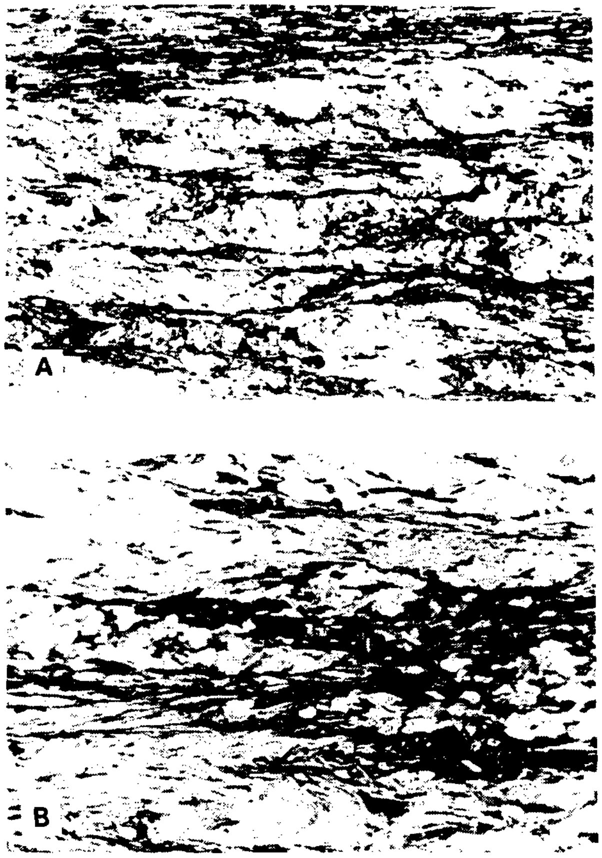


FIGURE 17. Typical microstructures of the lower structural level (B) and lower part of middle level (A). Photomicrographs of Mt. Mye formation phyllite (A) and biotite schist (B). Both specimens are pervasively S_2 foliated in hand specimen. In phyllites, S_1 preservation in thin section is clear and, with careful examination by hand lens, sometimes visible in hand specimen. In schists, S_1 preservation, even in thin section, is not commonly demonstrable except as inclusion trails in porphyroblasts. In hand specimens, S_1 is rarely seen.

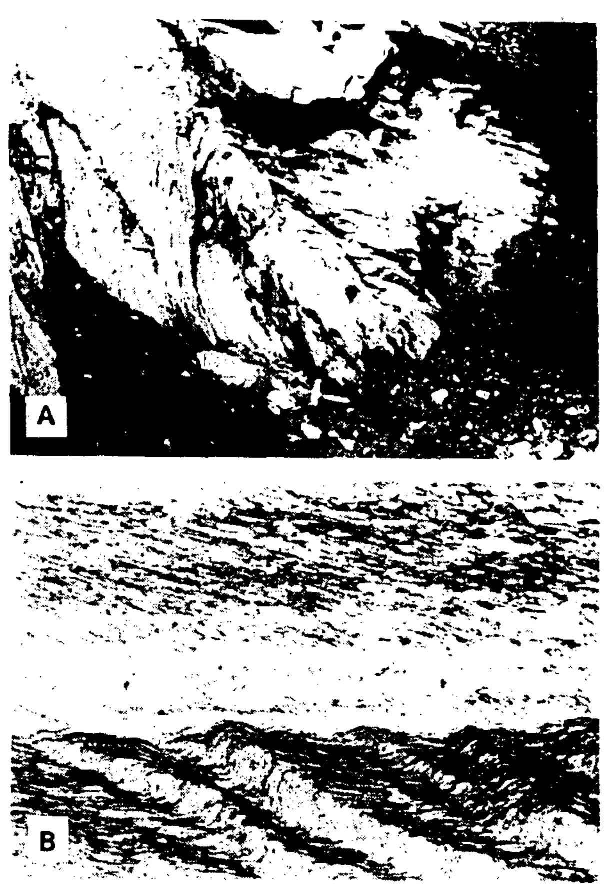


FIGURE 18. Examples of post D_2 structures in Anvil District rocks. (A) is a D_4 fold at the top of the Faro deposit, the photo was taken close to section 118 (Fig. 30). The folded element is pervasive S_2 in the altered wallrocks of the Faro deposit. S_4 is moderately developed as a crenulation cleavage. This example is from the lower structural level and illustrates the stronger development of post D_2 structures at that level. (B) is an example of small scale folding of S_2 in middle level rocks which imparts a wrinkle lineation to the S_2 surface and a very weak post D_2 crenulation cleavage where better developed. Folds similar to that in (A) are not commonly developed in the middle level. (Field of view 2 mm by 3 mm.)

Second phase folds on a variety of scales from macroscopic to microscopic are illustrated in Figures 22 and 23.

On the Vangorda Plateau and in all other areas of the middle structural level that have been examined, there is evidence of three distinct post D_2 deformation generations. A nearly pervasive fine wrinkle or crenulation lineation on S_2 is sub-parallel to L_2 over much of the district. This lineation represents the intersection of a weak non-penetrative foliation with S_2 and parallels the axes of small locally developed folds in S_2 whose axial surface is sub-vertical and parallel to the weak foliation.

A more widely spaced, less penetrative crenulation lineation trends more east-west and is due to the intersection of a weaker foliation with S_2. Axial planes of local, small related folds are sub-vertical.

A fracture cleavage to close spaced jointing trends approximately 60 degrees to 80 degrees and is only locally developed. Like the weak D_5 elements at Faro, this feature is commonly related to small faults.

These deformation features are not as intensely developed as those described previously in the Faro deposit area and it is not yet possible to make direct correlations with that area, but the geometric similarities are striking. Nowhere has the relative age of these features been worked out. Thus far, folds related to these generations have not proved to be of comparable importance to ore deposit shapes as those at Faro. The features are thought to be related to broad-scale warps in S_2 such as are shown in Figure 19.

Upper Structural Level

The upper structural level has not been studied in the same detail as the deeper portions of the pile in proximity to the ore deposits.

Progressively up-section on both flanks of the Anvil Arch, S_2 becomes less intensely developed and the dominant foliation becomes S_1 with only local S_2 development as a weak low angle cross-cutting crenulation foliation. Deep in the Menzie Creek formation, S_1 is well developed as a pervasive cleavage or a chloritic schistosity. Flattening of pillows and breccia clasts into this foliation is locally extreme.

On the north flank of the Arch, the development of S_1 also becomes much less intense up-section in the Menzie Creek formation. Near the top of the unit, virtually undeformed pillows are common and metamorphic foliation is rare, particularly in the larger of the two areas indicated as possible klippe in Figure 3. Tuffs interlayered with the Menzie Creek formation and shales interlayered with and overlying it commonly contain well preserved bedding cut by a slaty cleavage that is the equivalent of the S_1 chloritic foliation in the basaltic rocks. Some of this decrease in the effects of deformation is probably due to the more competent nature of the basaltic section, but a continuation of the upward decrease in strain away from the batholith already noted in the lower levels is apparent.

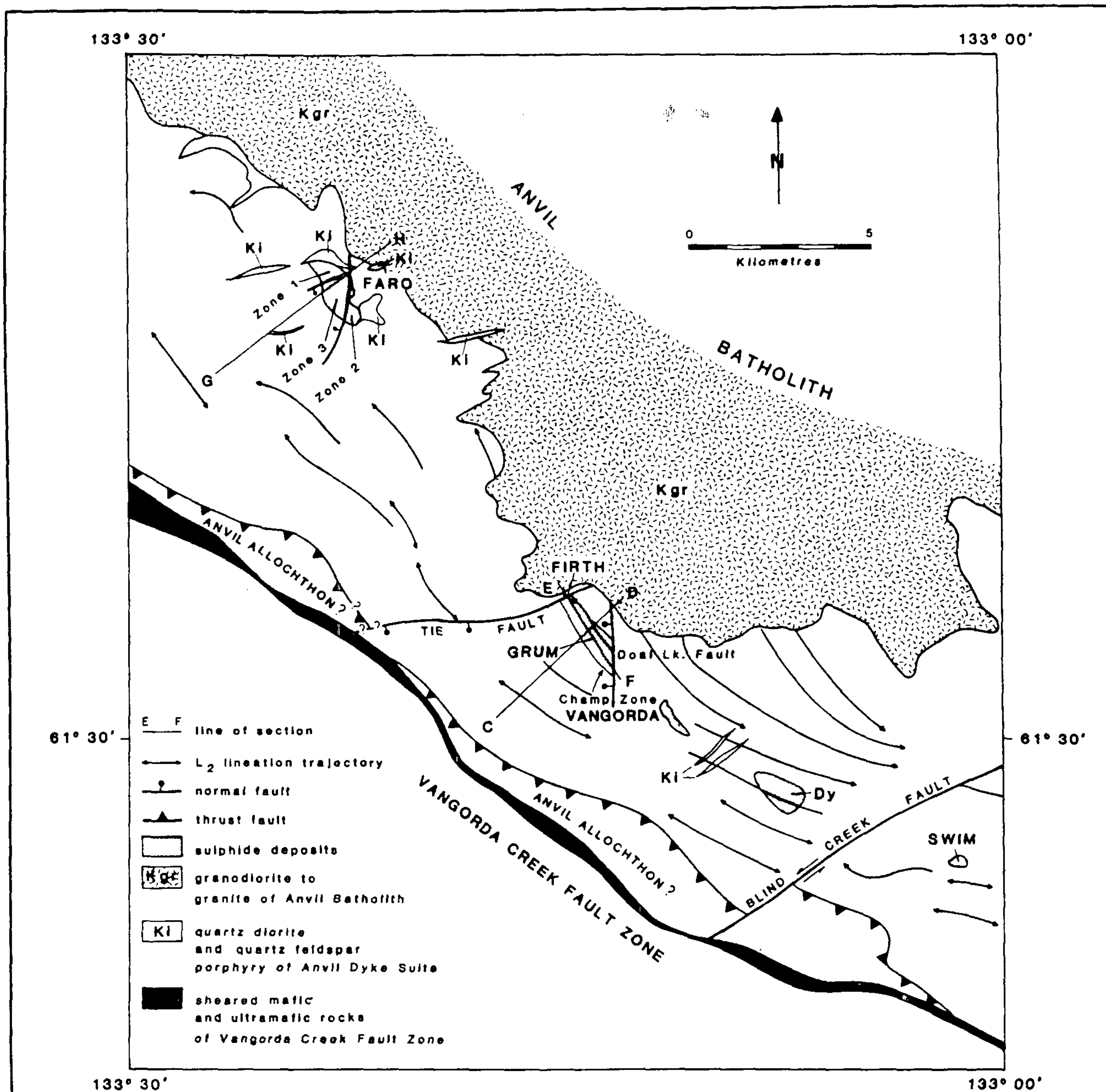


FIGURE 20. Map showing average L_2 lineation trajectories on the southwest flank of Anvil Arch. Each sulphide deposit is elongate parallel to the local L_2 and the over-all curvilinear trend of the deposits approximately parallels the regional trend of L_2. Section C-D is Figure 19, E-F is Figure 24 and G-H is Figure 16.

Post D_2 deformation features are not well developed in the upper structural levels. A fine crenulation lineation is commonly developed on S_1 and is due to the intersection of a steeply-dipping weak crenulation foliation trending 90 degrees to 130 degrees and axial planar to small folds in S_1 that are parasitic to the larger folds indicated in Figure 3. These folds appear to be due to post D_2 deformation, possibly D_4 at the Faro deposit.

Devonian and Mississippian strata on the north flank of the Anvil Range are thrown into northeasterly inclined northeast-verging asymetric folds with an axial planar slaty cleavage. These folds are associated with small northeast-directed thrust faults. The folds are thought to have formed during D_1 but this has not been established with certainty since this sequence is everywhere in fault contact with the older rocks to the southwest. This style of deformation appears to be present in strata as young as Triassic.

On the southwest flank of the Anvil Arch, Devonian and Mississippian strata show a different style of deformation. There, an intense phyllitic cleavage is developed with strong transposition of layering into the foliation. Coarse-grained chert pebble conglomerates are strongly flattened into this foliation. The foliation dips moderately to steeply southwest and is cut by a weak crenulation cleavage dipping shallowly southwest showing that the steeper foliation is S_1. A strong chloritic foliation is present throughout the underlying Menzie Creek formation as well. The extraordinary degree of foliation development and flattening in the Earn Group here may be due to proximity to the possible overthrust slab of Anvil Range Group and the Vangorda fault (see below).

Metamorphism

We have done little work on metamorphism in the district and refer the reader to Tempelman-Kluit (1972) for lists of assemblages and a map of metamorphic zonation. Regional metamorphism of the Buchan type (Miyashiro, 1961) accompanied the first two deformations with grade ranging from greenschist

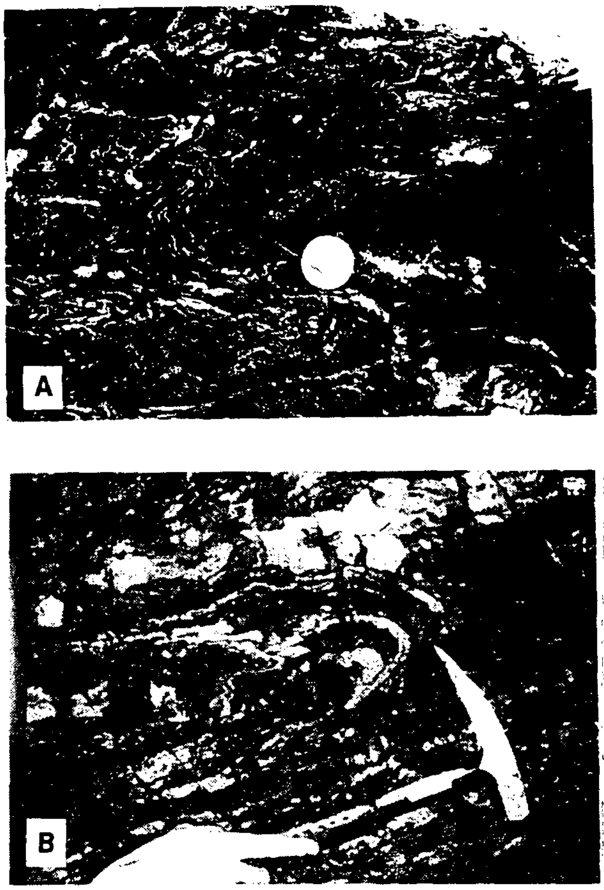


FIGURE 21. Examples of refolded F_1 folds in thinly banded green phyllites of Vangorda formation (A) and in banded sulphides of the Grum deposit (B). In (A), S_2 is slightly inclined toward the left (southwest) and S_1 sheet dip is inclined steeply to the southwest. Compare the "Z" shaped F_1 *fold in* (A) *to the* shape of the Grum deposit (Fig. 33) and the over-all structure of the Vangorda plateau (Fig. 19). The type 3 interference pattern of (A) typifies interference patterns in the District; (B) is an exception to this generalization.

through amphibolite facies. The degree of metamorphism attained during D_1 and D_2 appears to be comparable since mineral assemblages within and between lithons are comparable. Metamorphic grade decreases outward from a central metamorphic welt cored by Anvil Batholith. Immediately adjacent to the batholith, pelitic schists consist of the assemblage andalusite-staurolite-garnet-biotite-muscovite-quartz-plagioclase. Fibrolitic sillimanite and cordierite have been identified locally (Pigage, pers. comm., 1983). Metamorphic grade decreases to the muscovite chlorite zone of greenschist facies. In general, deeper stratigraphic units are more metamorphosed than their overlying units; however, isograds cross-cut stratigraphy on a large scale such that the base of the Vangorda formation is at greenschist facies at Grum, but at Faro, amphibolite facies is attained.

D_2 mineral assemblages at the Faro Deposit correspond to bathozone 2 or 3 of Carmichael (1978), suggesting a total pressure during metamorphism of approximately 3 kb. Limited sphalerite geobarometer work by Kuo (1976) corroborates this pressure range. This corresponds to a depth of burial of 9 km to 10 km, but evidence for only about 5 km of superincumbent section can be found in or around the district. This "missing" section may be accounted for by the former presence of over-thrust slabs of allochthonous oceanic or arc terranes predicted to have existed in the area by recent tectonic models (Tempelman-Kluit, 1979).

Age of Deformation and Metamorphism

The age and timing of the various deformational events in Anvil District have not been resolved. The entire Paleozoic sequence is affected by both the D_1 and D_2 events. Rocks containing upper middle Devonian fossils display a steeply southwest dipping foliation, parallel to S_1, implying D_1 to be younger. If the Permo-Pennsylvanian age assignment to Anvil Range Group is correct (Tempelman-Kluit, 1972), D_1 may be this age or younger since phyllitic cherts at its base possess a similar steep foliation. These relationships suggest D_1 is, at its oldest, uppermost Paleozoic and not lower Paleozoic as previously suggested (Tempelman-Kluit, 1972). Emplacement of allochthons of Anvil Range Group in the adjacent Yukon Tanana Terrane and Pelly Mountains during uppermost Triassic or early Jurassic (Tempelman-Kluit, 1979) may imply a similar age for D_1.

By virtue of cross-cutting relationships, D_2 is younger than D_1. Their separation in time may not be great, as suggested by the similarity of new metamorphic minerals defining S_2 and those defining S_1, implying reorientation of maximum principal stress to the D_2 direction in a still hot, metamorphic pile.

Locally, foliated plutonic rocks developed along the southeastern margin of Anvil Batholith display a shallow dipping foliation, similar in orientation to S_2 in surrounding country rocks. This relationship, plus at least one roof pendant showing continuity of the S_2 foliation in the pendant with the shallow foliation in the plutonic rocks, suggests the D_2 event post-dates at least part of the intrusive suite. At many localities, the Anvil Batholith clearly cross-cuts S_2, thus complicating the relationship. It is appealing, but certainly premature, to suggest an early phase of Anvil Batholith is synkinematic with the D_2 event and therefore K/Ar and Rb/Sr ages of 95 to 100 Ma noted above for the plutonic rocks imply a Cretaceous age for the D_2 event.

Faults

Introduction

Two of the most significant faults of the Anvil District are the Tintina and Vangorda Fault Zones which together form the southwest boundary of the district. Northeast of these structures are many smaller faults of more local importance. These faults are of diverse orientations, but two trends are well developed: 60 degrees and 340 degrees. Many of these faults are moderately to steeply dipping normal faults that appear to be part of a post-metamorphic extensional fault system, perhaps related to the rise of Anvil Batholith. Some of the faults appear to have strike-slip displacement and may be related to offset on the Tintina Fault. Older faults, possibly related to D_1, are present locally.

Normal Faults

The best studied normal fault of the district is the Tie Fault (Fig. 3). This structure has been intersected by five diamond drill holes and can be mapped on the surface by an abrupt change in metamorphic grade. In drill hole intersections the fault consists of coherent, sheared, black phyllite with augen of carbonatized metabasite and vein quartz. The black phyllites allow the fault to be mapped on the surface by electromagnetic surveys. Its trace is a conductor trending 60 degrees, almost perpendicular to the usual trends of conductors in the vicinity. The Tie Fault has been defined laterally for 4 km and 1 km down dip. Based on subsurface data, the fault dips about 45 degrees southeast. The fault truncates the D_1 and D_2 folded Grum Deposit (Fig. 24); the Firth showing consists of portions of the Grum deposit caught in the fault zone along with mobilized mineralization. Along most of the fault zone, footwall amphibolite facies metamorphic rocks are juxtaposed against greenschist facies hangingwall rocks. The fault is spatially related to an irregular projection of the Anvil Batholith. Near the fault, granitic rocks have developed a mylonitic foliation marked by ribbon quartz and feldspar augen. In the subsurface, sheared rocks of the fault zone are cut by unsheared quartz-feldspar porphyry of the Anvil Dyke Suite. These relationships demonstrate that the fault is post-metamorphic, postdates D_2 and is probably closely tied in

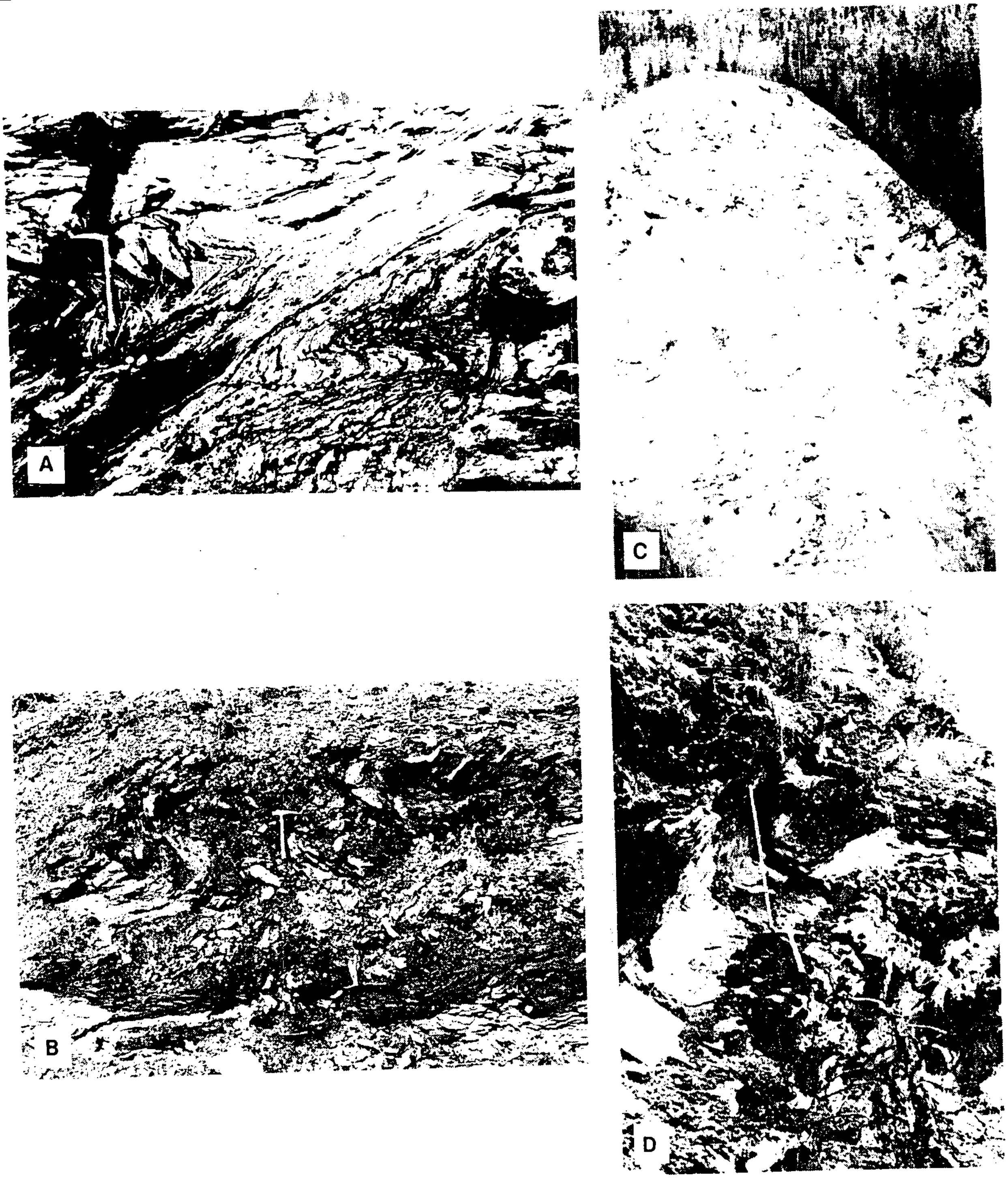


FIGURE 22. Typical mesoscopic structure of the middle structural level; D_2 folds of various scales in the Vangorda formation calcareous phyllites. Compare with small scale structures in Figure 23 and large scale structures of the Grum, Vangorda and Swim deposits, Figures 33, 34 and 36.

time to the late stages of emplacement of the Anvil Batholith. The magnitude of displacement on the fault is in the order of 1000 m (Fig. 24); its slip line appears to be almost down the faults dip.

A similar structure, the Doal Lake Fault (Figs. 20 and 24), truncates the southeast end of the Grum deposit, but this fault is marked by gouge rather than coherent fault rock. It trends north-south and dips about 40 degrees to the west.

A number of other major post-metamorphic faults similar to the Tie Fault are known to exist on the south flank of the Anvil Arch. These include the faults under the Dy and Swim deposits (Figs. 35 and 36 respectively) and one or more additional faults near the Grum. In most cases, these faults juxtapose older and more metamorphosed footwall against younger lower-grade hangingwall. The over-all fault pattern is not yet worked out and it is likely that several more major structures have yet to be recognized.

Northeast of the Anvil Batholith, there are a number of similar faults which are known only through reconnaissance surface geological mapping and geophysical surveys. The Graphite

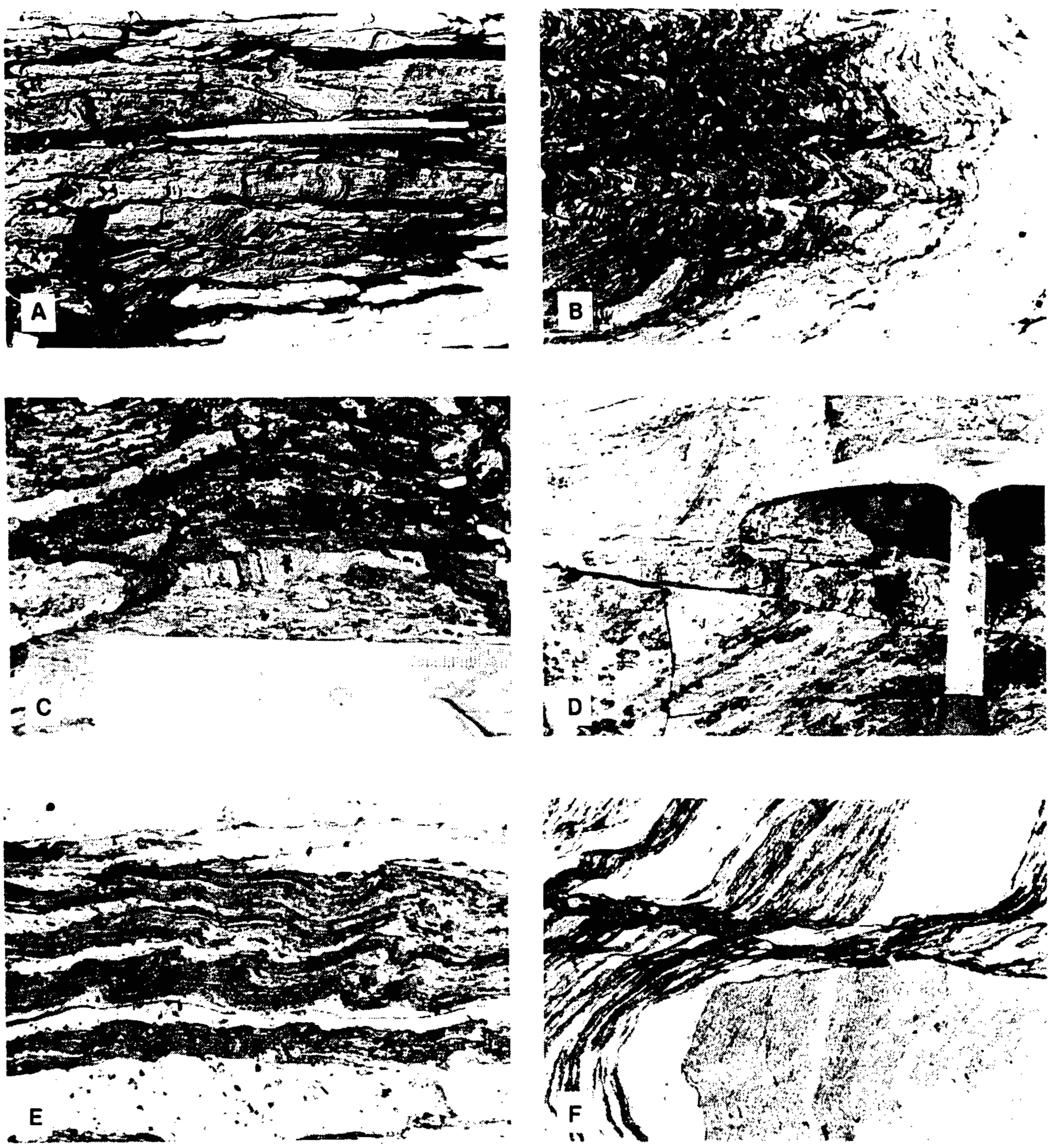


FIGURE 23. Comparison of mesoscopic and microscopic (all plane light, 2 mm by 3 mm view) structures of middle structural level phyllites. In all cases, S_2 is horizontal. (A) and (B) show typical lithon structure with dark, more carbonaceous S_2 folia separating lithons with folded S_1 parallel to compositional banding. (C) and (D) show phyllites with rare S_1 preservation in lithons separated by zones of pervasive S_2 (and D_1 micas rotated into S_2?). In (D), note post D_2 crenulations in S_2 and the darker, more carbonaceous nature of the pervasively S_2 foliated regions. (E) and (F) show the common small offset along S_2. In many cases, such offsets are apparent and probably result from pressure solution along S_2 resulting in the darker, carbonaceous micaceous residue. In some cases, however, there does appear to be slip along S_2 (but not necessarily during D_2). The microstructures of the dark horizontal band in (F) closely mimic the macroscale of Tie Fault Zone. All phyllites from Vangorda formation except (F) which is from uppermost Mt. Mye formation.

Fault (gf on Fig. 3) parallels the trend of the Anvil Batholith and along much of its length is marked by a prominent electromagnetic conductor due to the "smearing out" of the lower carbonaceous member of the Mt. Mye formation into the fault plane. Toward the fault's southeast end, progressively younger formations are juxtaposed against the middle part of the Mt. Mye formation showing stratigraphic omission of over 2000 m. At some localities, S_2 foliation and formational contacts are perpendicular across the fault. The fault is thought to dip moderately to steeply northeast, but the attitude, slip line and displacement on the fault are not known with certainty. The above observations suggest the northeast side is down dropped and that large displacements are implied. Like the Tie Fault, this structure is post-metamorphic.

A related structure, the Klunk Creek Fault (Fig. 3), occurs north of the graphite fault. This fault separates little metamorphosed northeast dipping and facing strata of the Menzie Creek formation from higher grade footwall calc-silicates of the

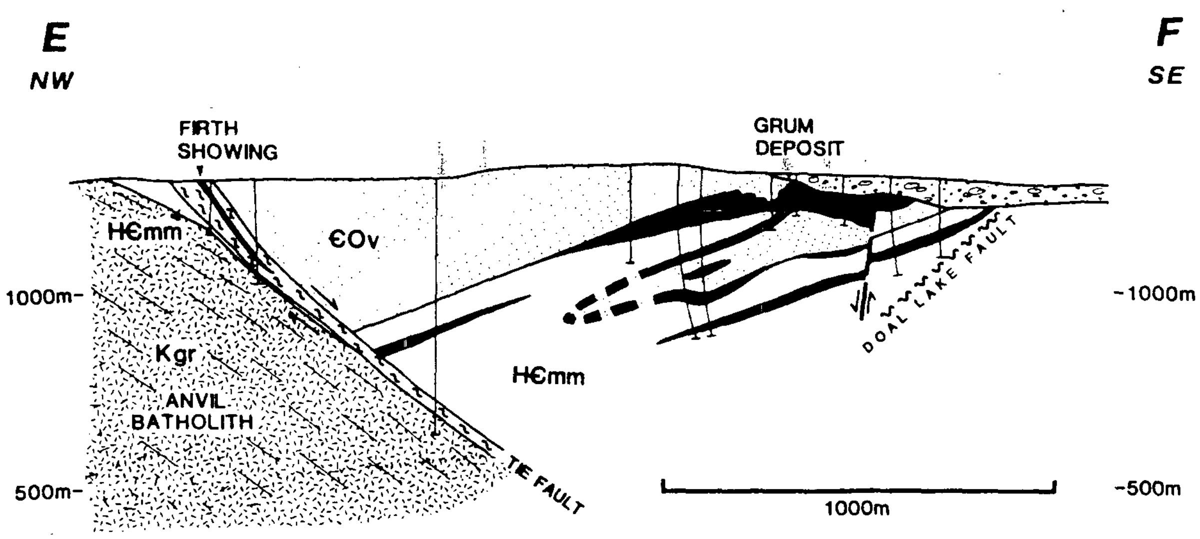


FIGURE 24. A diagramatic longitudinal section of Grum deposit showing the plunge of the Grum fold structure and the relationship of Grum to the Firth showing. Firth appears to represent slivers of Grum mineralization in a large extensional fault zone, the Tie Fault, that separates footwall amphibolite facies Mt. Mye formation and granitic rocks from hanging wall greenschist facies rocks of Vangorda and Mt. Mye formations. A similar fault, the Doal Lake Fault truncates the southeast end of the deposit. The Tie Fault and Doal Lake Fault together form the boundary between the lower and middle structural levels here.

Vangorda formation. The fault appears to subparallel S_2 in the calc-silicates and dips about 30 degrees to the southeast.

Also northeast of graphite fault is another possible member of this family of normal faults, the contact between map unit SDa and the Menzie Creek formation (Fig. 3). This contact appears to dip moderately to shallowly southeast based on intersection with topography. Bedding in map unit SDa dips west or southwest toward the fault with a stratigraphic omission of up to several hundred metres between Menzie Creek formation and the uppermost part of map unit SDa.

These faults appear to be part of a network of extensional faults that is related to the final stages of emplacement of the Anvil Batholith. They generally show down drop away from the core of the Anvil Arch and may be due to diapiric rise of the granitic and high-grade metamorphic core of the district through the lower-grade rocks flanking the Arch.

A myriad of other small faults with normal displacement occur throughout the district. Many of these appear to post-date the larger lower angle faults but still show evidence of being related to emplacement of the Anvil Dyke Suite.

The most important of these structures are the faults that bound the central graben of the Faro deposit, but there are many others with similar magnitudes of displacement that attract less attention.

Strike Slip Faults

The Blind Creek Fault (Tempelman-Kluit, 1972) is inferred to follow the linear 60-degree trending Blind Creek valley, Its existence is confirmed by offset of contacts, the trend of sulphide deposits and electromagnetic conductor patterns. The apparent sense of offset is left lateral and the amount of displacement is about 1 km.

Many other small faults with apparent strike-slip offset occur in the district—not all of these fall into any convenient geometric families. The trend and offset of the Blind Creek Fault is consistent with it being a second order wrench related to the Tintina Fault. The fact that many dykes and extensional faults related to the batholith also follow this trend perhaps suggest the batholith was emplaced when the stress regime of the Tintina was established.

Thrust Faults

Several small northeast directed thrust faults have been mapped in Earn Group strata along the northeast margin of the Anvil District by P.F. Lewis (1974). These faults are associated with close, northeasterly-inclined, northeast-vergent folds with a slaty axial planar cleavage. These thrusts appear to have formed during D_1.

A large allochthonous sheet floored by a shallowly dipping fault is interpreted to be present northeast of Anvil Arch (Fig. 3). The rocks of this sheet and those underlying it have a shallowly northeast dipping S_1 foliation and a dominantly more steeply northeast dipping bedding implying a Z shaped F_1 asymmetry and north or northeast D_1 vergence. This structural style is compatible with northeast-directed D_1 thrust faulting. Northwest of the area of Figure 3, we have mapped several other areas where rocks of the Menzie Creek and Vangorda formations appear to overlie Earn Group strata along shallowly dipping fault surfaces. All these faults emplace older on younger strata and thus have been assumed to be thrust faults. It is possible, however, that they are not thrusts but belong to the family of extensional faults described above and that the allochthonous sheet is actually a large gravity slide shed off the crest of the Anvil Arch.

The most significant potential overthrust occurs along the southeast edge of the district in the foothills of Rose Mountain. This fault is predicted on the basis of more regional mapping (see Tempelman-Kluit, 1979), but there is little evidence for it in the rocks of Rose Mountain. We have made numerous traverses in this area to look for evidence of the fault, but have found only a highly deformed sequence that grades from black and beige chert and chert conglomerate of the Earn Group to green beige and lesser red chert of basal Anvil Range Group. This problem has been recognized by Tempelman-Kluit (1979) who suggested that there may be both allochthonous and autochthonous Anvil Range Group. This is an attractive hypothesis but our regional mapping outside the Anvil District tends to confirm that the Anvil Range Group is not comfortably part of Selwyn Basin stratigraphy. It is more strongly linked to the Yukon-Tanana Terrane with which it is structurally interleaved at many localities.

For now all we can state with certainty is that if a thrust is responsible for emplacing the Anvil Range Group, it probably occurs within the highly deformed and flattened phyllitic chert sequence or perhaps in the black phyllites above the Menzie Creek formation (Figs. 3 and 14). Such a thrust does not occur at the base of the Anvil Range Group basalts since, as Tempelman-Kluit (1972) has demonstrated, the basalts and cherts interfinger.

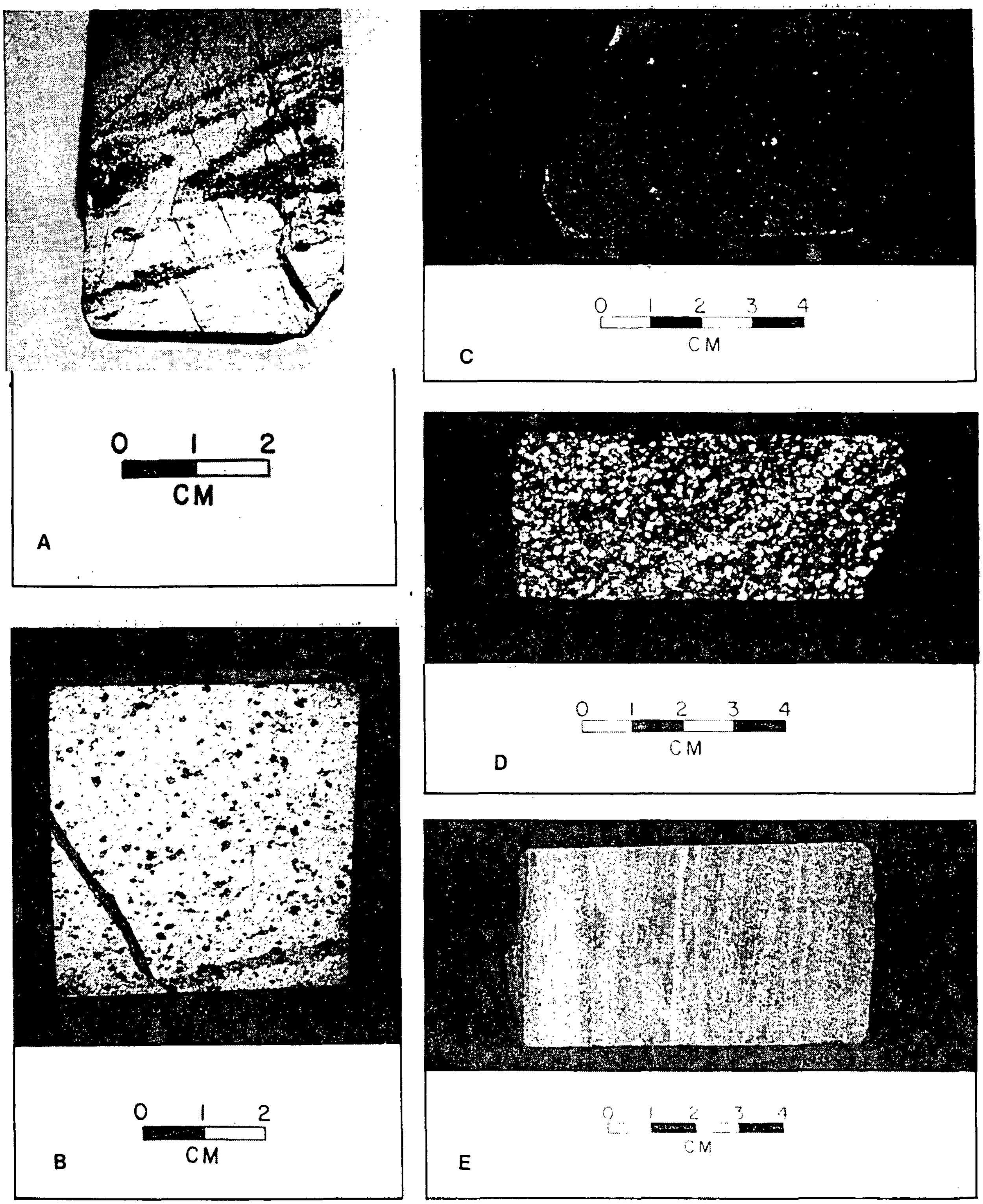


FIGURE 25. Massive sulphide lithofacies of the Anvil District deposits: (A) Banded massive pyritic sulphides from the Swim deposit. Dark material is largely sphalerite and galena, light is pyrite. Note the D_2 fold hinge and general transposition of layering into S_2 as is typical of massive sulphides. The pull apart structure approximately normal to S_2 is commonly developed in most very pyrite rich rocks especially at Faro, but not generally to this degree. (B) Homogeneous, but foliated and lineated, pyritic massive sulphide from the Faro deposit. Dark spots are magnetite porphyroblasts. The light material is pyrite, a network of grey quartz is developed between the pyrite grains. This is typical of the low-grade massive sulphides along the northeast edge of the Faro deposit. (C) High-grade pyritic massive sulphides from the Vangorda deposit. Light-coloured grains are pyrite in a matrix of dark galena and sphalerite. (D) The same lithology as (C) form, the Faro deposit illustrating the effect of metamorphic intensity on grain size (Tempelman-Kluit, 1970b). This is the buckshot ore (Campbell and Ethier, 1974). As lead-zinc content decreases, a network texture of galena and sphalerite surrounding pyrite porphyroblasts is developed. (E) Baritic massive sulphides form the Dy deposit. The light bands are dominantly pyrite and the grey bands barite, sphalerite and galena. Pure massive barite does not occur in the Anvil deposits; this is essentially as barite rich as the ore type becomes. Strongly developed, thin banding parallel S_2 is typical of this ore type except at Faro where compositional banding in all massive sulphides is less well developed.

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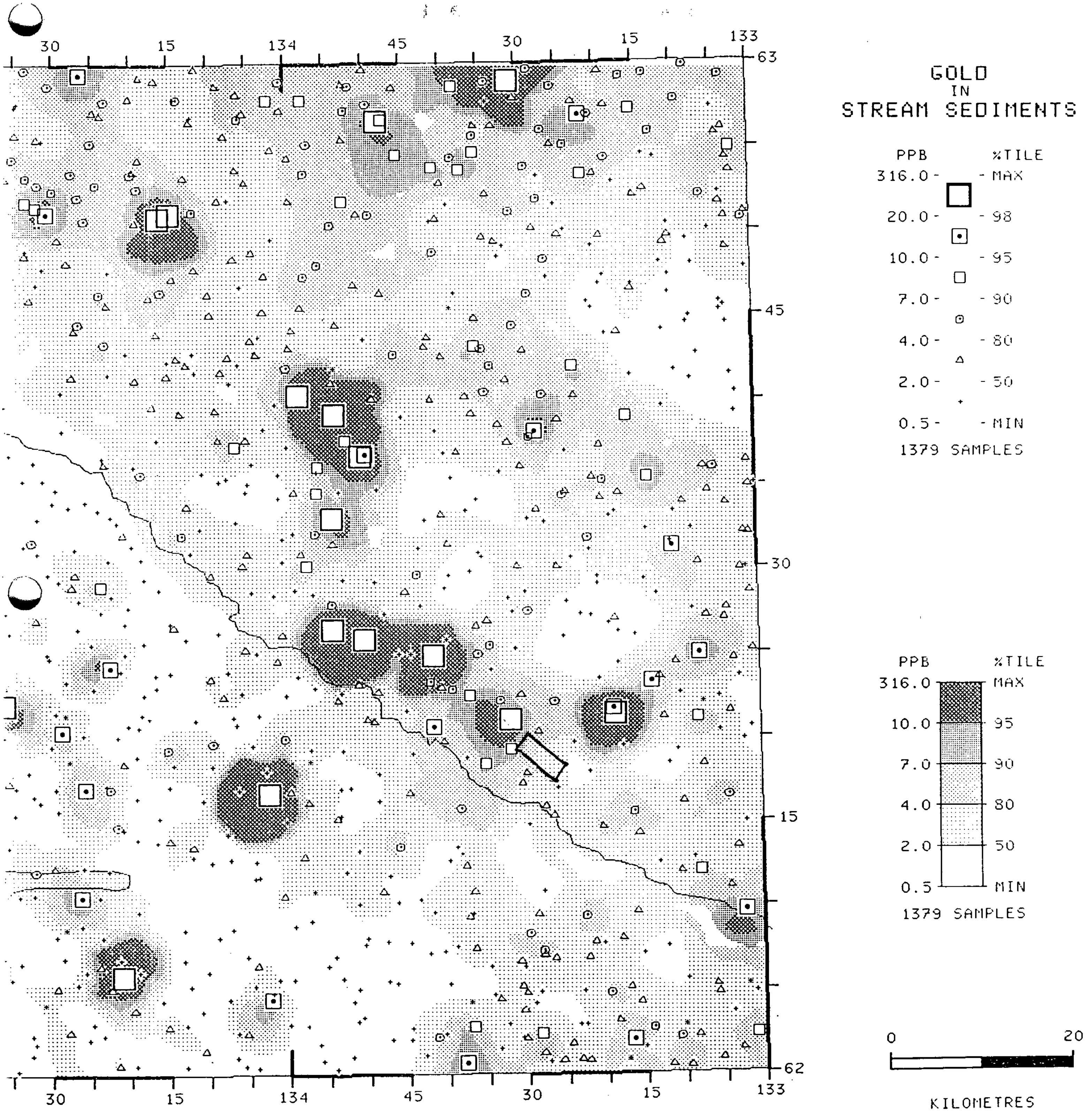

▭ BOOMER 1-18

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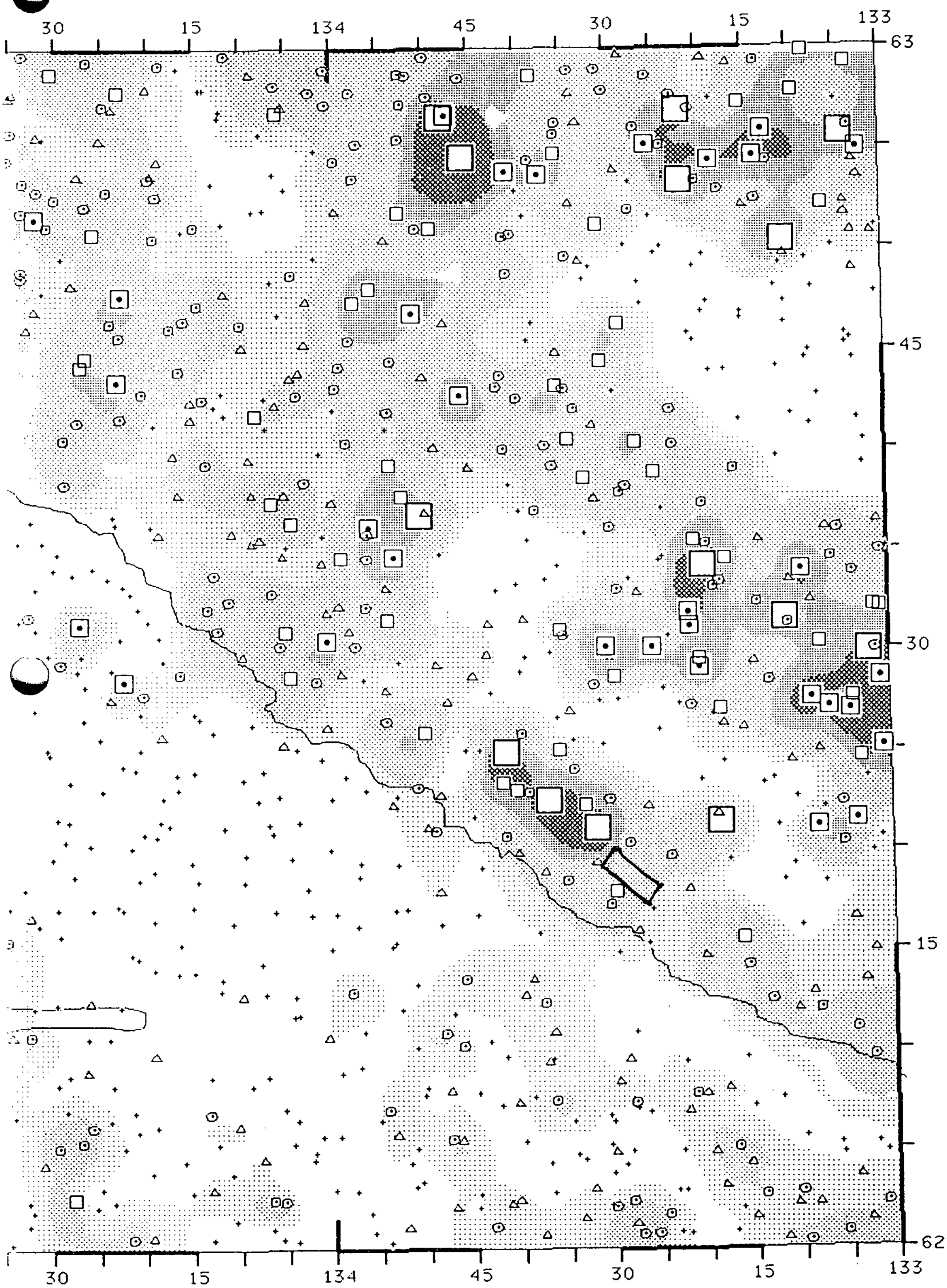

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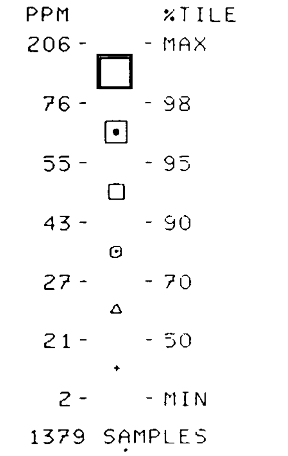

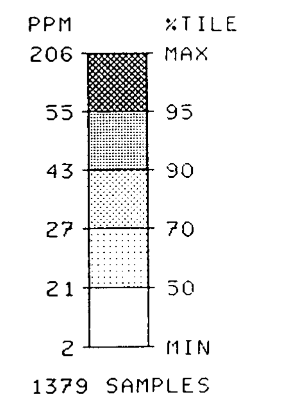

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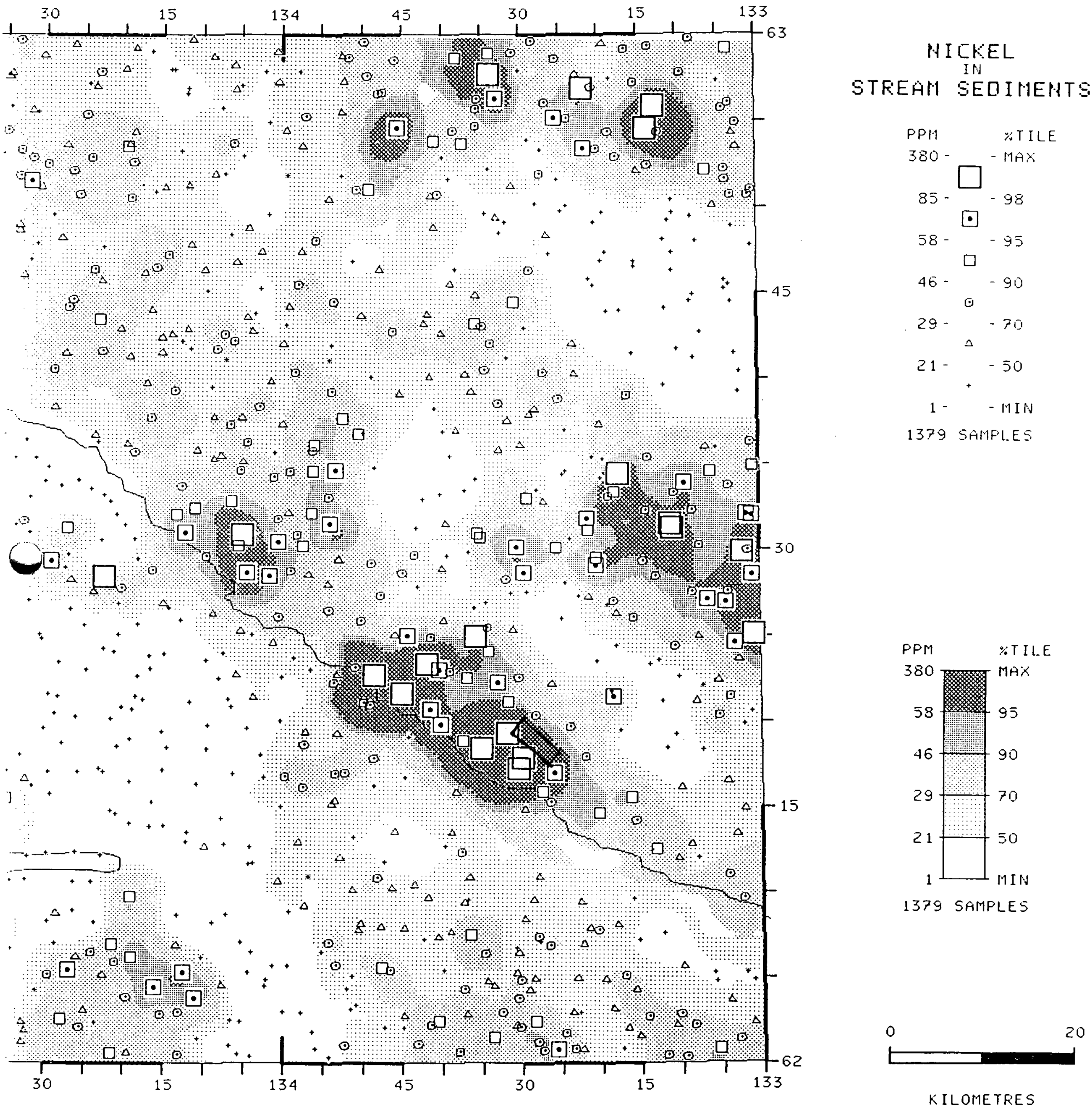

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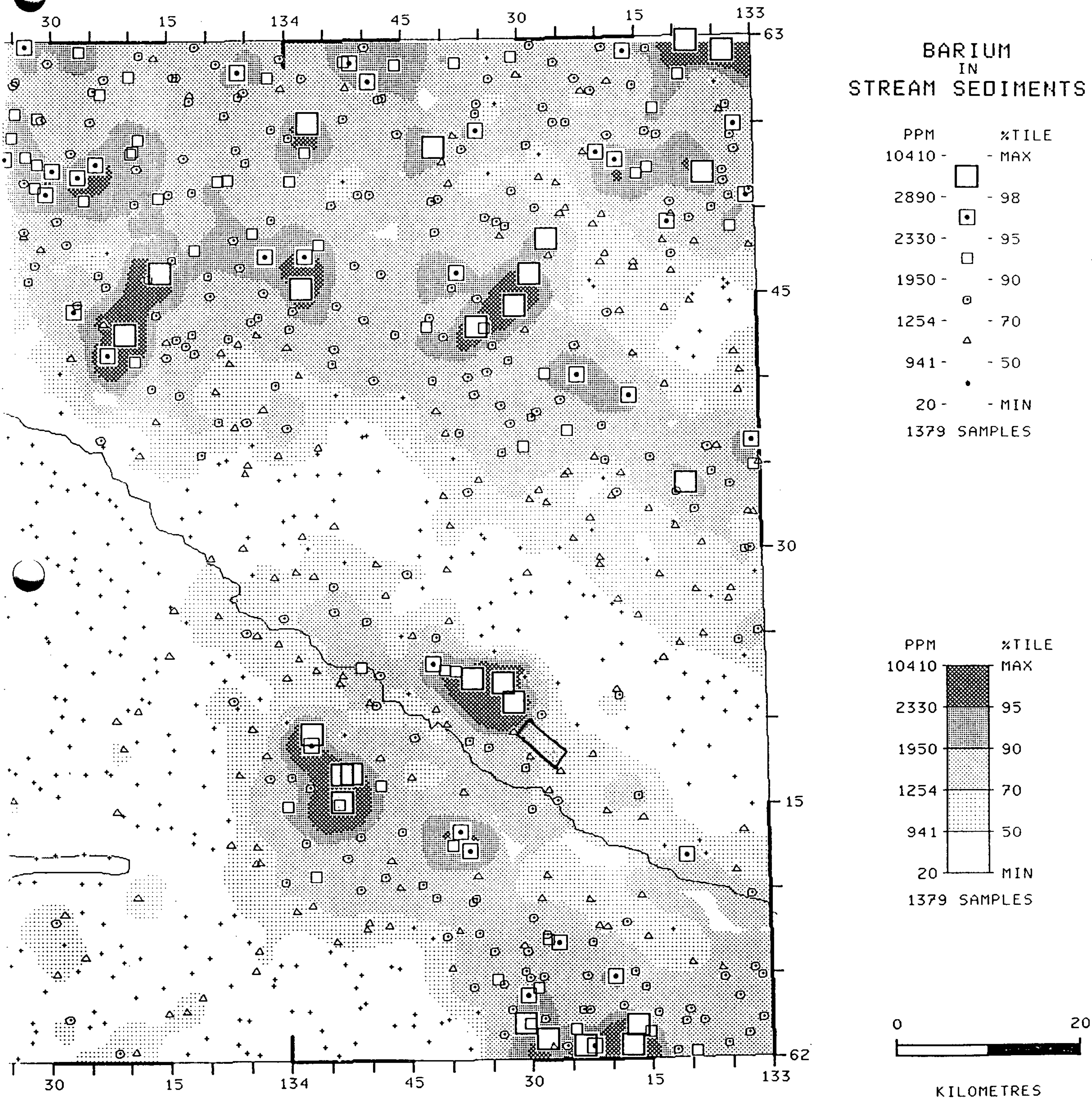

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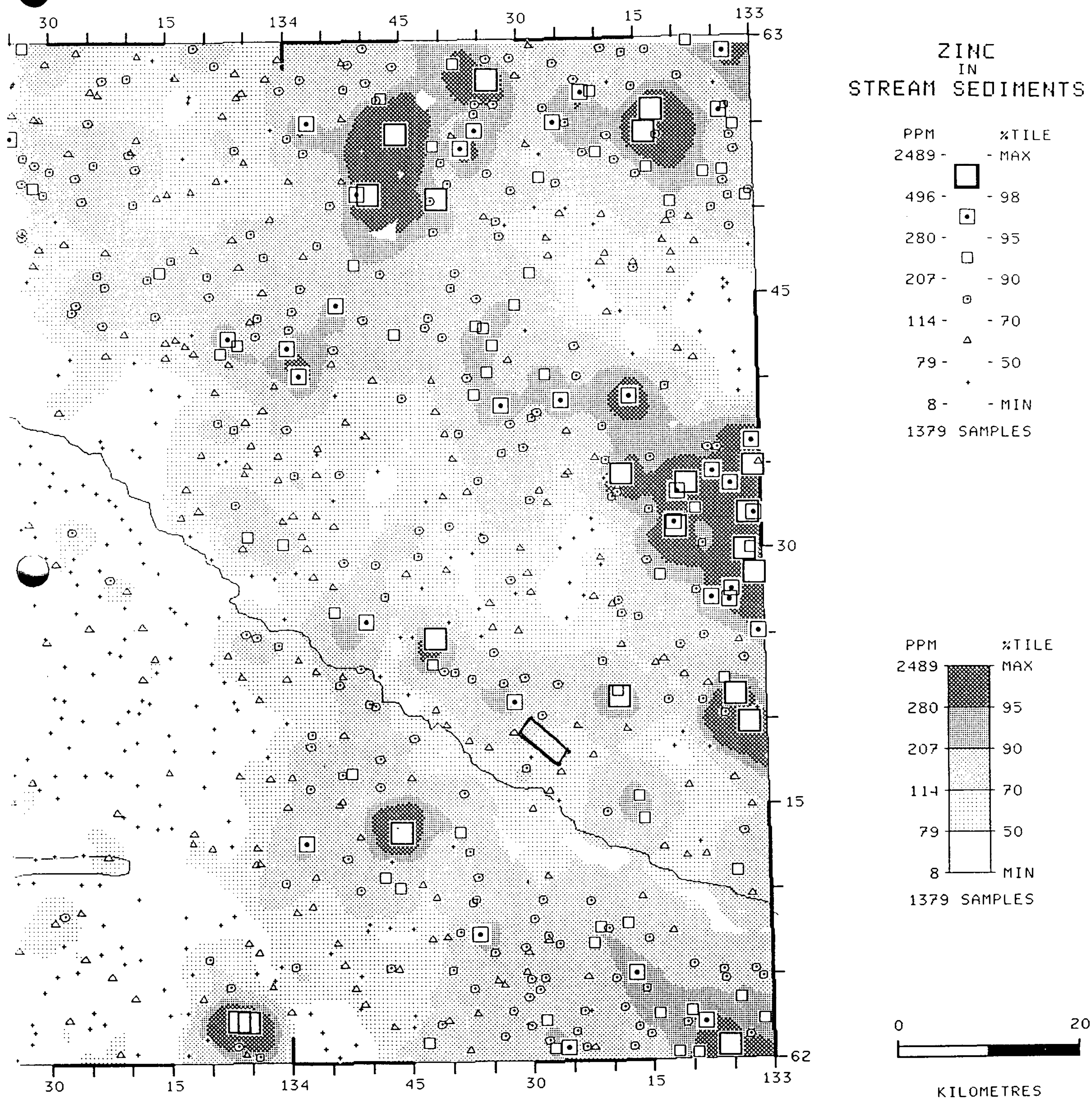

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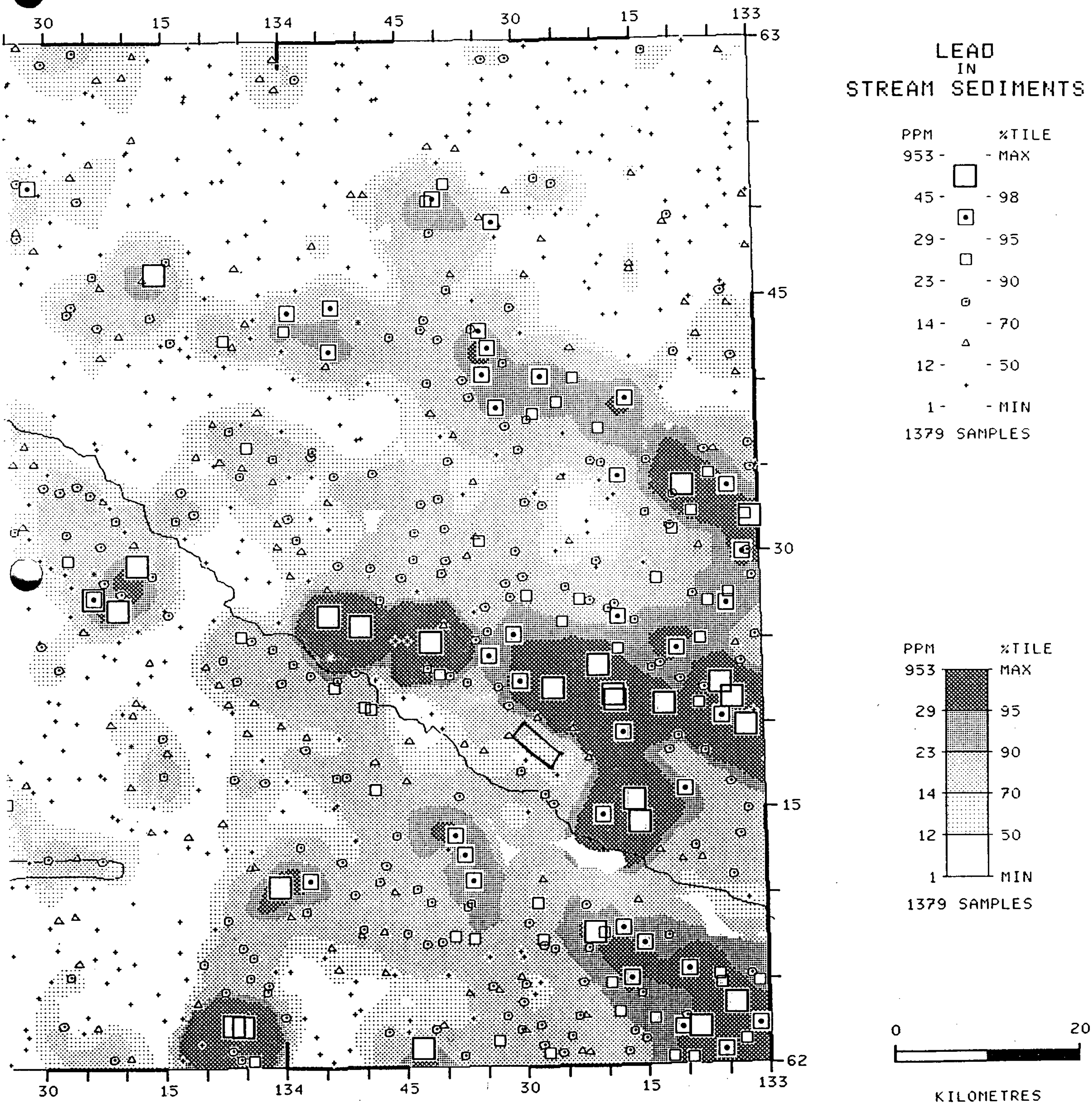

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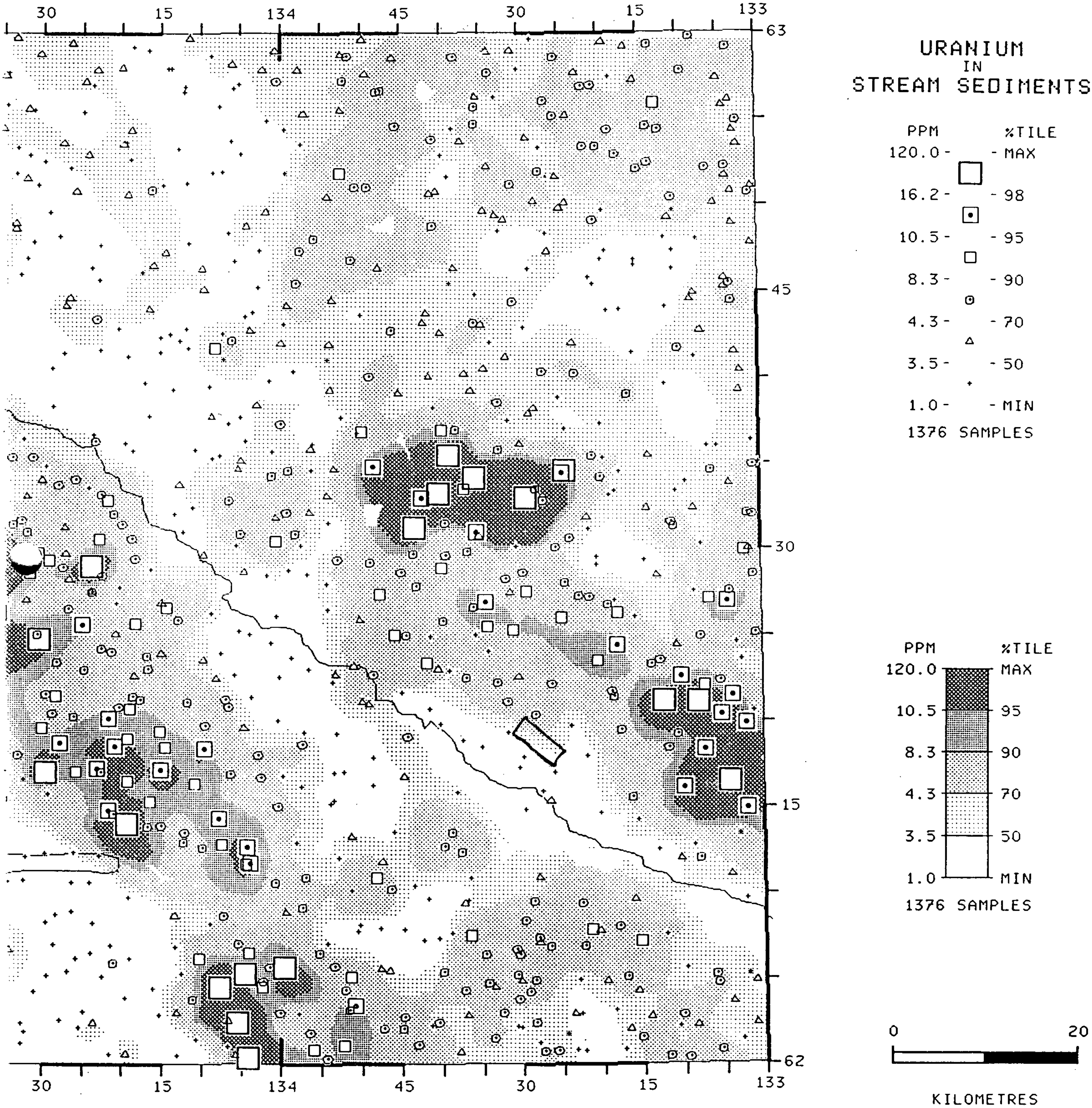

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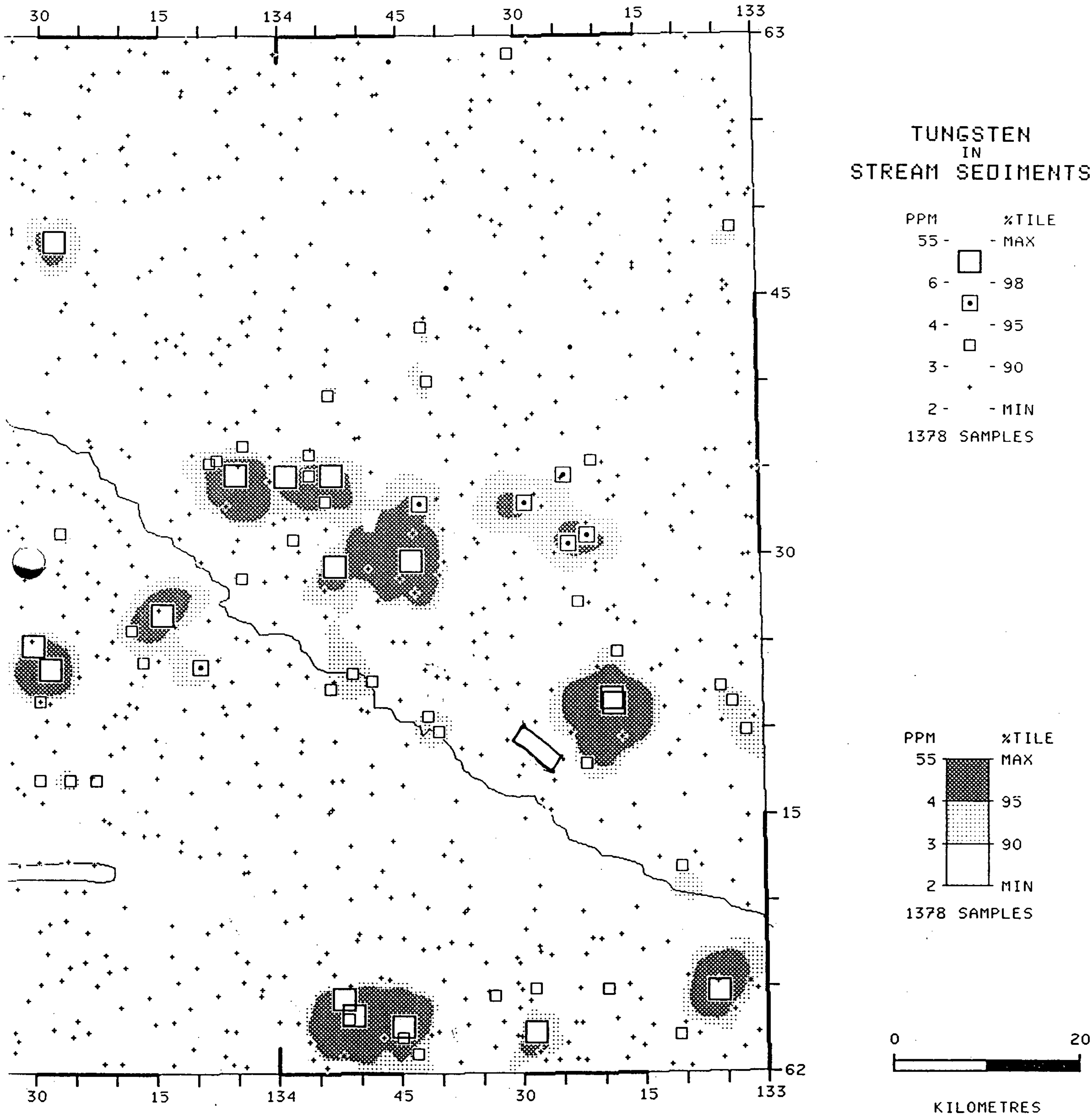

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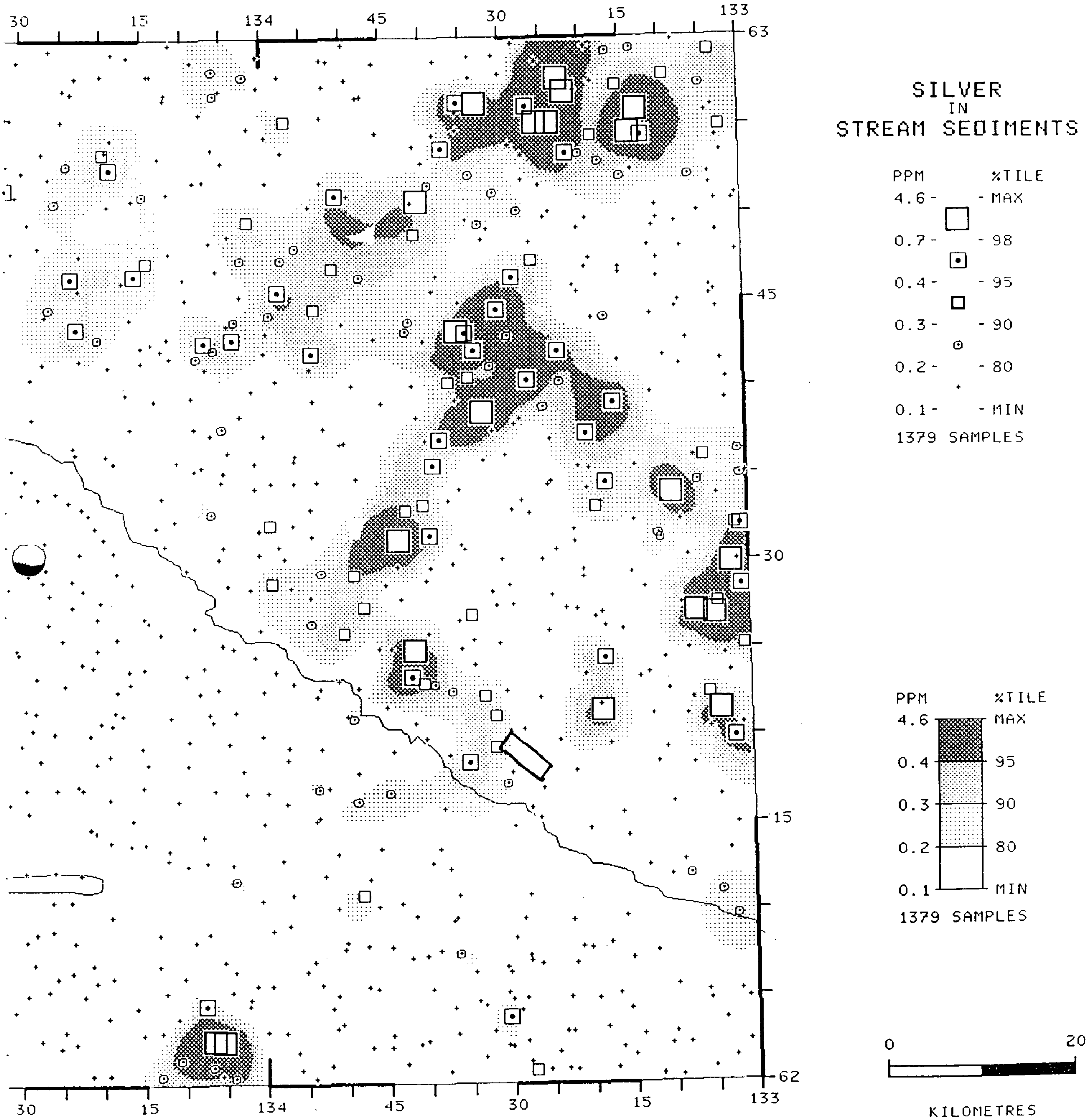

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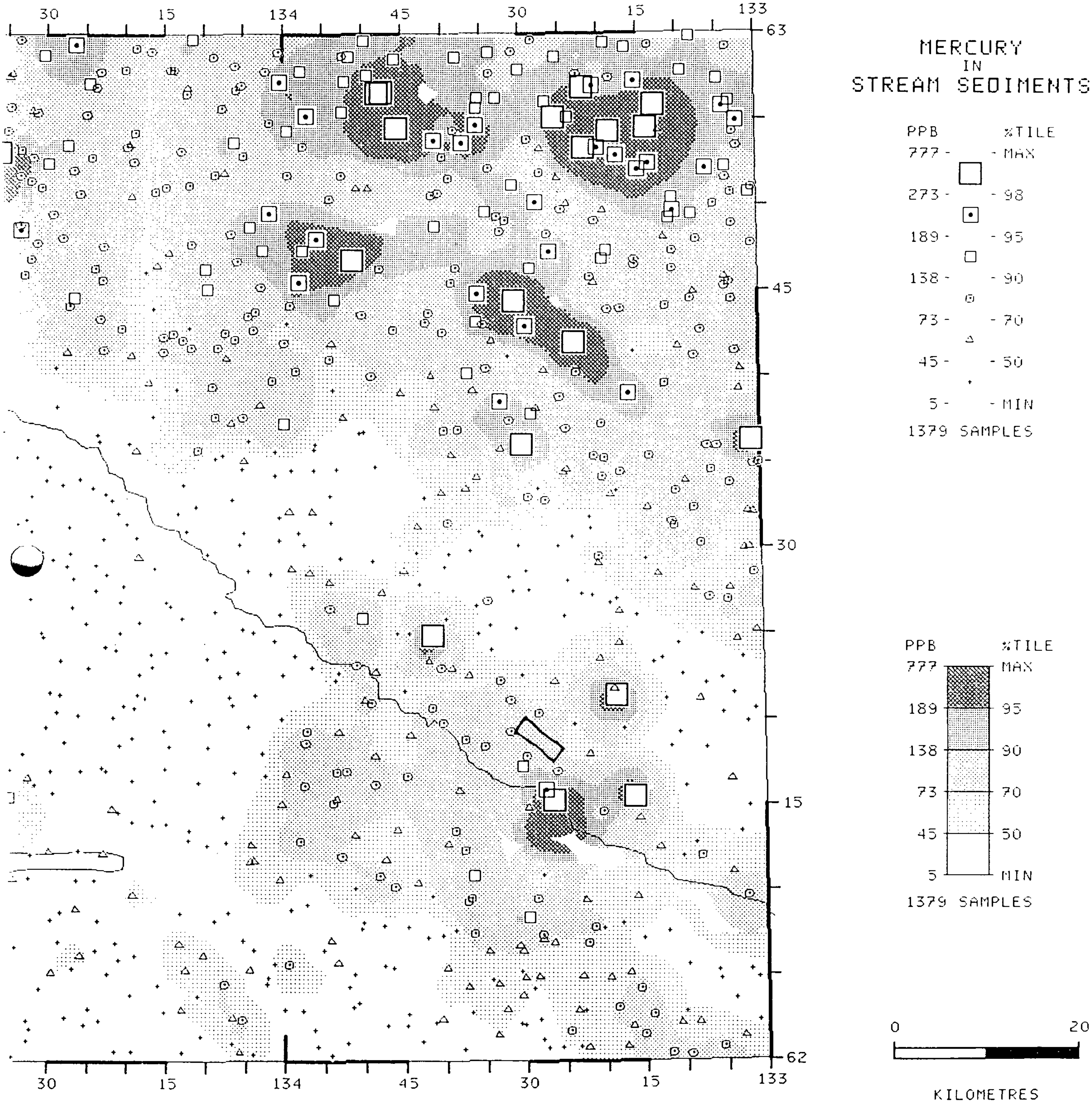


FIELD GUIDE ANVIL PB-ZN-AG DISTRICT YUKON TERRITORY, CANADA

Lee C. Pigage
CURRAGH RESOURCES INC.
117 Industrial Road
Whitehorse, Yukon Territory
Canada Y1A 2T8

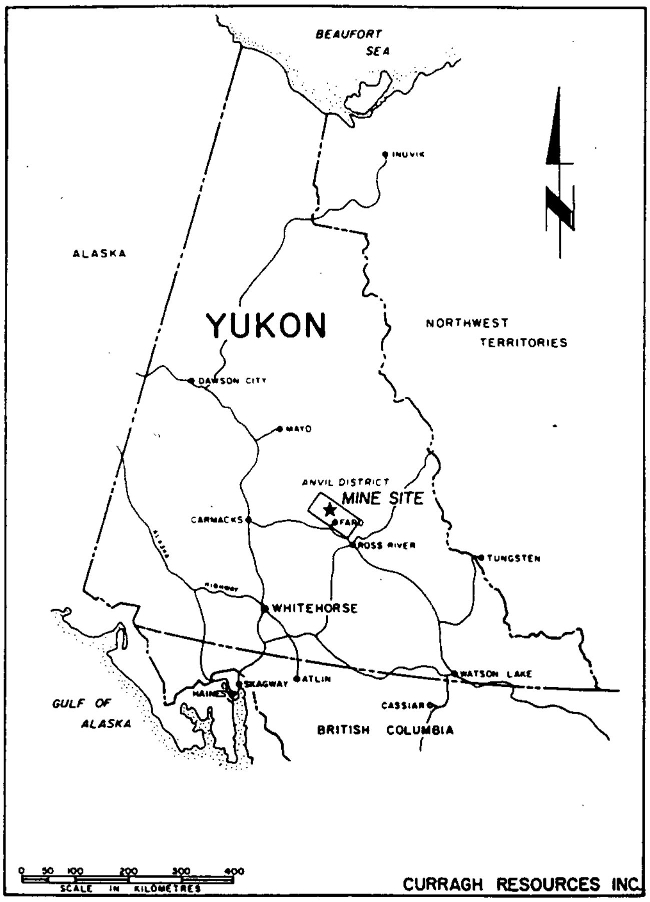


Figure 1 Location map of Anvil District in Yukon Territory, Canada. Concentrates are trucked to tidewater at Skagway, Alaska through Carmacks and Whitehorse.

INTRODUCTION

The Anvil Pb-Zn-Ag District is located near the town of Faro in central Yukon Territory 200 kilometers northeast of Whitehorse (Figure 1). Five deposits of the stratiform, massive pyritic sulphide type (Gustafson and Williams, 1981) have defined reserves within the district (Table 1). The mineral deposits define a curvilinear trend in plan (Figure 3) and occur within a 150 meter thick upper Proterozoic to Cambrian stratigraphic interval (Jennings and Jilson, 1986). The total geological reserves for the district is similar to that for other major stratiform Pb-Zn deposits (Figure 4). If all sulphide lithologies are considered, irrespective of grade, the district contains an estimated total of 225 million tonnes of sulphide-bearing rock (Jennings and Jilson, 1986).

Intensive exploration within the district began after Al Kulan discovered the Vangorda deposit in 1953 using conventional prospecting. Exploration methods are discussed by Aho (1966, 1969), Brock (1973), Chisholm (1957), and 1 Morton (1973). Anvil Mining Corporation began open-pit mining of the Faro deposit at rates of up to 10,000 tonnes per day in late 1969. The mine is currently owned and operated by Curragh Resources Inc. Open pit mining of the Faro deposit is continuing on a year-round basis with the concentrator processing 13,500 tonnes of ore per day. Concentrates from the mine are trucked to Skagway, Alaska (Figure 1) and then shipped to markets around the world.

Curragh Resources Inc. is also working on developing several additional mines in the district. Underground exploration has begun on a high grade portion of the Faro deposit. Pre-development and environmental studies are being undertaken for the Vangorda and Grum deposits. These latter two deposits will be open pit mines with the ores being processed at the Faro mine concentrator. The remaining deposits have not yet been developed, although a pilot drill hole is being planned for the Dy deposit.

This paper will discuss the general nature of the deposits including ore types, zoning patterns, alteration patterns, and subsequent metamorphism and deformation. The field trip will look first at the ore types and metamorphism-deformation in the Faro underground mine. Additional stops at the Grum and Vangorda deposits are planned depending on time constraints and development progress for these deposits.

Table 1 Summary of tonnage and grade figures for Anvil district ore deposits as of June 1983*

	Tonnage X 10^6 tonnes	Pb (%)	Zn (%)	Ag (g/mt)	Cutoff (%Pb+ Zn)
Faro (1)**					
Geological reserves before mining	57.6	3.4	4.7	--	5.0
Remaining geological reserves (1983)	33.0	3.0	4.6	36	4.0
Remaining open pit reserves (1983)	25.2	2.9	4.3	36	4.0
Grum (2)					
Geological reserves	30.8	3.1	4.9	49	4.0
Open pit reserves	16.9	3.0	4.9	47	4.0
Vangorda (3)					
Geological reserves	7.1	3.4	4.3	48	4.0
Open pit reserves	5.2	3.4	4.2	47	4.0
Dy (4)					
Geological reserves	20.3	5.7	7.0	82	9.0
Swim (5)					
Geological reserves	4.3	3.8	4.7	42	6.0
Total					
Geologcial reserves before mining	120.1	3.7	5.6	--	N/A
Remaining geological reserves (1983)	95.5	3.7	5.2	51	N/A
Remaining open pit reserves (1983)	47.3	3.0	4.5	41	4.0

* Compiled from various "in house" reports of Cyprus Anvil Mining Corp. and Kerr Addison Mines.
** Refers to the number on Figure 3

REGIONAL GEOLOGY

Roddick and Green (1961) first systematicaly mapped the Anvil District. After discovery of the Vangorda, Swim, and Faro deposits, Tempelman-Kluit (1972) undertook a more detailed geological study. More recently Gordey (1983) and Gordey and Irwin (1987) correlated rock units in the district with previously mapped areas to the east and southeast.

The Anvil District is part of Selwyn Basin (Figure 2), a large area of central Yukon where deep water clastics, chert, and minor carbonate accumulated along the ancient North American continental margin during late Proterozoic and Paleozoic (Gabrielse, 1967). Sediments in the basin contain several large-scale compositional sequences which reflect its evolutionary development. An excellent summary of these stages is presented in Abbott et al. (1986).

The late Proterozoic to early Cambrian "Grit Unit" (Gabrielse et al., 1973) is the oldest unit exposed in the basin. It consists of a thick sequence of

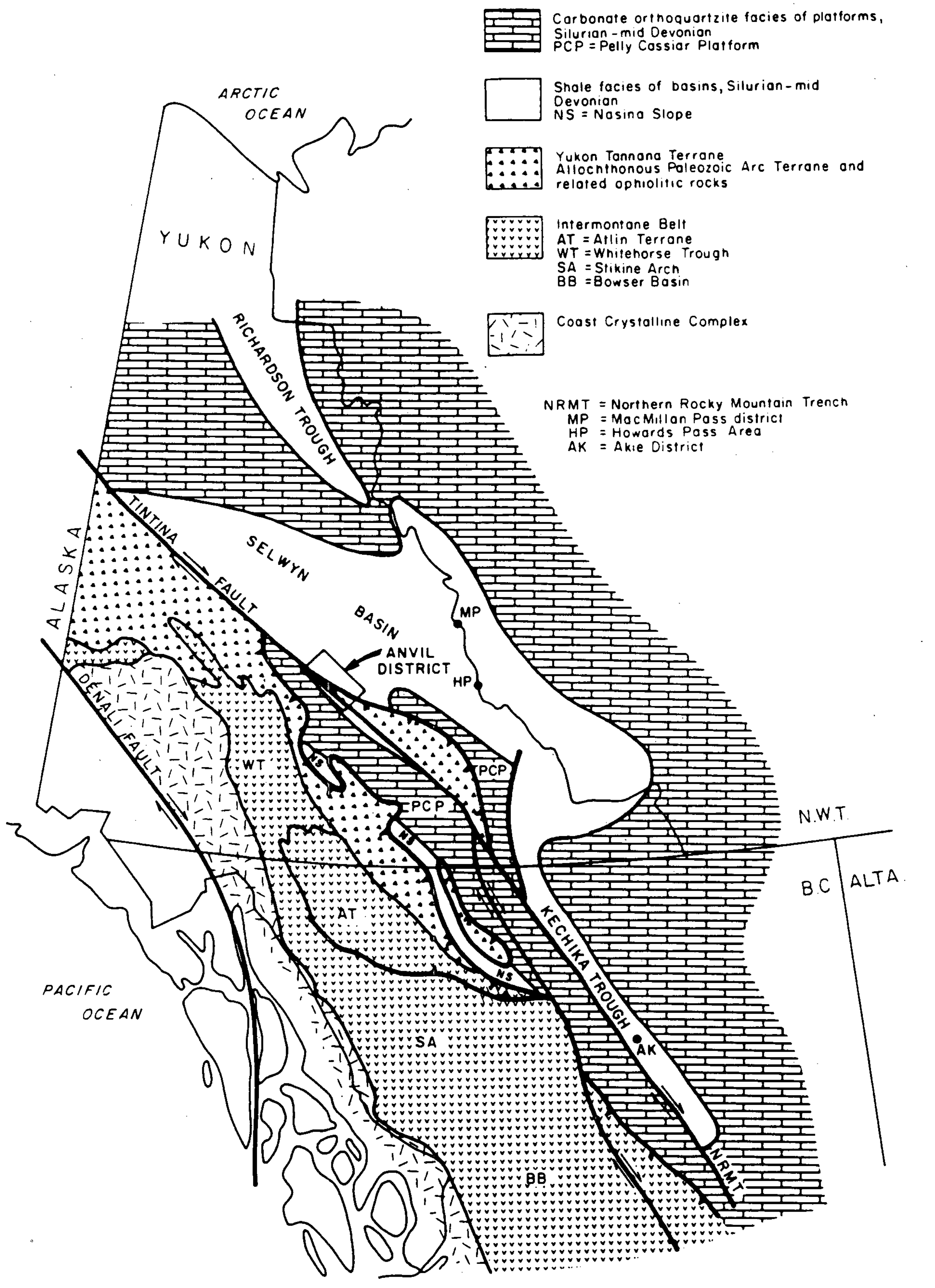


Figure 2 Location map of Anvil District. The major sulphide deposits are indicated in tectonic features of northwestern Canada.

quartzofeldspathic turbidites and shales. The lowermost portion of the sequence reflects initial rifting forming the ancient continental margin (Eisbacher, 1981).

During the interval early Cambrian to middle Devonian the basin is characterized by passive continental margin sedimentation of dominantly carbonaceous fine clastics and chert with a shallow carbonate platform to the northeast (Mackenzie Arch) (Abbott et al., 1986). Scattered occurrences of Ordovician basaltic flows, volcaniclastic breccias, and tuffs indicate intermittent extension within the basin.

A transgressive shale and chert sequence replaced carbonate platform sedimentation in the Mackenzie Arch during middle Devonian to Mississippian time. Intrabasinal or westerly derived chert and quartz-rich coarse clastics interbedded with carbonaceous shales and cherts in Selwyn Basin indicate a tectonic event during this interval which resulted in local extension (Abbott et al.,1986). Extension is also indicated by the local occurrence of felsic volcanics and plutonics during this interval (Mortensen, 1982).

Locally preserved Mississippian to Triassic fine grained shallow water clastics and cherts delineate a return to an oxygenated, stable, marine continental margin depositional pattern.

Selwyn Basin is immediately northeast of the Yukon-Tanana suspect terrane (Coney et al., 1980), a mid-Paleozoic volcanic-plutonic assemblage built on continental crust (Mortensen and Jilson, 1985). At least part of the Yukon-Tanana terrane was emplaced as an allochthon overlying North American rocks along the outboard edge of Selwyn Basin. This structure is thought to be part of a transpressive suture developed during oblique collision of the suspect terrane with North America in Jurassic through Cretaceous (Mortensen and Jilson, 1985). This collision initiated metamorphism and deformation of the basin with development of northeast directed thrusting and folding. Collisional deformation culminated with the intrusion of mid-Cretaceous granites.

Right lateral, transcurrent movement along the Tintina Fault in latest Cretaceous or early Tertiary time completed the deformation history of Selwyn basin. Estimates of offset along the Tintina Fault range from 450 kilometers (Tempelman-Kluit, 1970a) to 750 kilometers (Gabrielse, 1985).

The clastics of Selwyn Basin host most of Canada's large stratiform lead-zinc deposits, making it a metallogenic province of world-wide significance (Carne and Cathro, 1982). Mineral deposits within the basin range from Cambrian through Devonian in age. The Anvil District differs from the remainder of the Selwyn Basin because the rocks and ore deposits are metamorphosed and significantly recrystallized. This has resulted in coarser grain size with improved metallurgical performance. This geologic factor and the size and location of the Faro deposit have combined to determine that Faro is as yet the only producer of Selwyn Basin.

DISTRICT STRATIGRAPHY

The stratigraphic sequence of Anvil District ranges in age from latest Precambrian to Permian (Figure 3). The lower part of the sequence is divisible into three major mappable units. From the base these are noncalcareous metapelite of the Mount Mye formation, calcareous pelite of the Vangorda formation, and basalt of the Menzie Creek formation (Figures 4, 5; Jennings and Jilson, 1986). All formational names in this interval are informal. The aggregate thickness for this pre-Silurian sequence is approximately 5 kilometers.

The overlying sequence is characterized by shale, chert, basalt, minor limestone, and coarse clastics rich in chert fragments. Strata of the Earn Group (Gordey et al., 1982) and Anvil Range Group (Tempelman-Kluit, 1972) are present. This sequence ranges in age from Devonian to Permian. All or part of this upper sequence may be allochthonous with respect to the underlying units. The Earn Group locally contains stratiform barite deposits.

The Devonian and younger rocks are not related to the ore deposits in the district and consequently are not discussed further. The three older units either host the ore deposits or bear a possible relationship to the ore and are considered in more detail below.

Mount Mye formation

The Mount Mye formation (Figure 5) consists dominantly of noncalcareous, biotite-muscovite-andalusite-staurolite +/- garnet schist in areas of amphibolite facies metamorphism and noncalcareous, weakly carbonaceous, light to medium

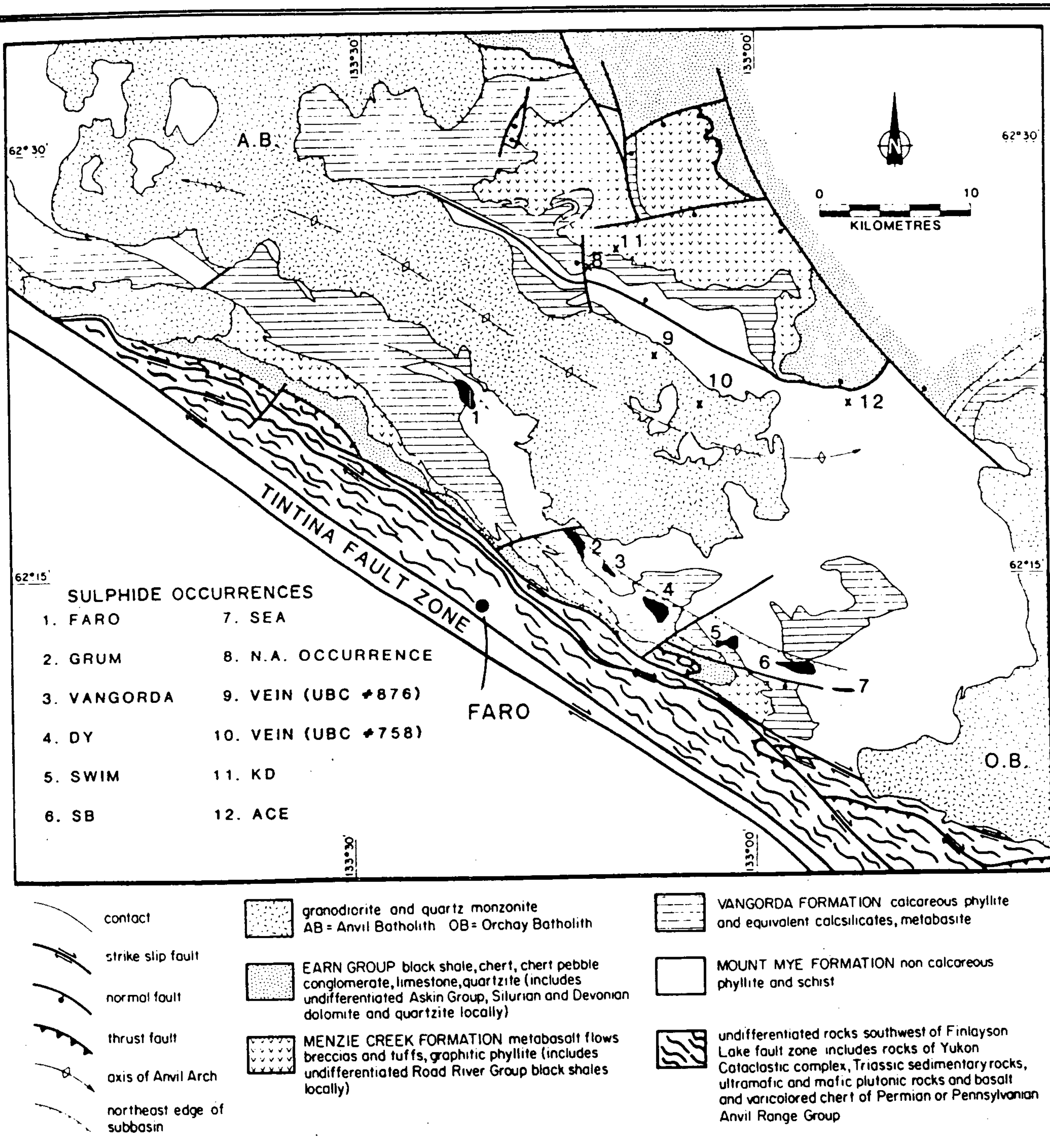
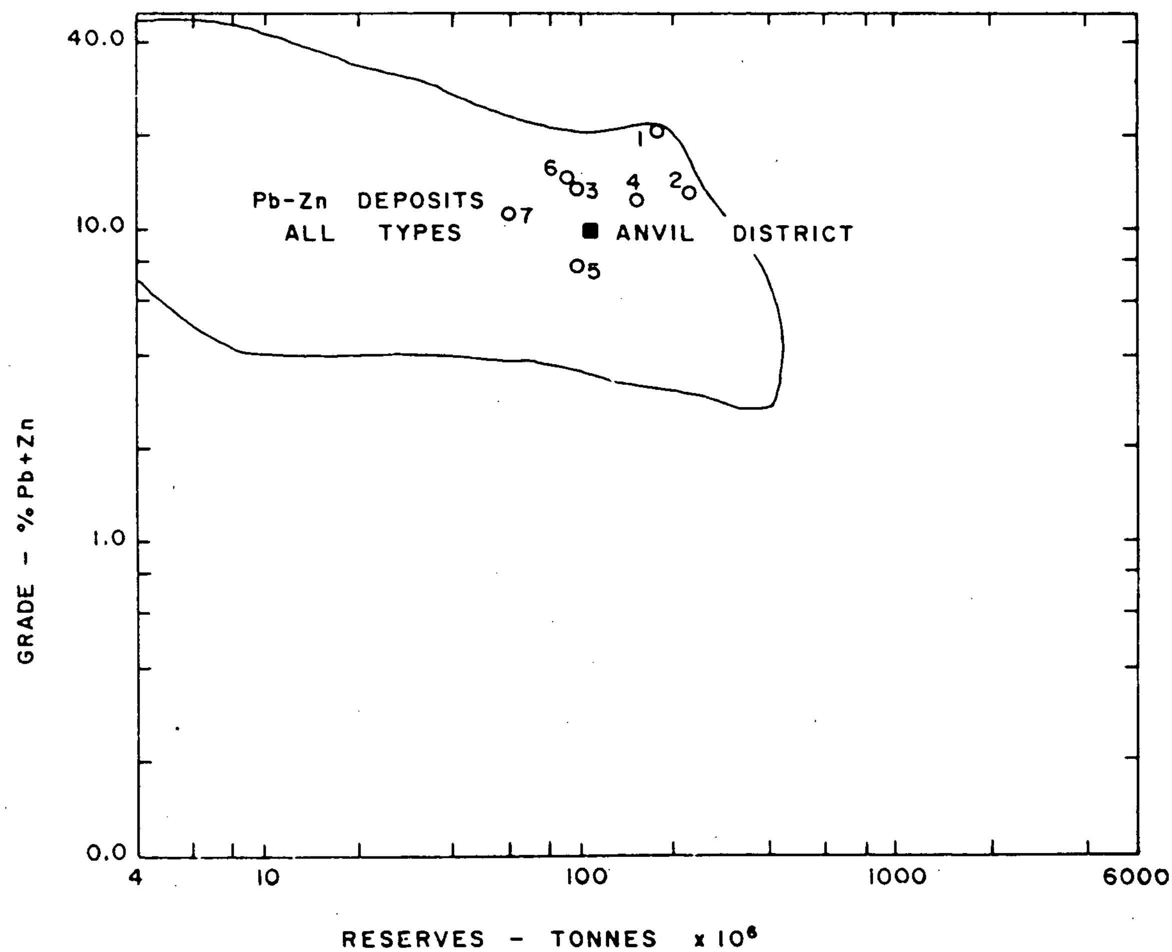


Figure 3 Geology map of Anvil District. The major sulphide deposits are indicated in black.



1 BROKEN HILL, AUSTRALIA
2 McARTHUR RIVER, AUSTRALIA
3 MT. ISA, AUSTRALIA
4 SULLIVAN, CANADA
5 HOWARDS PASS, CANADA
6 RED DOG, ALASKA
7 MEGGEN, WEST GERMANY

Figure 4 Comparison of size-grade characteristics of some major lead-zinc deposits. Modified from Gustafson and Williams (1981).

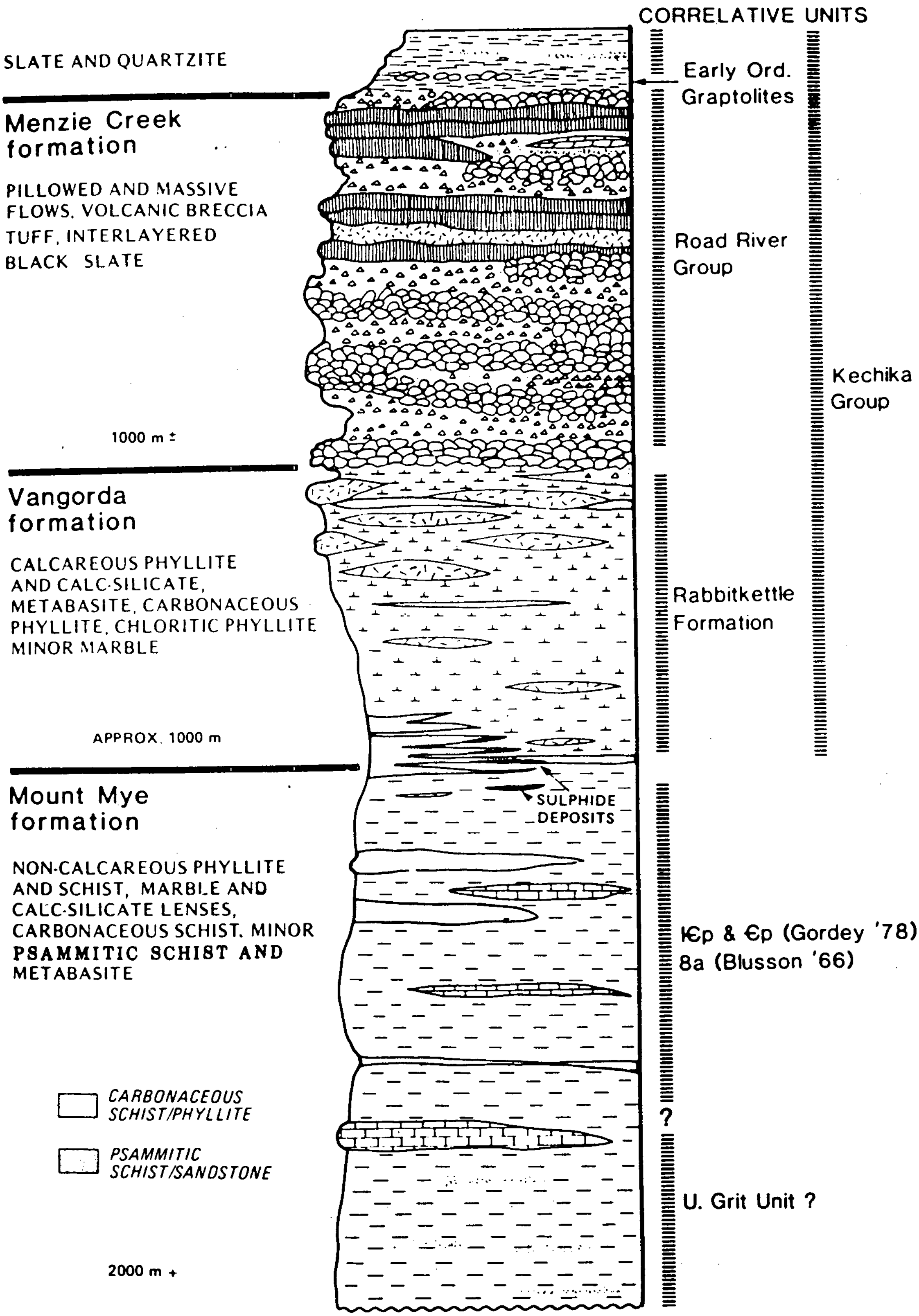


Figure 5 Stratigraphic column of the older portion of the rock units in the Anvil District.

gray muscovite-chlorite phyllite in areas of greenschist facies metamorphism. It contains lesser, interlayed, black carbonaceous phyllite or schist, calcitic marble, calc-silicate phyllite or schist, metabasite, and psammitic schist. The unit has a structural thickness of at least 2 kilometers with the base not being exposed. The reddish brown weathering color of the unit is characteristic and helps distinguish it from noncalcareous portions of the overlying Vangorda formation.

Dark grey to black carbonaceous phyllite or schist members comprise about 10 per cent of the formation. They are more abundant in the upper 200 meters of the unit.

Calcitic marble and calc-silicate schist or phyllite also constitute about 10 per cent of the Mount Mye formation. The marble is light grey, medium crystalline calcite with boudins of pelite, amphibolite, and calc-silicate. Marble bodies may be up to 75 meters thick but are generally only a few tens of meters thick; they can be traced laterally for several kilometers. The calc-silicate lithology is a thinly interbanded sequence of purplish brown biotite pelite and pale green actinolite-epidote calc-silicates. Typically the calc-silicates are spatially associated with the marbles. A persistent marble and calc-silicate horizon occurs about 200 to 400 meters below the top of the Mount Mye formation.

Metabasite bodies are generally only a few meters thick and have small to moderate lateral dimensions. Volumetrically they constitute less than 1 per cent of the Mount Mye formation. They are generally strongly foliated, dark green amphibolites lacking relict igneous texture. Compositions are similar to basalts of the Menzie Creek formation (Jennings and Jilson, 1986). They are interpreted as subvolcanic feeder dykes and sills of the Menzie Creek basalts.

The upper portion of the Mount Mye formation is very similar to the buff weathering mudstone and blue-gray mudstone units described by Gordey (1978) to the east near Howards Pass and to unit 8A of Blusson (1966). Correlation with these units would imply the top of the formation is lower Cambrian or possibly middle Cambrian. Jennings and Jilson (1986) suggested that the persistent marble and calc-silicate package may correlate with the widespread early Cambrian limestone conglomerate of Selwyn Basin. Parts of the Mount Mye formation also resemble rocks underlying those presumed correlative units, implying that the Mount Mye probably includes rocks as old as Hadrynian.

Vangorda formation

The Vangorda formation is characterized by light to medium-gray, calcareous, phyllitic rocks made up of very thin (0.1-2 cm) interlayers of medium grey, non-calcareous, weakly carbonaceous, muscovite-chlorite pelite and light grey, generally calcareous quartz-calcite +/- dolomite siltstone. At the higher metamorphic grade of amphibolite facies, the Vangorda phyllites are transformed to a thinly banded, pervasively foliated, green, cream, and purplish brown, calc-silicate. Major interbanded units include metabasite, carbonaceous pelite, and phyllitic limestone. The Vangorda formation varies between 0.5 and 2 kilometers in apparent thickness. The formation becomes more calcareous up section. The light grey to tan colored drusy weathering of the formation is characteristic both within the district and elsewhere.

The metabasite bodies range from 1 to 100 meters in thickness and are up to several kilometers in length. They comprise approximately 15 per cent of the Vangorda formation and are more prevalent near the top of the formation. Whole rock analyses show that the metabasites are compositionally similar to the overlying Menzie Creek basalts (Jennings and Jilson , 1986). Locally the metabasites contain coarsely crystalline serpentinized pyroxenite subunits. Most metabasite bodies have medium-grained, equigranular centres with strongly foliated margins. Although marginal contacts of the bodies are superficially conformable, detailed inspection indicates the units are locally slightly crosscutting. The metabasites are thus interpreted as subvolcanic dyke and sill feeders to the Menzie Creek formation.

Typically the Vangorda formation adjacent to the metabasites is a thinly banded, hard, pale green, calcareous, chloritic phyllite. Originally this lithology was interpreted as a marginal tuff adjacent to basaltic flows. More extensive drill intersections and additional outcrop exposures indicate that instead it represents a slight contact metamorphic aureole caused by intrusion of the metabasite bodies.

Black, slightly calcareous to dolomitic, carbonaceous pelite members occur throughout the

Vangorda formation. Dimensions and lateral continuity of these members are poorly known. The thickest and most extensive of these occurs at the base of the formation; it ranges from only a few tens of meters to 100 meters in thickness. This basal member becomes thicker in the immediate vicinity of the ore deposits and appears to be laterally equivalent to black, sulphide-bearing, ribbon-banded, carbonaceous, quartzite ores within the mineral deposits.

The Vangorda formation is lithologically similar to, though more argillaceous than the Rabbitkettle Formation seen to the east (Gordey, 1978; Gabrielse et al., 1973). Based on this correlation the Vangorda formation may range in age from middle or late Cambrian through early Ordovician.

Menzie Creek formation

The Menzie Creek formation is a unit of basaltic metavolcanic rocks consisting of pillowed and massive flows with comparable amounts of massive, coarse, monolithic breccias and lesser, thin-bedded, tuff and/or volcanic sandstone and siltstone. The formation reaches a maximum structural thickness of 1.5 kilometers in the district. Whole rock major element and trace element data (Jennings and Jilson, 1986) imply that the flows of the Menzie Creek volcanic unit are dominantly alkali basalt erupted in a within-plate setting. Similar major and minor element compositions for the metabasites in the Mount Mye and Vangorda formations suggest the metabasites are subvolcanic feeders for the Menzie Creek formation.

Carbonaceous phyllite and brown siltstone immediately overlying the Menzie Creek formation northeast of the Anvil Batholith contain graptolites of middle Ordovician or early Silurian age (Tempelman-Kluit, 1972; Gordey, 1983) suggesting correlation of the Menzie Creek volcanics with the widespread Road River Formation black shale and chert to the northeast. The Menzie Creek formation has been traced for 100 kilometers along strike and 30 kilometers across strike, showing that it is one of the largest of several basaltic units of its age in Yukon.

Relation of Stratigraphy to Ore Deposits

The ore deposits of Anvil District are stratiform and confined to an approximately 150 meter thick interval straddling the contact of the Mount Mye and Vangorda formations (Figure 5). This stratigraphic position indicates the mineralization is Cambrian in age. The deposits consist of one to five sheets of sulphide mineralization with interbanded metasedimentary rocks. For those deposits with more than one sulphide horizon, the mineralized horizons are generally stacked one above the other. At least three of these mineralized horizons appear to be laterally equivalent to part of the basal carbonaceous pelite member of the Vangorda formation. Unlike other sedimentary exhalative deposits of Selwyn Basin, the Anvil deposits are not characterized by a host stratigraphic section dominated by black carbonaceous rocks. Instead the carbonaceous rocks in the district are thin and subordinate or locally not even present.

DEFORMATION, METAMORPHISM and PLUTONISM

The structural and metamorphic history of the Anvil District is complex and of considerable significance to the present form and nature of the ore deposits. Five deformation phases have been recognized within the metasedimentary and metavolcanic rocks of the district. The first two are periods of intense mid-Mesozoic fold deformation and concurrent metamorphism which determined the gross structure of the mineral deposits (see Figure 6). The remaining deformations are only locally developed and do not generally form large or significant structures.

The first deformation (D1) produced a regional metamorphic foliation (S1) axial planar to tight to isoclinal mesoscopic folds (F1) in bedding (S0). Mesoscopic D1 early folds are rarely preserved in the district; they are ubiquitously north-easterly inclined to upright, northeasterly verging structures with shallow northwesterly or southeasterly plunging axes (Figure 6).

During the second deformation event (D2), S1 was strongly crenulated and ubiquitous close to tight mesoscopic folds (F2) in S1 were produced. S0 primary bedding was transposed into near parallelism with the S1 foliation. Parallel to the axial planes of the D2 folds is a crenulation cleavage (S2) which imparts a well developed lithon structure to most rocks of the district, especially the strongly banded phyllites of the Vangorda formation. F2 axial planes and S2 axial plane foliations dip shallowly to the southwest or northeast, with fold axes subparallel to F1 fold axes. Southwest of the Anvil batholith (see Figure 3) the S2 surfaces dip dominantly southwest, and F2 minor folds have southwest

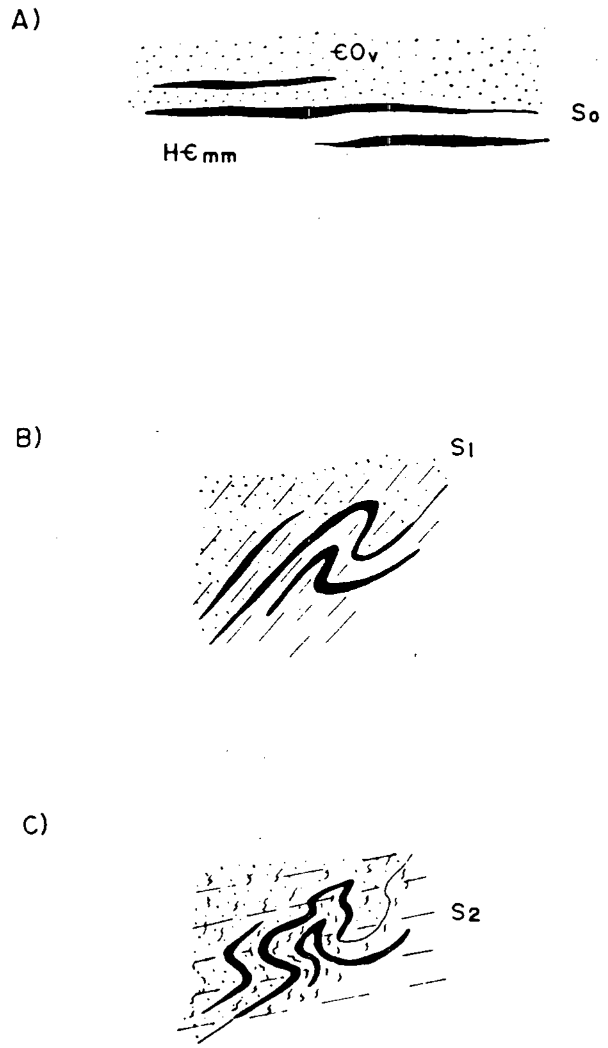


Figure 6 Schematic cross-section through the Grum deposit. Section oriented SW-NE and looking northwest. Stacked en echelon ore horizons are shown in black. This section shows the sequential development of the type 3 interference pattern between D_1 and D_2 folding deformations.

A) Deposition of sulphide ore horizons parallel to S_0.

B) Formation of northeast-verging, steeply dipping, D_1 minor folds.

C) Formation of type 3 interference pattern with development of southwest-verging, shallowly dipping, D_2 minor folds.

vergence. Northeast of the batholith S2 surfaces dip dominantly northeast, and F2 minor folds have northest vergence.

The largest megascopic folds known to have been formed during D2 are those at the Grum Deposit (Figures 10, 11) and comparable folds in the Swim Deposit. Three later, less intense periods of folding and associated faulting followed. The later events (D3 through D5) generally produced open folds and weak crenulations in S2 related to broad, regional structures. An important exception to this general rule is found in the vicinity of the Faro deposit where the fourth event (D4) is intense with tight mesoscopic folds developed in nearly pervasive S2. D4 minor folds have appreciable mica growth along S4 axial plane crenulation cleavages (see Figures 8 and 9 for examples of fourth phase folds affecting the outline of the Faro deposit).

During the later stages of this deformation history a large granitic body (Anvil batholith) was intruded into the metamorphic sequence. Anvil batholith ranges in composition from a biotite-muscovite peraluminous granite to a metaluminous to peraluminous hornblende-biotite granodiorite (Pigage and Anderson, 1985). Textures include equigranular massive, megacrystic massive, and various strongly to weakly foliated variants. Foliation within the intrusive rocks is concordant with S2 surfaces in the surrounding metasediments. Several K-Ar ages on the granitic rocks yielded ages of 85-100 Ma (Templeman-Kluit, 1972). Rb-Sr isochron ages of 99-100 Ma (Pigage, and Anderson, 1985) are concordant with the K-Ar ages and indicate rapid cooling after high-level emplacement.

Intrusion of the Anvil batholith further deformed the metamorphic sequence so that the overall structure of the district is an elongate dome cored by the batholith (Figure 3). In the later stages of emplacement large extensional fault displacement occurred along the margins of the batholith (Pigage and Jilson, 1985). S-C mylonitic banding within these fault zones is consistent with development of the faults during late D2 deformation. These faults determine the present day limits of several of the deposits.

Anvil batholith and surrounding metasedimentary rocks are crosscut by two general types of post-tectonic dykes. The majority of the dykes are northeast-trending, medium to dark green, porphyritic, unfoliated, hornblende-biotite quartz diorite. These quartz diorite

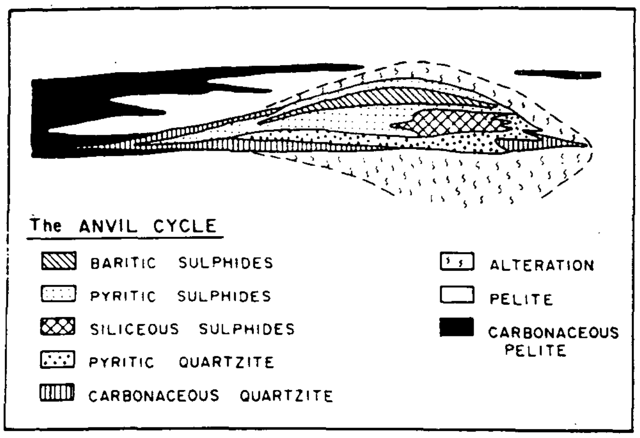


Figure 7 Idealized Anvil cycle of ore type facies variatinos based largely on the Faro and Vangorda deposits. The section is greatly vertically exaggerated.

dykes appear to be associated with late extensional faults. Unfoliated, pale tan, smoky quartz-feldspar porphyry also occurs as late crosscutting dykes. These dyke suites have not been isotopically dated; their absolute ages are uncertain.

Metamorphism was concurrent with deformation and was most intense during the major D1 and D2 folding deformations. D1 metamorphism has been largely overprinted by the later D2 metamorphism. Metamorphic grades during these two events appear to be comparable since mica mineral assemblages between microlithons (i.e. S1 foliations) are similar to those defining the S2 foliation surfaces. The rest of the discusion will focus on the D2 metamorphism.

Metamorphic grade ranges from upper amphibolite facies (sillimanite-muscovite zone) to lower greenschist facies (muscovite-chlorite zone) i.. a low pressure Buchan type facies series. In pelites adjacent to the intrusions the typical assemblage is andalusite-staurolite-garnet-biotite-muscovite-quartz-plagioclase with laocal fibrolite and cordierite. Lower greenschist facies pelites contain the assemblage muscovite-chlorite-quartz-plagioclase.

Metamorphic isograds are roughly concentric about the Anvil batholith. Locally isograds are truncated and juxtaposed by the late D2 extensional faults. The Faro deposit (closer to the batholith) is metamorphosed to amphibolite facies. All other deposits are only weakly metamorphosed to lower greenschist facies. This difference in metamorphism is reflected in decreased grain size and increased degree of mineral intergrowth in the less metamorphosed deposits (Tempelman-Kluit, 1970b). This has a significant impact on metallurgical response of Anvil district ores.

ORE DEPOSITS

General Description

The lead, zinc, silver deposits of Anvil District are of the sediment hosted, stratiform, massive pyritic sulphide type (Gustafson and Williams, 1981; Large, 1980) or sedimentary exhalative (sedex) type (Carne and Cathro, 1982). They occur either as a thick sulphide lens with little or no interbanded metasedimentary rocks (e.g. Faro) or as several thinner lenses stacked approximately one above the other with substantial metasedimentary interlayers (e.g. Grum and Dy).

There are presently five known lead-zinc bearing mineral deposits along a curvilinear trend on the south flank of the Anvil batholith (Figure 3). From northwest to southeast they are Faro, Grum, Vangorda, Dy, and Swim. Additionally two base metal deficient sulphide occurrences, the SB and Sea, are also known.

The Anvil deposits are distributed through a 150 meter thick stratigraphic interval straddling the boundary of the Mount Mye and Vangorda formations. They are associated with the regionally developed, but laterally discontinuous carbonaceous pelite unit forming the base of the Vangorda formation. Some sulphide lenses are, or appear to be, the lateral facies equivalent of this carbonaceous pelite. Some lenses (such as the upper horizons of Grum) are at the base of fingers of the carbonaceous pelite unit on a local scale as well as being its lateral equivalent on a more regional scale. In other cases, the ore lenses occur at lower or higher stratigraphic intervals than the carbonaceous pelite.

Detailed mapping and drilling suggest the linearly distributed deposits lie close to a northeasterly "pinch out" or "zero edge" of the associated carbonaceous pelite (the basal member of Vangorda formation). To date, no sulphide deposit lithofacies have been encountered in a moderate number of drill holes through the ore-bearing horizon southwest or northeast of the deposit line. Taken together, these observations suggest some relationship between sulphide deposits

Preliminary geology of Rose Mountain, Anvil District, central Yukon (105K/05)

Lee C. Pigage
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Pigage, L., 1999. Preliminary geology of Rose Mountain, Anvil District, central Yukon (105K/05). *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 91-103.

ABSTRACT

A 2000 m thick succession of six metasedimentary and metavolcanic units ranging in age from Ordovician through Permian strikes northwest and dips moderately to the southwest in the Rose Mountain area (105K/05). Units 3-6 have conformable contacts exposed and form a continuous succession. Units 1, 2 and 4 are correlated with lower to middle Paleozoic regional stratigraphic units of ancestral North America. Unit 3 consists of pale green argillite with lesser chert pebble conglomerate, sandstone and shale chip breccia interbeds, and is unique to the Rose Mountain area. Unit 5 is bedded chert and is correlated with North American Mount Christie Formation. Unit 5 is also similar to chert units in Slide Mountain Terrane. Unit 6 correlates with basalts of the Slide Mountain Terrane.

Unit 4 is correlated with Earn Group and contains two stratiform barite horizons. No sulphides are visibly associated with the barite, but the unit is favourable for stratiform base metal mineralization.

All units contain one major deformation fabric. This contrasts with structural style immediately to the northeast where two major deformation fabrics occur. The Rose Mountain fabric is correlated with the older deformation fabric present to the northeast.

RÉSUMÉ

Une succession de six unités de roches métasédimentaires et métavolcaniques datant de l'Ordovicien au Permien d'une épaisseur de 2000 mètres est orientée au nord-ouest et présente un pendage modéré en direction du sud-ouest dans la région du mont Rose (105K/05). Les unités 3 à 6 présentent des contacts concordants qui sont exposés et constituent une succession continue. Les unités 1, 2 et 4 sont en corrélation avec les unités stratigraphiques régionales du Paléozoïque inférieur à moyen du protocontinent nord-américain. L'unité 3 consiste en argilite vert pâle avec de moindres interlits de conglomérat à cailloux de chert, de grès et de brèche à éclats de shale et ne se retrouve que dans la région du mont Rose. L'unité 5 présente des affinités et avec le protocontinent nord-américain et avec le terrane de Slide Mountain. L'unité 6 est en corrélation avec les basaltes du terrane de Slide Mountain.

Deux horizons de barytine stratiforme ont été documentés dans l'unité 4, qui est en corrélation avec le groupe d'Earn. Bien que la pyrite ne soit pas associée de manière visible à la barytine, la stratigraphie de l'unité 4 est favorable à la minéralisation stratiforme de métaux communs.

Une structure de déformation majeure touche toutes les unités, ce qui contraste avec le style structural présent immédiatement au nord-est qui est caractérisé par deux structures de déformation majeures. La structure du mont Rose est en corrélation avec les structures de déformation plus anciennes présentes au nord-est.

INTRODUCTION

The Anvil District (Figs. 1, 2) in central Yukon contains five known pyritic massive sulphide deposits (Faro, Grum, Vangorda, Grizzly, and Swim) with a total mineral inventory of 120.1 million tonnes averaging 9.3% combined lead and zinc, and two uneconomic pyritic sulphide occurrences (SB and Sea; Jennings and Jilson, 1986). The deposits were discovered between 1953 and 1976. Faro and Vangorda have been mined, Grum is partly mined, and Grizzly and Swim have not yet been developed.

Exploration potential in the district remains high. The Anvil Project is a new, multi-disciplinary study commissioned by the Yukon Geology Program to provide a unified geological framework for the Anvil District to assist future exploration. Projects within this integrated study include bedrock geology mapping and compilation (this report), surficial geology mapping and basal till sampling (see Bond, this volume), detailed lithogeochemistry of the immediate host rocks to the massive sulphide deposits, and a seismic reflection profile over the Grizzly deposit. These projects began in 1998.

The goal of the bedrock mapping and geological compilation of the district is to bridge the gap between detailed property-scale geology mapping of exploration companies and regional geology mapping of the Geological Survey of Canada. Geology will be presented on a series of maps at a scale of 1:25 000. A significant portion of this project will consist of re-interpretation, harmonization, and consolidation of the detailed geological information from the 45-year exploration history.

One month was spent in the field during 1998 conducting bedrock geological mapping, including eight days of traverses on the southeast and northwest flanks of Rose Mountain (Figs. 2, 3, 4 and 5). This report details the stratigraphy and structure observed on Rose Mountain. All descriptions are based on field and hand sample observations; samples have been sent for geochemical and chronological analysis.

LOCATION AND ACCESS

Rose Mountain (NTS map 105K/05) is located 19.5 km northwest of the Town of Faro and 12.5 km west of the Faro minesite in central Yukon. Rose Creek flows west into Anvil Creek on the north edge of the area, and the Pelly River flows to the northwest in Tintina Trench, a major northwest-trending physiographic feature immediately south of the area. Tree line occurs at the approximate elevation of 4500 ft (1370 m). Outcrop is extensive on ridges above tree line. Below tree line, outcrop is generally restricted to stream cuts and scattered ridge crests. Valley bottoms are typically covered with thin to thick glacial till.

Overgrown exploration roads extend to the southeastern and northern margins of Rose Mountain. Outfitting trails lead into the area for hunting. Access is most readily accomplished by helicopter. Camps during 1998 were placed using contract helicopter services out of Ross River.

PREVIOUS WORK

Rose Mountain lies within Tay River map area (105K), where the regional geology was mapped by Roddick and Green (1961) and Gordey and Irwin (1987). The discovery of the massive sulphide deposits in the Anvil District led to more detailed geology studies by Tempelman-Kluit (1972) and Gordey (1990).

Early exploration activity near Rose Mountain occurred dominantly on the lower slopes of Rose Creek valley and was focussed toward lead-zinc targets because of the Faro discovery. In 1977 Cyprus Anvil Mining Corporation staked the URN claims over two barite horizons on the northeast-facing slopes of Rose Mountain.

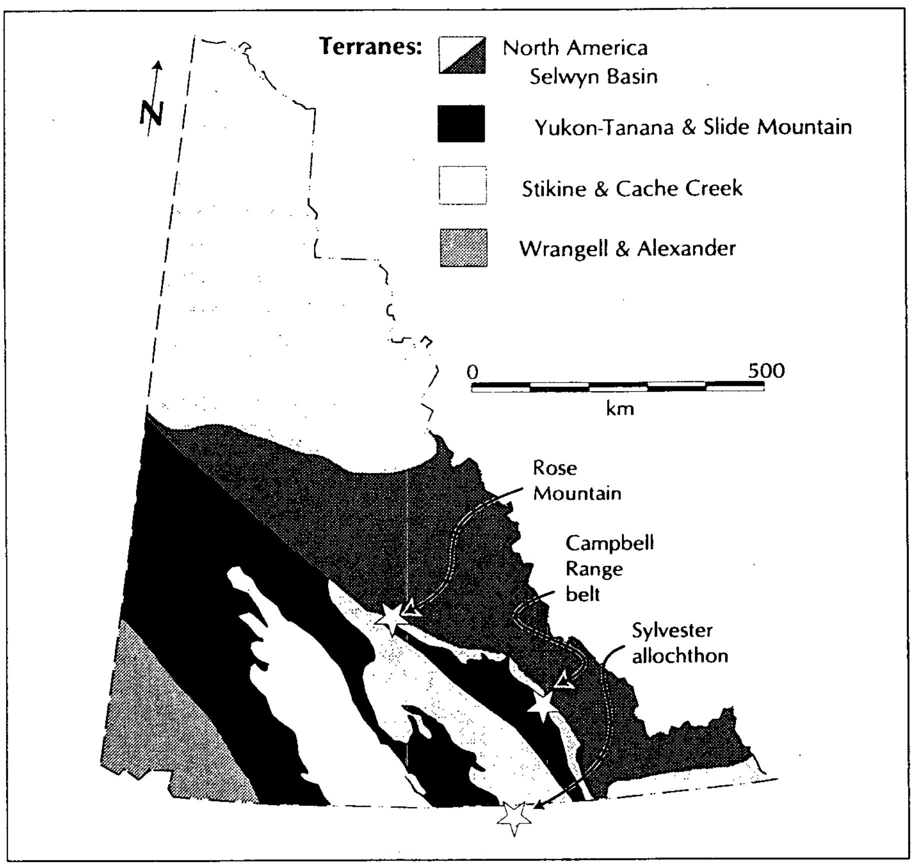


Figure 1. Locations of Rose Mountain in Anvil District (Fig. 2), Campbell Range belt, and Sylvester allochthon. Modified from Wheeler and McFeely (1987).

The URN barite horizons were sampled in 1977 (Franzen, 1978) and 1981 (Read, 1982) for their industrial mineral potential. Yukon Minfile 105K 106 summarizes the URN barite exploration work.

REGIONAL GEOLOGY

Rose Mountain is located on the southwest flank of the Anvil District (Fig. 2) in central Yukon. Anvil District is part of the Cordilleran miogeocline, a prism of sedimentary rocks of Precambrian to Jurassic age deposited along the relatively stable continental margin of western North America. Cordilleran miogeocline stratigraphy is presented in Abbott et al. (1986), and more detailed stratigraphy and structure in the Anvil District is given in Jennings and Jilson (1986) and Pigage (1990).

Anvil District is immediately east of the Yukon-Tanana Terrane (Coney et al., 1980), the easternmost of the accreted suspect terranes. The Yukon-Tanana Terrane is juxtaposed against Anvil District along the Vangorda fault (Jennings and Jilson, 1986) which Mortensen and Jilson (1985) have interpreted as a transpressive suture. Deformation and metamorphism associated with accretion of the suspect terranes was initiated during the Jurassic and culminated in the Cretaceous period (Tempelman-Kluit, 1979). More recently, strike-slip faulting along the Tintina Fault zone immediately southwest of Rose Mountain resulted in 450-500 km of right lateral strike-slip displacement during late Cretaceous-early Tertiary time (Tempelman-Kluit, 1970).

Tempelman-Kluit (1972) mapped four southwest-dipping units on Rose Mountain. The two lowermost units outcrop on the lower slopes of Rose Mountain and consist of chlorite-quartz-muscovite phyllite overlain by grey slate. These units were tentatively assigned ages of Hadrynian to Ordovician, and Devonian to Mississippian, respectively. They were conformably overlain by the Anvil Range Group, a succession consisting of a lower member containing interbedded cherts and coarse clastic rocks, and an upper unit consisting of mafic volcanic rocks with lesser interbedded cherts. Fossils from the lower unit allowed an age assignment of Pennsylvanian through Permian for both units. The uppermost member of the Anvil Range Group, as defined by Tempelman-Kluit, does not occur in the Rose Mountain area. Tempelman-Kluit (1979) considered the Anvil

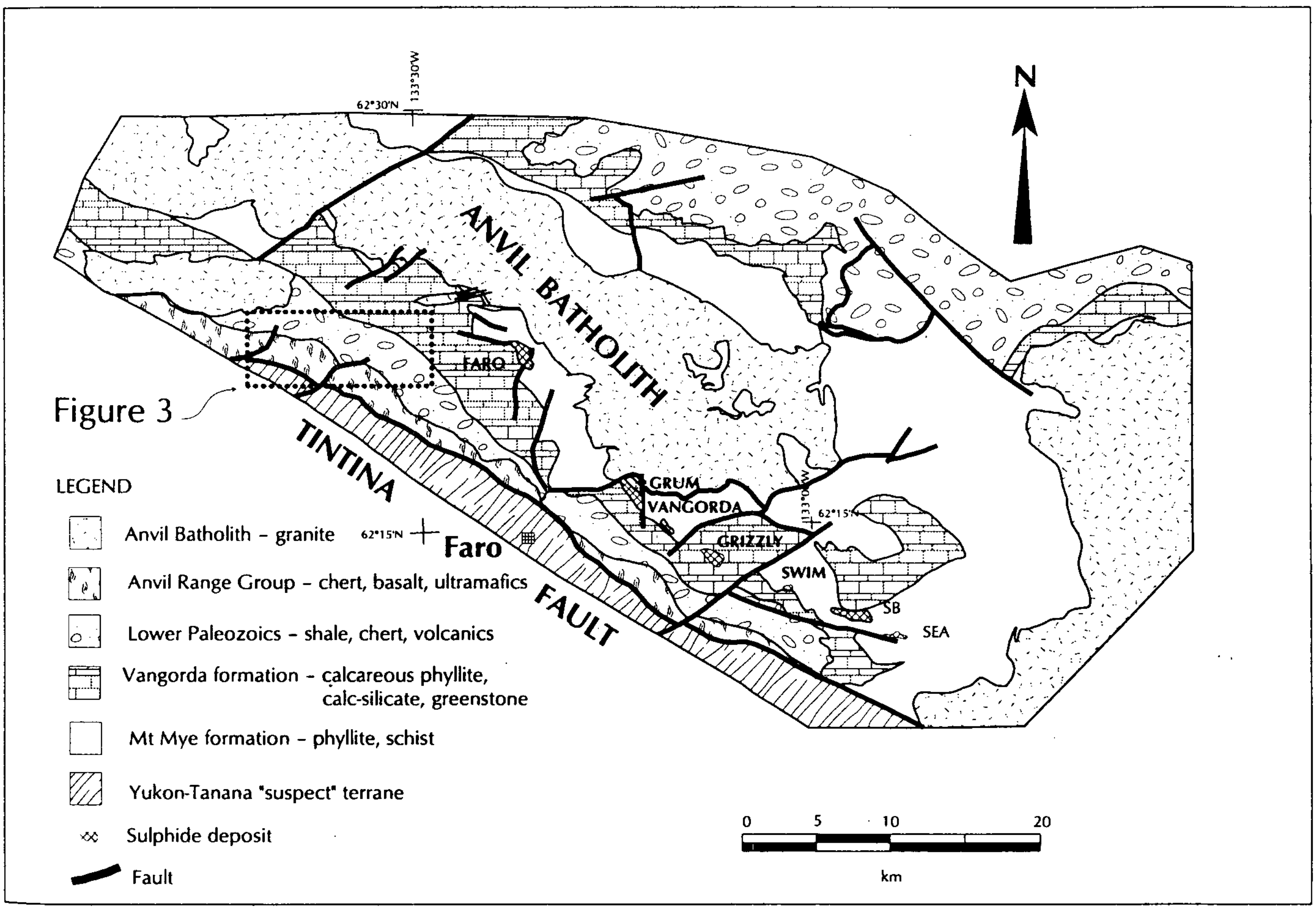


Figure 2. *Schematic geology of Anvil District, Yukon, showing the Rose Mountain area (Fig. 3). Modified from Jennings and Jilson (1986).*

Range Group as autochthonous at Rose Mountain, and suggested that it was an intact correlative unit of the major Anvil allochthonous assemblage.

Gordey (1990) correlated the units mapped by Tempelman-Kluit to regional stratigraphy mapped southwest and northeast of Rose Mountain. The two lower units were correlated with Ordovician Menzie Creek formation and Ordovician-Silurian Duo Lake Formation, respectively. These units are an integral part of the early Paleozoic North American miogeocline. In contrast, the Anvil Range Group was correlated with the Anvil allochthonous assemblage and considered to be an obducted slice of oceanic terrane emplaced on North American stratigraphy during Mesozoic accretion of suspect terranes to North America.

Geologists working for Cyprus Anvil Mining Corporation suggested that at least part of the Anvil Range Group had North American affinities and was autochthonous (Jennings and Jilson, 1986). They were unable to identify a location for the required thrust fault flooring an obducted sequence (G. Jilson, pers. comm., 1998).

The 1998 traverses suggest that the Rose Mountain stratigraphy represents a structurally concordant succession of stratigraphic units. Several of these units can be correlated with regional North American stratigraphic units, implying that the entire Rose Mountain stratigraphy has North American affinities. At the same time the two uppermost units previously mapped as Anvil Range Group are similar to correlative units in Campbell Range belt and Sylvester allochthon (Fig. 1). In these latter areas, the correlative units have been mapped and interpreted as Slide Mountain Terrane. Further work is needed to clarify the similarity of Anvil Range Group lithologies to successions in both North American and Slide Mountain Terranes.

ROSE MOUNTAIN GEOLOGY

INTRODUCTION

Figure 3 shows geological mapping completed during 1998 on the southeast and northwest ends of Rose Mountain. The two areas are located approximately 10 km apart but have similar

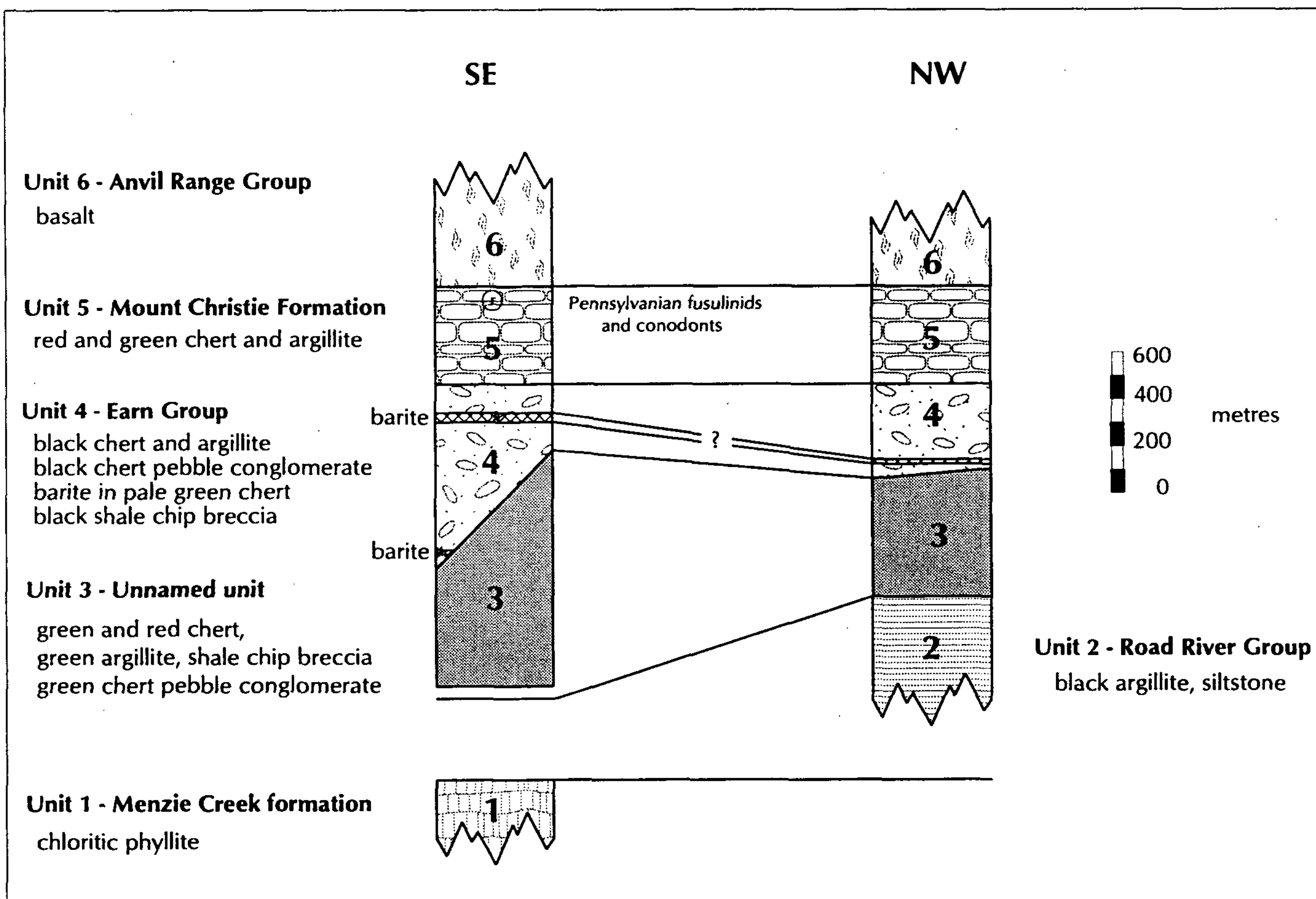


Figure 6. Stratigraphic columns for mapped areas on Rose Mountain.

stratigraphy. Figures 4 and 5 are detailed geology maps for the areas, and Figure 6 presents a combined stratigraphic column based on the geology maps.

Six northwest-trending stratigraphic units form a 2000 m thick succession that uniformly dips moderately to the southwest, with an average orientation of 164°/32°SW. The succession overlies Hadrynian-Cambrian pelites and calcareous pelites of the North American miogeocline. West of the uppermost unit, the succession is bounded by mafic and ultramafic units constituting the Vangorda fault zone (Jennings and Jilson, 1986; Gordey, 1990).

All units contain a single deformation foliation (S_1) consisting of either a slaty cleavage (argillite) or a spaced fracture cleavage (chert). The S_1 foliation also trends northwest and dips southwest (average orientation 147°/37°SW) more steeply than the S_0 bedding. Stratigraphic thicknesses are a minimum because of the pervasive S_1 foliation. The entire sequence is interpreted to be structurally upright with northeast vergence. Stratigraphic tops from rare graded beds are consistent with this structural interpretation. Scattered outcrops with overturned S_0 bedding denote local macroscopic parasitic folds within the generally upright succession. Minor folds were not observed.

To the northeast, closer to the Anvil Batholith, metasedimentary and metavolcanic rocks contain two pervasive deformation foliations (Jennings and Jilson, 1986). This contrasts with the one foliation present in the Rose Mountain area. Detailed studies have demonstrated that the second foliation developed concurrently with emplacement of the Anvil Batholith during Cretaceous time (Pigage and Anderson, 1985; Jennings and Jilson, 1986; Smith and Erdmer, 1990). These studies also showed that the second deformation fabric decreased rapidly in intensity laterally away from the batholith. The timing of development of the first foliation is loosely constrained to be post upper Paleozoic (Jennings and Jilson, 1986). Based on orientation and distance from the Anvil Batholith, the pervasive Rose Mountain foliation is correlated with the earlier foliation adjacent to the batholith.

The Rose Mountain area is within the muscovite-chlorite zone of greenschist facies metamorphism. Qualitatively, individual mica and chlorite grains are not readily visible, even with a hand lens.

STRATIGRAPHY

UNIT 1 - MENZIE CREEK FORMATION

Medium green, pervasively foliated, noncalcareous to slightly calcareous chloritic phyllite is exposed SE of Rose Mountain. The unit commonly contains pale tan to white calcite amygdules up to 1 cm across. Epidote locally forms irregular apple green patches. Dark green streaks are locally visible on the S_1 foliation surface. Although primary structures have been largely destroyed by deformation, Unit 1 is interpreted as an amygdaloidal volcanic basalt unit.

Jennings and Jilson (1986) and Gordey (1990) mapped a continuous northwest-trending band of this unit along the lower slopes of Rose Creek valley. It conformably overlies calcareous phyllites and calc-silicate rocks of the informal Cambrian-Ordovician Vangorda formation (Jennings and Jilson, 1986) and is conformably overlain by black phyllites correlated with Road River Group. Both contacts have been mapped regionally as interbedded with an interval of alternating pelitic phyllite and chloritic phyllite. The upper contact with the overlying unit is not exposed in the SE area, and the lower contact is outside of the map limit in both areas.

Unit 1 is similar in both lithology and stratigraphic position to the lesser deformed Menzie Creek formation (Jennings and Jilson, 1986; Gordey, 1990) which occurs on the northeast side of the Anvil Batholith. These northeastern volcanic rocks are interlayered with black phyllites containing Ordovician graptolites (Tempelman-Kluit, 1972; Gordey, 1983). On the basis of this similarity, Unit 1 is correlated with the informal Menzie Creek formation of Jennings and Jilson (1986). Similar volcanic rocks have been described in several localities in the northern Cordillera (Goodfellow et al., 1995).

UNIT 2 - ROAD RIVER GROUP (DUO LAKE FORMATION)

Unit 2 consists of black, carbonaceous, silty argillites with subordinate siltstones, sandstones, and limestones. It is exposed in the NW area (Fig. 4); the expected location of Unit 2 in the SE area does not contain any outcrop (Fig. 5).

The carbonaceous argillites (Fig. 7) are indistinctly bedded on a scale of 15 to 30 cm. They weather with a patchy deep orange-brown surface coating, although locally the weathered surface has a slight bluish grey tinge. Medium grey, tan weathering, noncalcareous siltstone to fine sandstone is interbedded with

Figure 7. *Black argillite of Unit 2, Duo Lake Formation, Road River Group.*

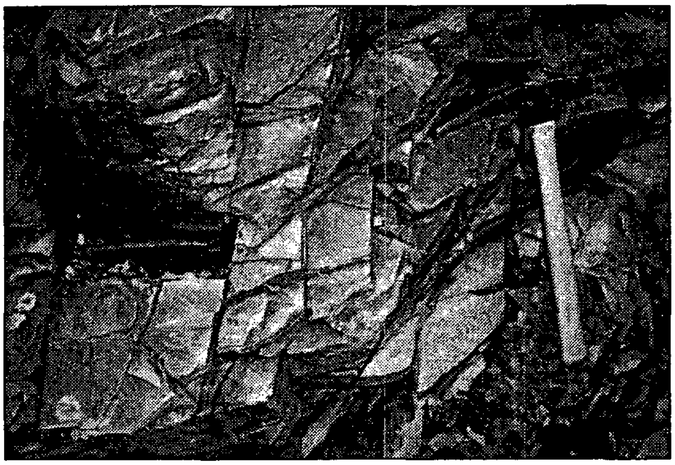


Figure 8. Pale green argillite of Unit 3.

the carbonaceous argillites on a scale of centimetres to tens of metres. Thick siltstone beds are more prominent near the top of Unit 2. Locally, the siltstones contain thin calcareous intervals. In places they contain a fine millimetre-scale colour pinstriping between light and dark grey. Unit 2 also locally contains silty, dark grey, argillaceous limestone interbeds up to 10 m thick.

The argillites contain a pervasive S_1 deformation foliation which forms a slightly irregular surface. They break on both the S_0 bedding and S_1 foliation surfaces.

Unit 2 is approximately 440 m thick in the NW area. The upper contact with Unit 3 is not exposed, and the lower contact with Unit 1 is outside the map limit. Unit 2 is similar in lithology and in stratigraphic position to the Duo Lake Formation (Cecile, 1982) as mapped by Gordey (1990) on the northeast side of Anvil Batholith. Middle Ordovician to early Silurian graptolites have been found in the Duo Lake Formation northeast of the batholith (Tempelman-Kluit, 1972; Gordey, 1983).

UNIT 3

Overlying the carbonaceous argillites is a mixed unit consisting dominantly of pale silvery grey-green, noncalcareous, silty argillite with lesser amounts of grey sandstone, pale green bedded and massive cherts, maroon chert and argillite, pale green chert pebble conglomerate, and pale green shale chip breccia. These lesser lithologies are interbedded with the green argillite on a scale ranging from a few centimetres to tens of metres. Sandstones, conglomerates, and breccias are much more common in the SE area where they constitute up to 50% of the unit. In contrast, the NW area contains largely the pale green argillite. Maroon rocks are restricted to exposures in the SE area and occur largely at the top and bottom of the unit. Bedded cherts occur dominantly near the top of the unit; massive cherts are scattered in minor amounts through the entire unit as beds up to 1 m thick.

The predominant argillite (Fig. 8) is soft and weathers with a patchy, medium brown surface coating. Bedding is locally marked by subtle centimetre-scale colour banding caused by thin pale grey to tan siltstone interbeds. It is pervasively foliated with a smooth S_1 foliation surface. Chert pebble conglomerates (Fig. 9) contain matrix-supported, subangular to angular clasts of pale green to white chert, light greenish grey siltstone, and minor dark grey to black chert or argillite in a silty to sandy matrix. Clasts up to 3 cm across are strongly flattened in the plane of the foliation with aspect ratios ranging from 2:1 to 8:1. Sandstone interbeds within the argillite are generally medium to dark greenish grey and have an indistinct bedding defined by variations in shades of grey. Locally, the bedding has a pinstriped appearance. Shale-chip breccias contain numerous siltstone and shale clasts which are visible on the slightly irregular S_1 foliation surface. Crude, large-scale graded bedding can be seen locally with conglomerate passing upwards to sandstone and then siltstone. Bedded cherts are rhythmically bedded with 15-20 cm pale cream to green chert alternating with thin pale green argillite interbeds.

Unit 3 ranges in thickness from 500 m to 1000 m. The thickest section occurs in the SE area and contains abundant sandstone, chert pebble conglomerate, and shale-chip breccia interbedded with argillite. The lower contact with Unit 2 is not exposed in the NW area. In the SE area a 200 m covered interval separates exposures of Unit 3 from Unit 1; Unit 2 is assumed to occur in this covered interval.

The upper contact of Unit 3 with Unit 4 is transitional with interbedding of pale green and dark grey lithologies, and mixing of pale green and dark grey to black clasts within the sandstones and conglomerates of both Units 3 and 4. The thickness of Unit 3 is inversely proportional to the thickness of Unit 4 in the SE area.

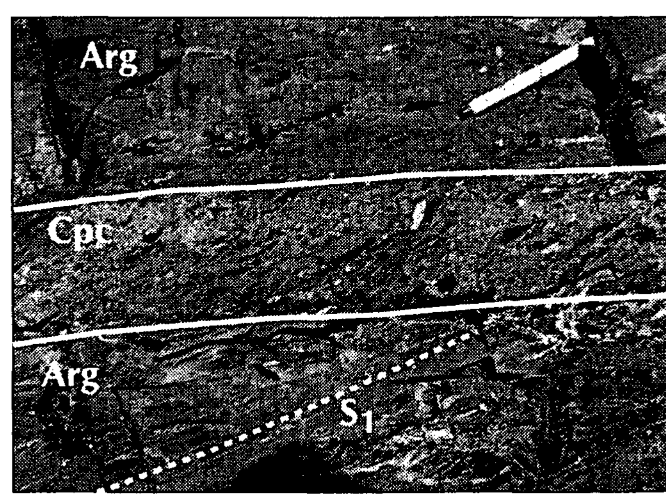


Figure 9. Chert pebble conglomerate (cpc) interval in argillite (arg) of Unit 3. Foliation (S_1) crosses from lower left to upper right.

Unit 3 does not readily correlate with known Lower Paleozoic regional stratigraphy of the North America Cordilleran miogeocline (Abbott et al., 1986; Gordey and Anderson, 1993). Strata similar to Unit 3 were not described from the northeast side of Anvil Batholith (Jennings and Jilson, 1986; Gordey, 1990). Roddick and Green (1961), however, mentioned minor green, pink, and red chert within a Road River succession in the Sheldon Lake map area (105J), 100 km northeast of Rose Mountain. Unit 3 could possibly correlate with bioturbated, pale grey siltstones of the Silurian Steel Formation (Gordey and Anderson, 1993).

It is possible, however, that Unit 3 is part of the Devonian-Mississippian Earn Group (Gordey et al., 1982) succession which unconformably overlies the Lower Paleozoic miogeocline succession. Although the pale green and maroon colours in Unit 3 are not characteristic of Earn Group, the coarse clastic component of Unit 3 lithologically resembles Earn Group rocks. Older strata with similar colours in the miogeocline occur in the latest Precambrian to Cambrian Narchilla Formation of the Hyland Group (Gordey and Anderson, 1993). Gordey and Anderson (1993) identified an area in northeast Tay River map area (105K) approximately 100 km northeast of Rose Mountain, where Earn Group rests unconformably on Hyland Group strata. The Hyland and overlying Road River strata would be a reasonable source for the material constituting Unit 3. The suggested southwest transport direction, however, does not correspond to sparse paleocurrent indicators from Earn Group in the Nahanni map area (105I) which indicate a general southeast transport direction for Earn Group conglomerates and sandstones.

Figure 10. *Chert pebble conglomerate in Unit 4 - Earn Group.*

Unit 3 also cannot be readily correlated with stratigraphy in Yukon-Tanana Terrane (cf. Mortensen, 1992; Murphy, 1998), Sylvester allochthon (Nelson and Bradford, 1993), or Campbell Range belt (Plint and Gordon, 1997), all of which have at various times been considered possible extensions of the Anvil allochthonous rocks.

UNIT 4 - EARN GROUP

A dark grey to black, mixed unit consisting of interbedded noncalcareous silty argillite, sandstone, shale chip breccia, chert pebble conglomerate, phyllitic bedded chert, pale green phyllitic bedded chert, and stratiform barite constitutes Unit 4. These rock types are interbedded on a scale of centimetres to tens of metres. Proportions of the different lithologies within Unit 4 vary greatly both laterally and vertically. The unit is readily recognized from a distance because the various carbonaceous rock types weather with a characteristic pale grey to bluish grey surface coating.

Black, silty argillite with lesser black bedded chert is the dominant rock type. Bedded cherts are rhythmically bedded with 5-20 cm thick black chert bands alternating with thin dark grey to black argillite interbeds. The NW area consists almost entirely of argillite and/or bedded chert. The lower part of Unit 4 in one exposure in the NW area consists of a 60 m interval with black siliceous argillite alternating with medium to dark grey, finely laminated limestone; individual beds range up to 30 cm in thickness. The limestones have been sampled for possible microfossils.

Chert pebble conglomerate successions, interbedded with thin argillite intervals, range up to 50 m in thickness. Typically the conglomerates contain predominantly dark grey to black chert, light to dark grey siltstone, and lesser pale grey to white chert clasts in a sandy to silty matrix (Fig. 10). Clasts are flattened within the S_1 foliation and may range up to 10 cm in length, although 1-2 cm lengths are most common. Thick conglomerate beds are restricted to the lower half of Unit 4 in the SE area; thin conglomerate beds occur through the entire unit in the SE area. Only one 2 m thick conglomerate was noted in the NW area. Commonly the conglomerates are interbedded with shale chip breccias which contain dark to light grey flattened siltstone clasts in a silty argillite matrix. At the base of Unit 4 in the SE area, the conglomerate and shale chip breccia include pale green argillite and/or chert clasts and are interbedded with pale green argillite, chert, and shale chip breccia. Exposures of dark grey quartzite up to 3 m high also occur in the basal part of Unit 4 in the SE area.

In the SE area, Unit 4 contains two stratiform to nodular barite horizons (Yukon Minfile 105K 106, URN) separated by a stratigraphic interval of approximately 600 m. Both barite horizons occur within pale cream to silvery green phyllitic bedded chert intervals ranging up to 40 m in thickness. No pyrite is visibly associated with the barite. The barites contain the same pervasive S_1 deformation foliation as the enclosing cherts and argillites (Fig. 11). Both horizons have previously been sampled for possible use in drilling mud (Franzen, 1978; Read, 1982). The major gangue mineral with the barite is quartz, and the barite would have to be concentrated for industrial drilling mud use. The barite occurrences have been sampled for sulphur isotopic analysis.

In the Rose Mountain area, Unit 4 ranges in thickness from 300 to 900 m. The upper contact with the overlying Unit 5 is conformable. In the SE area the contact is sharp, and in the NW area the contact is transitional with interbedding of lithologies for a 20 m interval. The contact is placed at the top of the last dark grey to black bed. The lower contact is transitional in both the NW and SE areas with interbedding of lithologies for an interval ranging up to 20 m in thickness. The contact is placed at the lowermost interval with argillite and/or the silty matrix in conglomerate being dark grey to black.

Unit 4 is correlated with the middle Devonian to Mississippian Earn Group (Gordey et al., 1982) on the basis of lithologic similarity and stratigraphic position. The pale grey weathering colours, coarse clastic lithologies, and presence of stratiform barite are typical. The same unit as described by Gordey (1990) and Jennings and Jilson (1986) is also present on the northeast side of the Anvil Batholith. Previously, Tempelman-Kluit (1972) and Gordey (1990) included the rocks here assigned to Unit 4 in the Anvil Range Group.

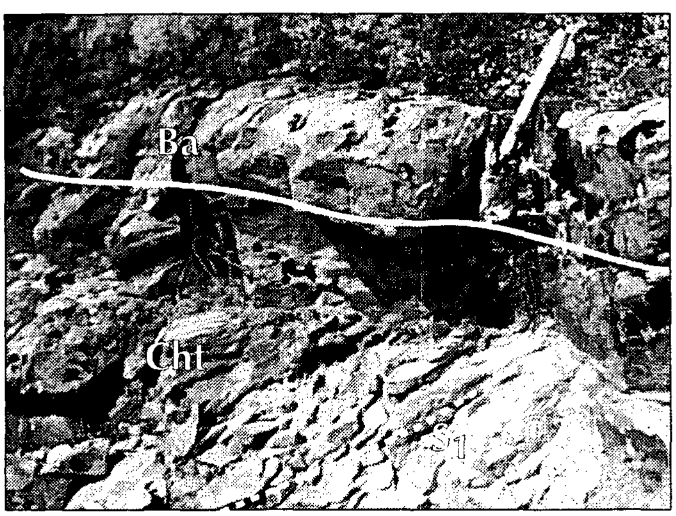


***Figure 11**. Lower barite horizon in Unit 4 - Earn Group. Ba is barite, and cht is chert. Foliation (S_1) is shown by the dashed line.*

UNIT 5 - MOUNT CHRISTIE FORMATION

Pale green, noncalcareous, bedded, phyllitic cherts constitute Unit 5. The chert beds are 5 to 15 cm thick and alternate with pale green argillite interbeds (Fig. 12). Unit 5 typically weathers orange brown; locally it contains an intense dark brown manganese oxide surface staining.

The pale cherts contain minor intervals of dark grey to black chert and argillite up to 15 m thick. Locally, the upper portion of Unit 5 contains thin to thick interbeds of maroon to dark red argillite and lesser chert. The proportion and thickness of these reddish interbeds changes rapidly along strike; in the NW area the red beds are not present and in the SE area they are slightly over 60 m thick.

Both upper and lower contacts are conformable. The upper contact is transitional with interbedding of cherts and the overlying volcanic rocks of Unit 6. The lower contact is also transitional with local interbedding of dark grey to black chert with pale green chert over a 20 m interval. Unit 5 is approximately 420 m thick.

Tempelman-Kluit (1972, 1979) collected latest Pennsylvanian or earliest Permian fusulinids and Pennsylvanian conodonts from a thin limestone bed approximately 60 m below the upper contact of Unit 5 in the SE Rose Mountain area. On the northeast side of Anvil Batholith, the rocks correlative with Unit 5 are described by Gordey and Anderson (1993) as thin-bedded, light grey green to black chert of the middle Pennsylvanian Mount Christie Formation. The Mount Christie Formation does not contain red or maroon cherts and argillites, but is equivalent to a green and red slate with minor chert unit in Dawson map area (Unit 14 of Tempelman-Kluit (1970). Previously Tempelman-Kluit (1972) and Gordey (1990) included the rocks here assigned to Unit 5 in the Anvil Range Group. On the basis of age and lithologic similarity, Unit 5 is herein correlated with Mount Christie Formation.

***Figure 12**. Bedded, pale cream phyllitic chert of Unit 5 - Mount Christie Formation.*

UNIT 6 - ANVIL RANGE GROUP BASALT

Dark green, massive, aphanitic basalts which weather to a dark reddish brown characterize Unit 6 in the Rose Mountain area. Breccia textures with subangular to rounded clasts of basalt in a dark green to reddish green, aphanitic matrix are locally visible (Fig. 13). Patchy epidote alteration locally gives the basalt a medium green colouration. Foliation within the basalt is rarely visible.

The lower contact is conformable with some transitional interbedding of basalt with chert. The upper contact of Unit 6 was not observed. Tempelman-Kluit (1972, 1979) included the rocks here assigned to Unit 6 as part of the Anvil Range Group and considered them to be Permian. Exposures of this unit occur along a southeast trend with a strike length of at least 50 km (Gordey and Irwin, 1987).

Rocks equivalent to Unit 6 have not been observed northeast of Anvil Batholith, nor have they been recognized elsewhere in North American miogeocline stratigraphy (Abbott et al., 1986). Tempelman-Kluit (1979) correlated Unit 6 with basalts and ultramafic rocks of Anvil allochthon, a major obducted oceanic ophiolite assemblage, on the basis of age and lithologic similarity. Other regions correlated with Anvil allochthon and therefore consistent with Unit 6 are in Campbell Range belt (cf. Plint and Gordon, 1997) and Sylvester allochthon (cf. Nelson and Bradford, 1993).

SUMMARY AND DISCUSSION

Units 1 through 6 form a consistent, mappable succession over 10 km in strike length and approximately 2000 m in structural thickness. The units range in age from Ordovician to Permian. Within this succession units 3 through 6 have transitional contacts indicating they also form a stratigraphic succession without any internal structural discontinuity. The contact between Unit 3 and Unit 2 is not exposed; its structural nature is unknown.

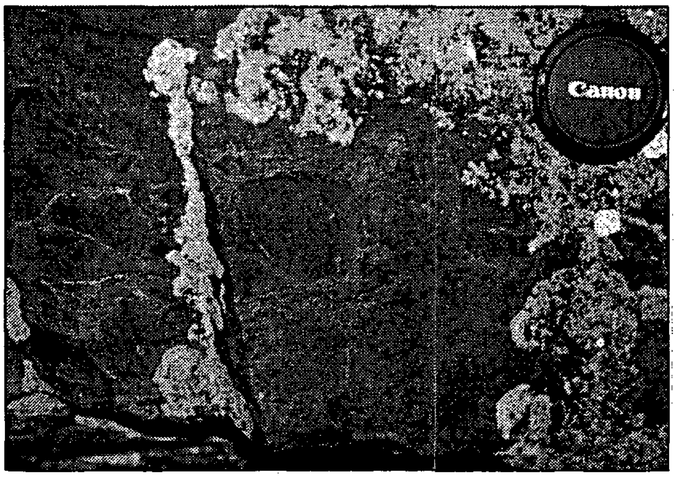


Figure 13. Auto-brecciated metabasalt of Unit 6 - Anvil Range Group.

Units 1 and 2 have been correlated with Lower Paleozoic North American regional miogeocline stratigraphic units. Units 4 and 5 are also confidently correlated with Earn Group and Mount Christie Formation of the North American miogeocline, respectively. The lithologic similarity of these units to ancestral North American regional stratigraphy suggests that the entire Rose Mountain succession from Units 1 through 6 should be considered as a concordant package of units deposited on the ancient North American margin.

Unit 3 is inconsistent with correlation to regional stratigraphic units in both the North America miogeocline and Yukon-Tanana Terrane. It occurs above the Ordovician to Silurian Duo Lake Formation and below the Devonian to Mississippian Earn Group. If the Rose Mountain succession is intact, Unit 3 should be considered Silurian to Devonian in age. It would possibly correlate with bioturbated, pale grey siltstones of the Steel Formation (Gordey and Anderson, 1993). Alternatively it would possibly correlate with Earn Group strata with the source provenance for the coarse clastics and maroon metasediments within Unit 3 being Hyland Group. Because of the intimate intermixing of pale and dark grey lithologies at the upper contact of Unit 3, and the occurrence of typical Earn Group coarse clastic lithologies within Unit 3, I would favour the latter interpretation.

Units 3 through 6 have previously been interpreted as allochthonous Anvil assemblage thrust northeastward over the Road River Group (Unit 2) and Menzie Creek formation (Unit 1) of North American affinity (Gordey, 1990). If the Rose Mountain succession is entirely North American stratigraphy, the structural necessity for a large displacement thrust fault is removed. The allochthonous Anvil terrane is therefore not present atop North American terrane. Similarly, in the Finlayson area, about 190 km to the southeast, Murphy (1998) suggested that allochthonous Anvil assemblage may actually represent intrusive sills within Yukon-Tanana Terrane. Further work is needed to determine the true nature and provence of the Anvil assemblage.

Unit 6, with no correlative unit within ancestral North American stratigraphy, is most similar in age and lithology to mafic volcanics in Campbell Range belt and in the Sylvester allochthon. Unit 5 also appears similar to rocks in Campbell Range belt and in Sylvester allochthon. In these locations, the correlative units are mapped and interpreted as the suspect Slide Mountain Terrane. The dual correlative nature of Units 5 and 6 in Rose Mountain area suggests the possibility that by Pennsylvanian time, North America and Slide Mountain basements were contiguous so that subsequent units were deposited as an overlap assemblage.

YUKON MINFILE
YUKON GEOLOGY PROGRAM
WHITEHORSE

MINFILE: 105K 106
NAME: URN
DEPOSIT TYPE: SEDEX
STATUS: DRILLED PROSPECT
TECTONIC ELEMENT: SLIDE MOUNTAIN TERRANE

NTS MAP SHEET: 105K\5
LATITUDE: 62° 19' 28" N
LONGITUDE: 133° 30' 49" W

OTHER NAME(S):
MAJOR COMMODITIES: BARIUM
MINOR COMMODITIES:
TRACE COMMODITIES:

CLAIMS (PREVIOUS & CURRENT)

WORK HISTORY

Staked as Urn cl (YA19142) in Jul/77 by Cyprus Anvil Mg Corp, which explored with mapping and sampling in 1977 and 1978, and added more Urn cl (YA51584) in Sep/80. The property was sold in 1985 to Curragh Res L.

GEOLOGY

Ten barite showings, representing two or three horizons from 5 to 12 m thick, occur over a strike length of 3.7 km in phyllitic chert of the Permo-Pennsylvanian Anvil Allochthonous Assemblage. A sample across the best showing, which is partly exposed over an area of 60 by 25 m, returned 79.2% $BaSO_4$ across 21.5 m. Specific gravity is 3.94 and silica (the main impurity) results in a product that is below shipping grade.

REFERENCES

CYPRUS ANVIL MINING CORP., Jan/82. Assessment Report #091369 by W.S. Read.

MINERAL INDUSTRY REPORT 1977, p. 67; 1978, p. 43.

YUKON EXPLORATION AND GEOLOGY 1982, p. 144.

YUKON MINFILE
YUKON GEOLOGY PROGRAM
WHITEHORSE

MINFILE: 105K 018
NAME: TAKU
DEPOSIT TYPE: UNKNOWN
STATUS: DRILLED PROSPECT
TECTONIC ELEMENT: SLIDE MOUNTAIN TERRANE

NTS MAP SHEET: 105K\6
LATITUDE: 62° 17' 56" N
LONGITUDE: 133° 26' 55" W

OTHER NAME(S): URN, GAL, EAGLE
MAJOR COMMODITIES:
MINOR COMMODITIES:
TRACE COMMODITIES:

CLAIMS (PREVIOUS & CURRENT)

WORK HISTORY

Staked as Taku cl (Y1909) in Mar/66 by Richore Gold ML and Peerless Can EL. The northwest end of the claim block was restaked as Eagle cl (Y12335) in Mar/67 by Eagle Head ML. Richore conducted a magnetometer survey and soil sampling program in Jun/67 but an attempt to drill in September had to be abandoned due to weather. Eagle Head conducted a limited prospecting, soil sampling and magnetometer program.

Cyprus Anvil drilled one hole (230.7 m) 1.6 km to the northeast on claim Gal 85 (92384) and restaked this target as part of a 124 claim block of Urn cl (YA19142) in Jul-Sep/77. Control of Cyprus Anvil was sold to Hudson's Bay O & GL and subsequently to Dome Pet L in 1981. Dome's interest was sold in 1985 to Curragh Res Inc. In Nov/94 Anvil Range Mining Corp. acquired all claims owned by Curragh following the bankruptcy of the latter.

Restaked as Our Claim (YB57992) by D. Templeman-Kluit and J. McDonald in Jul/95.

GEOLOGY

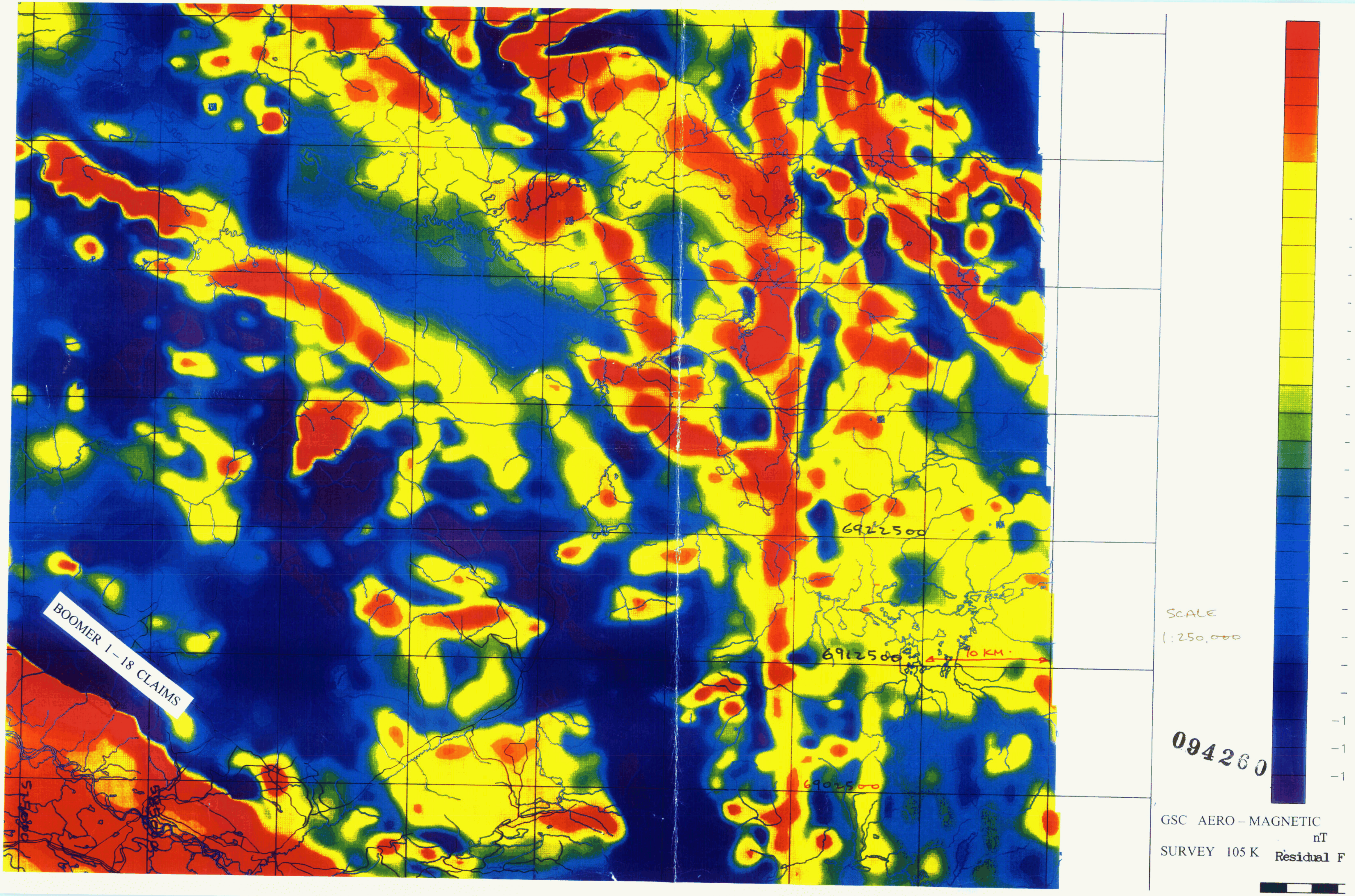
The claims cover the faulted contact between two allochthonous assemblages: Permo-Pennsylvanian basalt, tuff and breccia of the Anvil Assemblage and serpentinite of the Carboniferous to Triassic Nisutlin Assemblage. No mineralization was found.

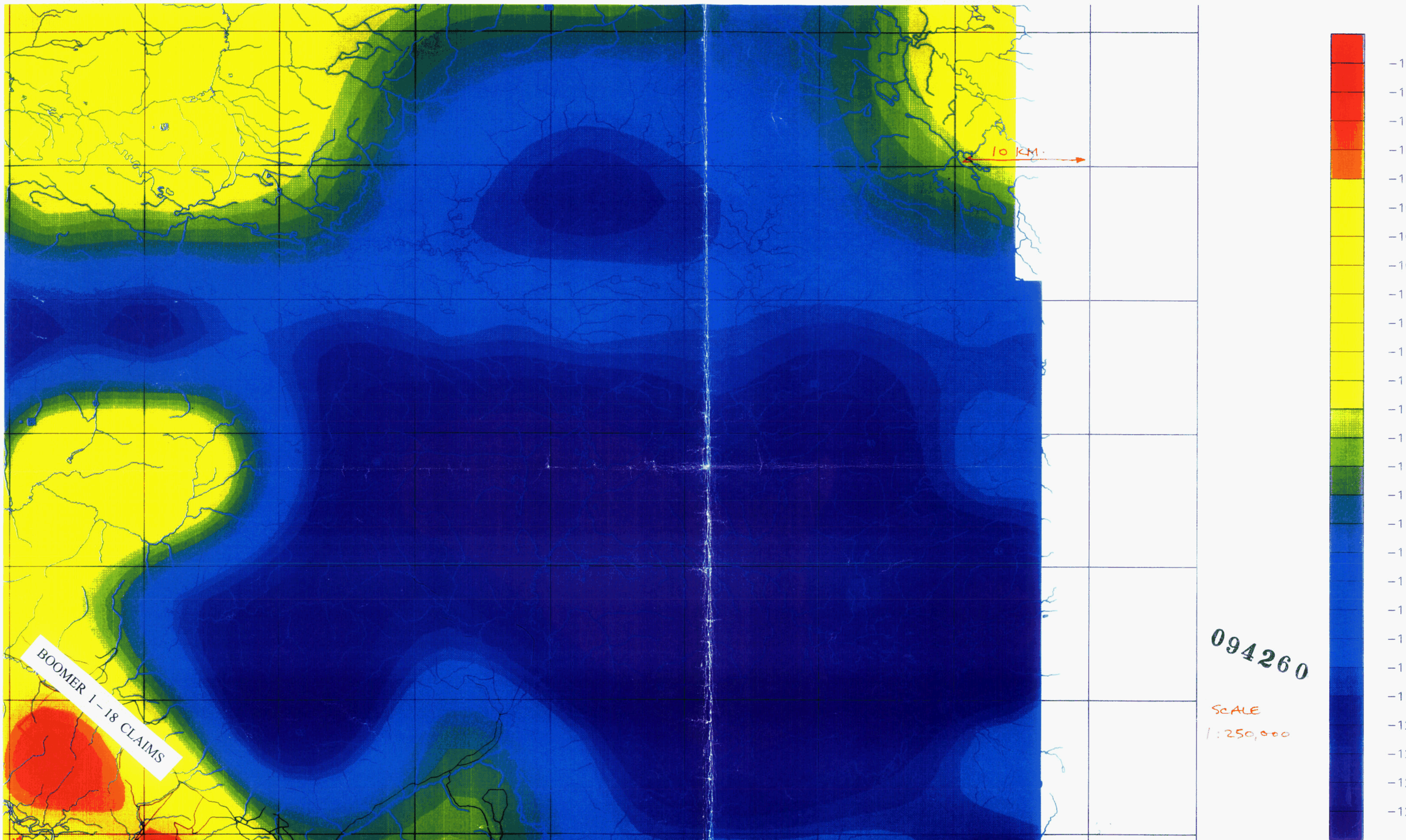
REFERENCES

EAGLE HEAD MINES LTD, Oct/66. Prospectus Report by A.R. Archer.

RICHORE GOLD MINES LTD, Jun/66. Engineer's Report by R.J. Cathro.

RICHORE GOLD MINES LTD, Jul/67. Assessment Report #018997 by J.C. Shaw.


BOOMER 1 – 18 CLAIMS
6922500
6912500
10 KM
6902500
SCALE
1:250,000
094260
GSC AERO – MAGNETIC
SURVEY 105 K
nT
Residual F

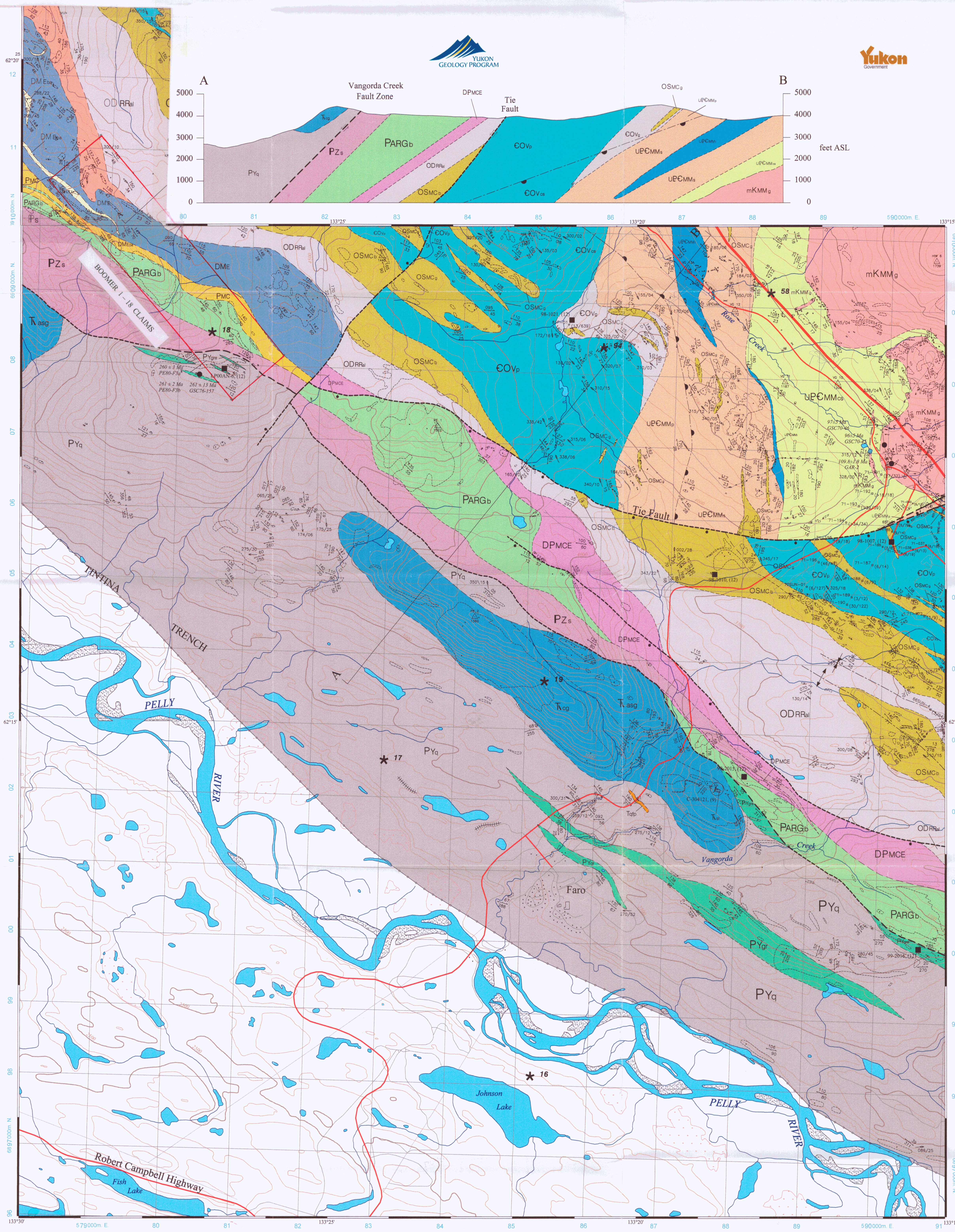


GSC BOUGUER GRAVITY SURVEY 105 K

mGal

YUKON GEOLOGY PROGRAM

Yukon Government



105K/3 NW & 105K/6 SW

YUKON TERRITORY

SCALE 1:25 000

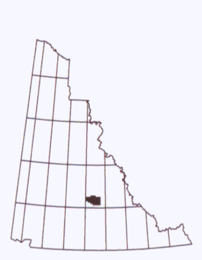
Miles 1 0 1 Milles

Metres 1000 0 1000 2000 Mètres

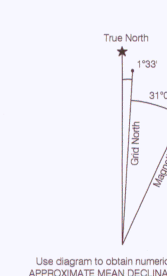
CONTOUR INTERVAL 100 FEET
Elevations in feet above Mean Sea Level
North American Datum 1983
Transverse Mercator Projection

Topographic base produced by SURVEYS AND MAPPING BRANCH DEPARTMENT OF ENERGY, MINES AND RESOURCES

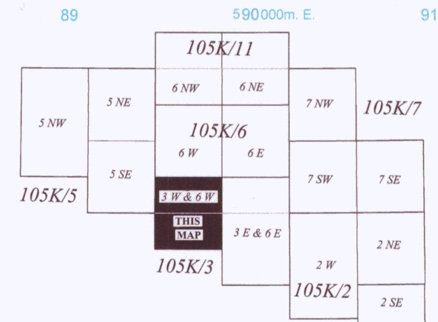
ONE THOUSAND METRE
Universal Transverse Mercator Grid
ZONE 8



YUKON INDEX MAP

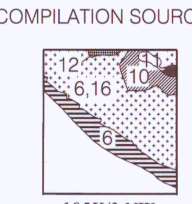


Use diagram to obtain numerical values
APPROXIMATE MEAN DECLINATION 1972
FOR CENTRE OF MAP
Annual change decreasing 4.0'



ANVIL PROJECT INDEX MAP

COMPILATION SOURCES



105K/3 NW
105K/6 SW

LEGEND

TERTIARY

Tqfp White-weathering, aphanitic to fine-grained, locally flow-banded quartz-feldspar porphyry.

CRETACEOUS

ANVIL PLUTONIC SUITE

mKUg Grey, resistant, generally medium- to coarse-grained, locally megacrystic, undifferentiated granite to granodiorite.

mKMg Marjorie phase - biotite ± hornblende granite to granodiorite. Characterized by phenocrysts of smokey grey quartz and white feldspar.

mKOg Orchay phase - biotite ± hornblende granite to granodiorite.

mKMMg Mount Mye phase - biotite-muscovite granite. Locally foliated.

TRIASSIC

Ƚcg Resistant, massive, polymictic conglomerate. Clasts include quartzite, chert, limestone, and serpentinite. Matrix contains detrital muscovite.

Ƚsl Dark grey carbonaceous, locally calcareous shale or siltstone interbedded with medium to dark grey, fine-grained limestone.

Ƚch Grey, green, red, or black bedded chert.

Ƚasg Interbedded cherty argillite, chert, sandstone, and mafic greywacke or conglomerate.

Ƚb Massive, dark green, fine-grained to aphanitic basalt. Occurs within Vangorda Creek fault zone; may be equivalent to Anvil Range Group basalt.

PALEOZOIC

YUKON-TANANA COMPLEX

PYq Medium to dark grey, locally gritty, muscovitic meta-quartzite to quartzose schist. Contains bands of greywacke, gabbro, phyllite. Rarely contains eclogite lenses.

PYl Grey to tan, massive limestone or dolostone.

PYgr Medium to dark olive green, chloritic phyllite to amphibolite. Locally displays relict equigranular igneous texture. Locally includes ultramafic and/or eclogite (PYgre). Contains lesser beds of medium to dark grey muscovitic quartzite to quartzose schist.

PYog Granitic orthogneiss, locally with feldspar augen.

PZ Mafic and ultramafic rocks of the Vangorda Creek fault zone. Locally extensively sheared and serpentinized.
PZs - serpentinite; PZh - harzburgite; PZe - eclogite; PZg - gabbro; PZd - diabase; PZb - basalt

PERMIAN

ANVIL RANGE GROUP

PARGb Epidotized, locally hematitic, dark green, resistant, massive, poorly foliated basalt or brecciated basalt. Contains lesser grey, green, red, and black bedded chert and pale green epivolcaniclastic sandstone or conglomerate.

PENNSYLVANIAN

MOUNT CHRISTIE FORMATION ?

PMC Pale green, tan-weathering, bedded phyllitic chert interbedded with lesser maroon chert and argillite, especially near top of unit. Also contains minor black bedded chert, black chert pebble conglomerate, siltstone, limestone and argillite. May be broadly similar to and lithologically equivalent to Mount Christie Formation.

DEVONIAN-PENNSYLVANIAN

UNDIVIDED MOUNT CHRISTIE FORMATION and EARN GROUP

DPMCE Dark grey to black, pale green, and maroon, noncalcareous argillite and bedded chert with lesser grey siltstone, sandstone, chert pebble conglomerate, and limestone.

DEVONIAN-MISSISSIPPIAN

EARN GROUP

DME Dark grey to black, noncalcareous, siliceous argillite and bedded chert with lesser grey siltstone, sandstone, chert pebble conglomerate, and rhythmically bedded limestone.

DMEba Silvery cream, tan-weathering, bedded phyllitic chert with light grey barite beds.

DMEg Pale green, noncalcareous argillite and bedded chert with lesser pale green shale chip and siltstone breccia, medium to dark grey sandstone, and grey to green chert pebble conglomerate. Locally contains maroon argillite and bedded chert, especially near bottom and top of unit.

ORDOVICIAN-DEVONIAN

UNDIVIDED ROAD RIVER GROUP

ODRRal Dark grey to black argillite with lesser medium to pale grey siltstone and fine sandstone, medium grey limestone, and basalt flows. Upper part of unit locally contains middle Devonian limestone beds with 2-hole crinoid macrofossils. Includes Duo Lake Formation and unnamed Devonian sedimentary rocks. Steel Formation is not present.

QUARTZ ARENITE and DOLOSTONE

ODqd Massive, medium-grained, quartz arenite interbedded with pale tan-weathering limestone or dolostone. Interbedded with units OSDL, ODRRal, and OSMCb.

ORDOVICIAN-SILURIAN

ROAD RIVER GROUP

STEEL FORMATION

Ss Tan- to orange-weathering, dolomitic, bioturbated, silty mudstone. Not differentiated southwest of the Anvil Batholith.

DUO LAKE FORMATION

OSDL Dark grey to black, graptolitic argillite. Contains lesser medium to pale grey siltstone and fine sandstone, medium grey limestone, and basalt flows.

MENZIE CREEK FORMATION

OSMCb Undivided dark grey green, foliated basalt. Includes massive and pillowed, locally amygdaloidal flows and heterolithic or monolithic breccias with lesser limestone, argillite, and tuff. Interbedded with undivided Road River Group (ODRRal), Duo Lake Formation (OSDL), ODqd, and Vangorda formation (COV).

OSMCbp Dark grey green, locally amygdaloidal, massive and pillowed basalt with minor monolithic basalt breccia, volcaniclastic sandstone, siltstone, and tuff. Interbedded with undivided Road River Group (ODRRal), Duo Lake Formation (OSDL), ODqd, and Vangorda formation (COV).

OSMCbbx Dark grey green, monolithic basalt breccia with lesser volcaniclastic sandstone, siltstone and tuff, and massive and pillowed flows. Interbedded with undivided Road River Group (ODRRal), Duo Lake Formation (OSDL), ODqd, and Vangorda formation (COV).

OSMCld Grey to off-white limestone locally interbedded with orange-weathering dolostone.

OSMCg Dark green, locally magnetic, coarse- to fine-grained, massive to foliated gabbro. Subvolcanic dykes and sills to Menzie Creek basalts (OSMCb) in Vangorda (COV) and Mount Mye (uPCMM) formations. Enclosing phyllites locally display thin contact metamorphic aureoles.

OSMCpx Dark green, locally magnetic, coarse-grained, massive to foliated, variably serpentinized pyroxenite. Subvolcanic dykes and sills to Menzie Creek basalts (OSMCb) in Vangorda (COV) and Mount Mye (uPCMM) formations. Enclosing phyllites locally display thin contact metamorphic aureoles.

CAMBRIAN-ORDOVICIAN

VANGORDA FORMATION

ЄOVp Soft, silvery grey, calcareous phyllite with lesser medium crystalline grey marble (COVl), dark grey to black phyllite (COVg), and dark green gabbro sills and dykes (OSMCg). Greenschist facies equivalent of calc-silicate (COVcs). Regionally correlated with Rabbitkettle Formation.

ЄOVcs Pale green and dark purplish brown, thinly banded calc-silicate with lesser black schist (COVg), marble (COVl), and dark green gabbro dykes and sills (OSMCg). Amphibolite facies equivalent of calcareous phyllite (COVp). Regionally correlated with Rabbitkettle Formation.

ЄOVg Black, locally calcareous, carbonaceous phyllite or schist. Commonly contains thin quartzose siltstone interbeds. Interbanded with dark green gabbro dykes and sills (OSMCg).

ЄOVl Pale to dark grey, foliated limestone to marble.

UPPER PROTEROZOIC-CAMBRIAN

MOUNT MYE FORMATION

uPЄMMp Brownish grey, noncalcareous, pervasively foliated phyllite. Locally indistinctly bedded. Contains minor siltstone, limestone/marble, calc-silicate, and carbonaceous phyllite beds and dark green gabbro dykes and sills. Regionally correlated with Gull Lake Formation.

uPЄMMs Brownish grey, noncalcareous, pervasively foliated muscovite-biotite schist. May contain staurolite, garnet, andalusite, or fibrolite. Locally indistinctly bedded. Contains minor siltstone, limestone/marble, calc-silicate, and carbonaceous phyllite beds and dark green gabbro dykes and sills. Regionally correlated with Gull Lake Formation.

uPЄMMcs Interbanded pale green calc-silicate and purplish brown biotite phyllite. Contains thin, medium to dark grey marble and silicated marble beds and dark green gabbro dykes and sills. Lithologically similar to Vangorda calc-silicate.

uPЄMMl Dark to pale grey, medium crystalline marble. Typically contains abundant boudins of calc-silicate and/or quartz. Locally contains coarsely crystalline garnet-pyroxene skarn.

uPЄMMg Black phyllite to schist. Locally contains lenses and beds of black carbonaceous limestone and dark green gabbro dykes and sills.

SYMBOLS

Geological contact (defined, approximate, assumed)

Fault or vein-fault, displacement unknown (defined, approximate, assumed)

Thrust fault (defined, approximate, assumed, teeth on hanging wall)

Normal fault (defined, approximate, assumed, dot on downthrown side)

Strike-slip fault (defined, approximate, assumed)

Fold surface axial trace (upright anticline, syncline, overturned anticline, syncline)

Metamorphic boundary (symbol on higher grade side) — schist / phyllite

Bedding (tops not known) — 090 / 20

Foliation (one tick indicates earliest phase of deformation, two or more ticks indicate subsequent phase(s) of deformation) — 090 / 20, 090 / 20

Foliation (phase of deformation unknown) — 090 / 20

Lineation (one arrow indicates earliest phase of deformation, two or more arrows indicate subsequent phase(s) of deformation) — 045/05, 045/05

Joint — 090 / 20

Igneous compositional banding — 090 / 20

Igneous mineral lineation — 045/05

Fault plane orientation, shear band (C-bands) orientation — 090 / 20

Shear band plane of flattening (S bands) — 090 / 20

Mineral lineation/rodding associated with shear bands — 045/05

Apparent dip of measured bedding, foliation (in cross-section)

Foliation form lines in cross-section

Limit of outcrop, subcrop

Projection to surface of mineral resource

Limit of mapping

Isotopic age determination sample location and age includes radiometric age, 2 sigma error, and sample number — *69.3 ± 0.5 Ma GSC70-45*

Fossil sample, includes sample number and reference — GC-98-05, (1)

Geochemical sample-whole rock with major oxides, minor and trace elements, includes assay number and reference — A098, (1)

Survey control station with station name and elevation (in metres) — HIW10 1500

Diamond drill hole collar (overburden depth/ total depth) in metres — 70X-01 (15/100)

Rotary drill hole collar (overburden depth/ total depth) in metres — 70RH-01 (15/100)

Field station

Trench

Line of cross-section — A B

MINERAL OCCURRENCES Yukon MINFILE (1997)			
105K 16	*	BRIDGE (MAG, TED)	Exploration Target
105K 17	*	FAN-TAN	Exploration Target
105K 18	*	TAKU	Exploration Target
105K 19	*	GLYN (WEDGE)	Exploration Target
105K 58	*	KIM	Exploration Target
105K 94	*	CESSNA	Exploration Target

FOSSILS

GSC Location No.	Material	Age Range	Ref
C-304121	conodont	Late Triassic, Early? Norian	(9)

ISOTOPIC AGE DATES

Sample	Date	System	Mineral	Comments	Ref
GSC76-157	258±13 Ma	K-Ar	muscovite	metamorphic cooling age	(16)
PE80-F3a	260±3 Ma	Ar-Ar	muscovite	metamorphic cooling age	(1)
PE80-F3b	261±2 Ma	Ar-Ar	muscovite	metamorphic cooling age	(1)
GSC70-45	96±5 Ma	K-Ar	muscovite	intrusion cooling age	(15)
GSC70-46	97±5 Ma	K-Ar	biotite	intrusion cooling age	(15)
GAR-2	109.8±1.8 Ma	U-Pb	monazite	intrusion age	(8)

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RECOMMENDED CITATION

Pigage, L.C., 2001. Geological map of Faro (NTS 105K/3 NW) & Mount Mye (NTS 105K/6 SW), central Yukon (1:25 000 scale). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Open File 2001-26.

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Yukon Region

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Geological Map of Faro (NTS 105K/3 NW) & Mount Mye (NTS 105K/6 SW), Central Yukon (1:25 000 scale)

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