Kangaroo Exploration Corporation

MOUNT MYE PROJECT

GEOLOGY

May 1973

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ORIGINAL

CONTENTS

INTRODUCTION

The purpose of this report is to present a complete account of the detailed geological mapping on the Mount Mye Property during 1972, and specifically to discuss the implications of the mapping that were omitted from a previous report by the present author and J. G. Simpson, dated February 1973, that was submitted to fulfil assessment requirements on claims Taf 1-12. Hence the sections "Stratigraphy" to "Mineralization" are repeated from that report, and the omissions are included in the section "Discussion".

Other exploration activities in 1972 are the subject of reports by G. A. Jilson and P. E. Walcott & Associates Ltd. and will not be referred to here. Location, access, physiography, vegetation, drainage and claims have been documented on these and previous reports, and are not discussed.

PREVIOUS WORK

Previous company geological work on the property has been rudimentary. Government work of a regional nature is referred to below. The complexity of the structural history of the area was realized when Cyprus began work, and reconnaissance mapping at 1 inch to 1/2 mile in 1971 by G. A. Jilson provided preliminary structural data and a lithological map which has needed very little revision. Jilson's constructive comments in the field and office have added considerably to the content of this report.

REGIONAL GEOLOGY

In very general terms, the mapped area lies on the north flank of the Anvil Arch (D. J. Tempelman-Kluit, 1972) in regionally metamorphosed sediments and volcanics of uncertain age (Paleozoic). The Anvil Batholith of Cretaceous radiometric age forms the core of the Arch, and the strongly metamorphosed rocks are in turn flanked by less metamorphosed eugeosynclinal sediments and volcanics.

The reader is referred to two Geological Survey of Canada publications (Roddick and Green, 1961 and Tempelman-Kluit, 1972) for conflicting geological descriptions of the area. The earlier work (mapping at four miles to the inch) has undergone stratigraphic revision in the light of new fossil discoveries made during the later mapping at two miles to the inch:-

1. It is now apparent that the Anvil Arch is flanked by both Triassic and Paleocene coarse immature sediments, implying uplift of the area in those times.

2. Fossils of Permo-Pennsylvanian, Upper Devonian-Mississippian, Middle Devonian and Ordovician-Silurian age have been found in the Arch between those flanking Triassic and Paleocene sediments.

The major sources of conflict lie in the age range of the metamorphic pile and the age of metamorphism. At one extreme (op. cit., 1972), the rocks are considered to be Hadrynian-Permian in age with one main metamorphism in the late Cambrian or early Ordovician. At the other (op. cit., 1961), the rocks span only the Devonian and Carboniferous, and were metamorphosed in the Permian.

In support of the latter hypothesis it is suggested that Permian metamorphism is compatible with formation of Triassic post-orogenic sediments, and rubidium-strontium isotope studies support homogenization of the sequence during the Permian (P. C. Lecouteur, personal communication).

Sulphur isotope studies on barytes from the Faro deposits support its formation in Cambrian seas (D. Sangster, personal communication).

DETAILED GEOLOGY

Stratigraphy

Detailed mapping has shown that the G.S.C. stratigraphic succession is, in fact, a metamorphic and structural gradient superimposed on different lithofacies which are, at least in part, stratigraphically correlatable. This superposition allows the areal classification of rock types as follows:-

Group I - in which depositional structures such as graded bedding, syn-sedimentary slumps, pillow structure, vesicles, etc., can be recognized. The rocks are of sub to low-greenschist facies metamorphic grade and are almost always foliated. Degree of development of foliation is a function of rock composition, ranging from a pervasive slaty cleavage in metapelites to absence of foliation in coarse basic igneous rocks and some pillowed varieties. The foliation is commonly lineated by both mineral alignment and crenulations, the latter occasionally giving rise to a crenulation foliation. A fracture cleavage probably equivalent to the crenulation foliation is sometimes present cross-cutting the early foliation in the more competent volcanic members of this group.

Group II - in which depositional structures are generally destroyed and foliation is usually pervasive and well developed. The cores of coarse-grained basic igneous bodies are notable exceptions, being massive. Metamorphism is sub-biotite grade in the greenschist facies. In pelitic rocks the crenulation foliation is dominant, the earlier foliation being represented by intrafoliate lithon structures.

Group III - in which lithon structure in pelitic rocks is rare and relic. Metamorphism is biotite, sub-garnet grade in the greenschist facies.

Group IV - in which lithon structure is absent, metamorphism is upper-greenschist/amphibolite facies (garnet and staurolite in pelites). The secondary crenulation foliation has become a pervasive schistosity in pelites, whereas calc-silicate gneisses and marbles retain an earlier gneissic banding.

The lithofacies on which these structural and metamorphic characteristics are superimposed are as follows:-

Group I - Dominantly volcanic with probable calc-alkaline affinities, i.e., andesitic with minor more acid and basic members. Minor sub-aqueous sediments and tuffaceous limestone.

Group II - Dominantly pelitic, but with a high percentage of volcanic material. Minor limestone.

Group III - Dominantly pelitic. Minor limestone and volcanic material.

Group IV - Dominantly pelitic, but with a high percentage of impure limy sediments. Minor volcanic material? (amphibolite lenses are noted in regional mapping (op. cit. 1972)).

Rock types mapped within the groups are as follows:-

GROUP I:

Unit 10. Massive crystalline limestone and fissile impure limestone, with tuffaceous bands.

Unit 9. Massive medium to coarse-grained metabasite of probable dioritic to gabbroic composition.

Unit 9v. Dark green vesicular metavolcanics. Limy inclusions imply destroyed pillow structure.

Unit 9p. As 9v but with recognizable pillow structures.

Unit 8v. Pale green vesicular metavolcanics, with possible relic phenocrysts. Probably of andesitic composition, but rare.

Unit 8p. Pale green, small, pillows in a dark chloritic matrix, associated with 8a. Rare.

Unit 8a. Pale green angular fragments of vesicular volcanic material in a dark green volcanic or orange limy matrix. Association with 8p implies that these rocks are andesitic pillow breccias - brecciated by the rapid quenching, in sea water, of a viscous magma.

Unit 8t. Metatuff, sometimes pisolitic but without recognizable bedding.

Unit 8ta. Sub-aqueous siliceous tuff with fine graded bedding. Occasional syn-sedimentary slumps are recognizable.

Unit 7t. Fine-grained, buff,tuffaceous sediments.

Unit 6s. Medium-grained, grey, fine banded, quartzose pelite.

Unit 6b. Alternating beds of buff metasiltstone and grey limy slate, probably indicating turbidite or flyschoid deposition. Beds are generally from 1 inch to 1 foot thick.

Unit 5g. Graphitic banded slate, exposed just off the mapped area to the north.

GROUP II:

Unit 10. Impure marble and slaty marble, with calc-silicate stringers outlining the foliations. Strain in these rocks is markedly heterogeneous giving rise to bands with well-developed secondary foliation separating "mesolithons" (outcrop scale) with close to isoclinal folds in the early foliation and a weakly developed secondary cleavage.

Unit 9. As in Group I. Analysis of Unit 9 from Eagle's Nest Ridge (Fig. 2) by the G.S.C. (op. cit. 1972) indicates a basic rock (46% SiO_2). Very low CaO and high alkali and TiO_2 contents imply spilitic affinities, and hence that this coarse basic body might be a sill intruded into unconsolidated marine sediments.

Unit 8. Generally pale to medium green, well foliated greenstone with dominant early foliation and later crenulation foliation. Some siliceous varieties have a banding, similar to Unit 8ta, parallel to the early foliation and controlling later mesolithon development.

Unit 7. Buff, fissile, phyllitic rock probably representing highly sheared Unit 8a and metamorphosed Units 7t and 8t.

Unit 6. Dominantly chlorite-sericite phyllite with a crenulation cleavage and micro to mesolithon structures. Often very limy giving a thinly laminated (1 mm) lime - phyllite rock and consequent development of a widely spaced crenulation foliation. The presence of numerous electromagnetic conductors in this unit indicates that graphitic members are present.

Unit 5. Highly contorted quartzose, graphitic phyllite. Significantly, this rock type outcrops and is traceable by electromagnetic methods along the northeastern and southwestern boundaries of Group II, but not always coincident with those boundaries. It is very likely that metamorphic and structural differences between Groups I, II and III/IV are due to heat dissipation and slip along Unit 5 horizons.

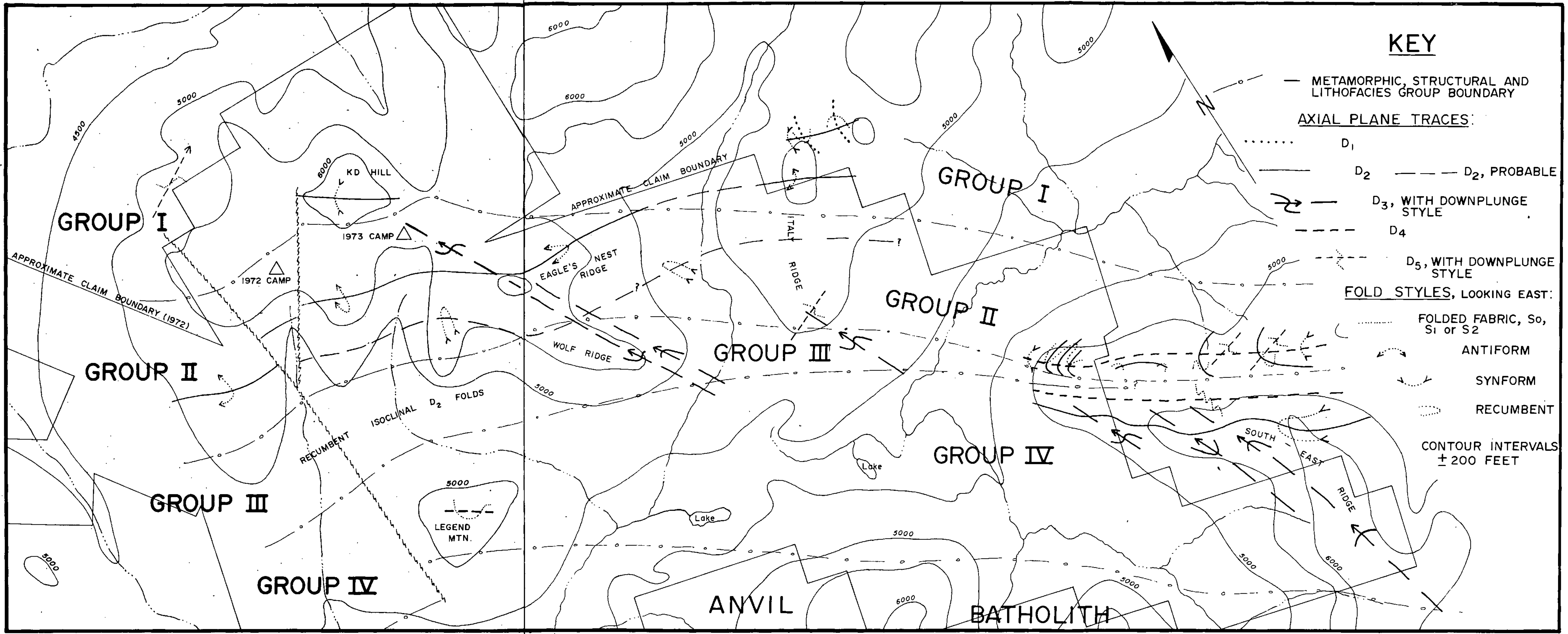

FIG. 2 : METAMORPHISM, STRUCTURE, LITHOFACIES, NOMENCLATURE

SCALE: 1" = 1/2 MILE. P.F.L. FEB. 1973

GROUP III:

Unit 4. Impure marble and very limy phyllite with early foliation transposed parallel to the later foliation.

Unit 3. Actinolitic schist and gneiss. Actinolite needles are randomly oriented on the foliation surfaces, which are parallel to the later foliation.

Unit 2. Chloritic schist and phyllite with pervasive secondary foliation.

Unit 1. Coarse quartzose phyllite with abundant quartz rodding. Quartz rods are the remnant noses of rootless isoclinal folds in vein quartz injected along or "sweated out" along the early foliation. The later foliation is almost pervasive, but rare relic microlithons showing the earlier foliation can be found.

GROUP IV:

Unit D. Interbanded marble and calcite-diopside-quartz gneiss, with early gneissic banding.

Unit C. Calc-silicate gneisses and associated rock types comprising:

Unit Ca. White, sugary-textured diopside-quartz gneiss.

Unit Cb. Green to black and white banded gneiss. White bands are of Unit Ca, green to black bands are of tremolite/actinolite-graphite-quartz gneiss.

Unit Cc. Grey and buff banded gneiss, as Cb, and blocky grey biotite-quartz phyllite, some with quartz rodding, with very planar, pervasive second foliation (compare Unit Ba, contrast Unit 1).

Unit Cd. Black biotite-albite-graphite-quartz gneiss. Biotite is both aligned parallel to the foliation and cross-cutting foliation as late poikilitic books. New albite is overprinting a fine foliation in graphite and appears black in hand-specimen.

Unit B. Muscovite-biotite phyllite and schist with an extremely planar pervasive cleavage, axial planar to tight folds in quartz veins, which is overgrown by very large (up to 8 inches long), prismatic andalusite porphyroblasts with graphite inclusions and also by smaller biotite porphyroblasts.

Unit Ba. Biotite-quartz phyllite wtih blocky weathering, as Cc.

Unit A. Quartz-muscovite-biotite (garnet-staurolite) schist. Quartz veins forming the only vestige of the early foliation are folded in close to tight folds, in contrast with the rootless isoclines of Unit 1. This indicates that although the metamorphic grade of Unit A is higher, Unit 1 may have suffered a greater, post-early-foliation, strain.

Unit Aa. Black muscovite-biotite-albite-graphite-quartz schist, compare Unit Cd.

INTRUSIVE ROCKS:

Unit G. Foliated medium-grained granodiorite/quartz-monzonite and altered granitic material. Foliation is best developed near the contact with the country rock schists and gneisses, but almost always observable within the mapped area. Locally the foliation is kinked and lineated in directions consistent with structures in the host rocks (Legend Mountain). Granitic dykes near the contact (South-east Ridge) are folded in cuspate folds of the same orientation as folds in quartz veins in the surrounding schists, and the pervasive schistosity of the latter is seen to be refracted passing through the dykes. Some dyke material may be more strongly folded and cross-cut by later cuspate, less altered dykes. In thin section the rock is badly strained with much sub-grain development in quartz and undulose extinction. Some biotite and quartz has suffered metamorphic recrystallization as evidenced by the parallel orientation of platy non-euhedral biotite and elongate quartz. However, thick books of oriented euhedral biotite, granular quartz and oriented euhedral zoned plagioclase indicate mechanical orientation and crystallization from a melt. Muscovite is usually in very coarse books of random orientation, or on vein surfaces, and is evidently a late, hydrothermal product. The above evidence may indicate that the intrusive was emplaced at a late stage in the deformation and metamorphism which produced the pervasive later cleavage in the host schists. Argon-retention ages on the schists and the intrusive are 90-95 m.y. whereas emplacement is dated by combined field and radiometric methods as before 100 to 117 m.y. (op. cit., 1972). Hence the deformation and metamorphism that produced the later foliation in the Anvil Range metamorphic pile must be, in part at least, Mesozoic rather than Cambro-Ordovician (op. cit., 1972).

Unit H. Hornblende -plagioclase porphyry. Dykes of altered andesitic porphyry of consistent 060^{o} trend cut the batholith and adjacent host rocks. Hornblende is altered to chlorite, epidote, quartz and opaques, plagioclase to epidote, albite and quartz, and apatite is a minor constituent.

Unit P. Aplite. One dyke of sugary-textured felsic intrusive was noted in a swarm of Unit H dykes.

In summary, the mapped rocks consist of metamorphosed Palaeozoic sediments and volcanics with an overall increase in volcanic material to the northeast, and limy sediments to the southwest abutting against a Mesozoic granitic batholith. Deformational and metamorphic intensity increases to the southwest.

Structure

Outcrops of Group II phyllite, Unit 6, often show a planar crenulation foliation which is in turn crenulated in two statistically separate directions and kinked in a third separate direction. Such outcrops allow a classification of structural elements as follows:-

S_1 - the pervasive early foliation

S_2 - the later, crenulation, foliation

F_2 - the axial directions of the crenulations of S_1, usually given by the intersection of S_1 and S_2

F_3, F_4 - the axial directions of crenulations on or of S_2

F_5 - the axial direction of the kinking

D_{1-5} - the deformations giving rise to linear elements F_{1-5} and planar elements S_{1-5}

Rocks of Group I have S_1 dominant, and weak S_2 is seen to be axial planar to gentle to open, steeply inclined to upright folds of sub-horizontal plunge (F_2). (Note: Fold descriptive terms are after Fleuty, 1964). S_1 is seen to be axial planar to recumbent buckle folds with sub-horizontal plunge (F_1) and highly sheared limbs rich in orange carbonate. Thrusting is believed to have occurred along these sheared zones.

D_2 folds become tighter to the southwest. In Group II a close to tight antiform in greenstone is traceable for the length of the property and towards the boundary with Group III, major D_2 folds probably become isoclinal and recumbent, still with sub-horizontal plunge.

The relative timing of crenulations on S_2 is unknown. Both are locally associated with larger structures. D_3 folds are assymmetric, having shorter western limbs, but this assymmetry is not apparently associated with any regional D_3 structure.

Large D_4 folds result in the overturning of S_2 near the batholith. These folds have axial planes of variable dip from horizontal to vertical, and are probably cascade folds off the Anvil Arch, which is presumably a regional D_4 structure.

D_5 is assumed to be the latest deformation due to its brittle nature, and the uniform orientation of F_5.

Orientation data for structural elements can be summarized as follows:-

Group I:

F_1	- no preferred orientation, sub-horizontal plunge
S_1	- sub-horizontal
F_2	- $320^{\circ} \pm 20^{\circ}$, sub-horizontal doubly plunging
S_2	- $320^{\circ} \pm 20^{\circ}$, dipping 30-60° north
F_3, S_3	- not measurable
F_4, S_4	- not measurable
F_5	- $060^{\circ} \pm 10^{\circ}$, sub-horizontal to northerly plunging
S_5	- sub-vertical

Groups II, III, IV:

F_1, S_1	- not measurable statistically
F_2	- $320^{\circ} \pm 20^{\circ}$, sub-horizontal doubly plunging
S_2	- $320^{\circ} \pm 20^{\circ}$, dipping 0-30° north (before later modification)
F_3	- $350^{\circ} \pm 30^{\circ}$, variable northerly plunge
S_3	- sub-vertical
F_4	- $320^{\circ} \pm 20^{\circ}$, sub-horizontal doubly plunging
S_4	- sub-horizontal to $320^{\circ} \pm 20^{\circ}$, vertical dip
F_5	- $060^{\circ} \pm 10^{\circ}$, variable northerly plunge
S_5	- sub-vertical

Three fault sets have been inferred from the mapping:

1. The syn-D_1 thrusts and shears in Group 1, discussed above.

2. High angle to vertical faults, trending north-northwest in the plane of S_3 and associated with D_3 folds, apparently with the eastern block generally down faulted, and minor displacements.

3. Northeasterly trending faults and fractures, of minor displacement, very evident in the drainage of the map area and surrounds.

On the southern flank of the Arch, the Rose and Vangorda Creek Faults may be related to the syn-D_1 thrusts, whereas the Blind Creek and Faro No. 1 faults are examples of the northeasterly trending set.

In addition, movement has probably occurred on the graphitic horizons during deformation. This may account for the lack of Group III rocks on the South-East Ridge in the map area.

In summary, the structural history of the rocks described is the same as that described for the Anvil Mines open pit - two intense deformations giving a more or less flat-layered metamorphic pile, which has subsequently been arched and wrinkled by later stresses. D_2 and D_4 are considered equivalent in part, i.e., when S_2 was forming in Group I, it was probably being folded in Group IV. D_1 and D_{2-4} show very rapid changes in intensity and associated metamorphism across strike - D_1 probably because of D_{2-4} effects. D_3 is only locally important and D_5 effects can be ignored.

Metamorphism

Three periods of metamorphism are recorded in pelitic and calcareous rocks:-

1. Probable Permo - Pennsylvanian formation of a pervasive primary fabric ranging from a gneissic banding in calcareous rocks and coarse schistosity in pelites in the southwest to a slaty cleavage in pelites in the northeast.

2. Recrystallization of micas along an initially mechanically formed crenulation foliation of probable Cretaceous age. Amphibolite facies (staurolite, garnet) in the southwest decreasing rapidly to the northeast, where it is absent.

3. Cretaceous overprinting of 2. above with biotite, andalusite and albite porphyroblasts, often with preferred orientations of unknown significance. Radiometric dating by K-Ar methods probably record only this event, with argon retention at 100 - 80 m.y. The effect is confined to the southwest.

Note: re sections: Stratigraphy, Structure and Metamorphism

The main differences between the two mapped sheets are as follows:

Sheet 1: a) Well developed Groups I and III rocks - poorly developed to absent on sheet 2, which has well developed Group IV.

b) Presence of Units P, H, 8v, 8p, 6s and Group III rocks (1, 2, 3, 4) and absence of Units 7t, 6b and B - vice versa on sheet 2.

c) Apparent dislocation between Groups I and II, absent on sheet 2.

d) Very uniform orientation of D_5 elements and locally well developed D_3 structures, in contrast to better definition of D_1 and D_4 structures on sheet 2.

Mineralization

Two phases of Pb-Zn-Cu sulphide mineralization are noted:-

1. Pre-D_1, hence probably pre-Permo-Pennsylvanian, and probably syngenetic and volcanogenic.

2. Probable Upper Cretaceous/Early Tertiary hydrothermal veins.

The early phase is represented on the Property by occurrences of copper (chalcopyrite and carbonates) in massive basic volcanics; of copper-zinc (chalcopyrite and carbonates, sphalerite and oxidation products) in more acid? volcanics, breccias and tuffs, and of zinc? (zincian oxides?) in graphitic phyllite. Lead mineralization is noticeably lacking in these showings.

The later phase is represented by coarse galena-bearing quartz veins with apparently little or no accompanying metal present. These veins trend approximately 060^{o} and parallel hornblende porphyry dykes, tensional fissuring noted on outcrop scale and D_5 structural elements. They are discrete local features and are considered very unlikely to have formed an economic stockwork. The source of metal may be either remobilization of the early phase mineralization by magmatic activity or fractionation from the porphyritic phase of the Anvil Batholith. Pre-D_3? and pre-D_2 quartz veins are barren and hence the latter source may be dominant.

There is apparently a correlation between known deposits and greenstones, calc-silicates (?) and graphitic phyllites (op. cit., 1972). Greenstones are considered as possible source rocks whereas graphitic rocks indicate a reducing environment suitable for sulphide deposition.

As such, graphitic horizons are considered to be a better exploration guide (there seems to be some doubt as to whether gneisses exposed in the Anvil Pit are metamorphosed calcareous sediments or volcanic material). However, graphitic rocks are very common in the metamorphic pile and have high background metal content - hence geological exploration criteria are very broad and need support from geochemical, electromagnetic, magnetic, and gravity surveys.

NOTE: The unit numbers given on the generalized geology map (Fig 3) overleaf are for colouring purposes only and do not refer to numbers in the text, which apply to Maps 1 and 2 enclosed.

Discussion

This section is largely an attempt to synthesize the results of the present author with those of officers of the Geological Survey of Canada, especially D. J. Tempelman-Kluit (1972).

Stratigraphy:

(1) A six inch band of Middle Devonian crinoidal limestone was intersected in a borehole near the Swim deposit, at a depth of 136 feet. Float of the same rock-type was found on surface nearby (op. cit. 1972).

This band of limestone must be part of the deformed pile and hence places the age of metamorphosed pelites (Units 1, 6, A and B) and calcareous sediments (Units 4, 10, C, D) at Devonian in part.

(2) Limestones of the same age are found north of Mount Mye (op, cit. 1972), to the north of outcrops of foliated orthoquartizites whose foliation dips to the south-east. These quartzites are thought to conformally overlie (op, cit. 1972) a graphitic chert-argillite assemblage containing Ordovician-Silurian graptolites.

The above graphitic chert-argillite assemblage is traceable along strike into the area of the present investigation as Unit 5g (north of sheets 1 and 2), and apparently forms a steeply dipping horizon between pillowed volcanics and pillow beccias to the south and similar volcanics to the north.

(3) Unit 5g is compared lithologically (op. cit. 1972) with an Upper Devonian and Mississippian graphitic chert-argillite assemblage which outcrops over a considerable area to the north-east (Roddick and Green, 1961). These authors consider this chert-argillite assemblage to be derived from the Ordovician-Silurian assemblage and note the similarity of the assemblages.

Discussion with S. L. Blusson, G. S. C., indicates that many graptolite zones may occur in comparatively short measured sections within the Ordovician-Silurian assemblage. Thus very slow sedimentation over a long period, as deduced in modern oceanic environments, is indicated for the assemblage. Hence the Ordovician-Silurian sedimentation is probably continuous into the Devono-Mississippian and the orthoquartzite unit is probably a part of the Ordovician to Mississippian pile. The appearance of crinoidal limestones in the Middle Devonian and of greywackes, grits and conglomerates in the Devono-Mississippian may indicate uplift as a precursor to Permo-Pennsylvanian events.

(4) Unit 5 on the South-East Ridge is also compared lithologically with the Upper Devonian-Mississippian assemblage (op. cit. 1972).

This horizon is traceable by geological mapping and airborne E.M. and magnetic data for a strike length of twenty miles. At its western end it may be terminated at the contact with the porphyritic phase of the Anvil Batholith. At its eastern end it forms the southern boundary of outcrop and electromagnetic expression of the Upper Devonian-Mississippian assemblage. The implication is that this horizon is responsible for a structural and metamorphic break between stratigraphically equivalent phyllite and chert-argillite assemblages at its eastern end just as it is apparently responsible for such a break between Groups II and IV on the South-East Ridge.

(5) Middle Devonian crinoidal limestone outcrops 3 1/2 miles south-southwest of the Faro deposit where it is in fault contact with Upper Pennsylvanian-Permian volcanics and "apparently overlain unconformably" by an Upper Pennsylvanian-Permian chert-argillite assemblage (op. cit. 1972).

If this unconformity exists, it may be intraformational and the chert-argillite assemblage thus may be part of the above proposed Ordovician-Mississippian chert-argillite assemblage, i.e. the metamorphic pile may include deep-water sediments deposited slowly but more or less continuously from Ordovician time through to the Permian.

(6) A graphitic chert-argillite horizon mapped 10 miles west of the mine has been included (op. cit. 1972) with the Devono-Mississippian assemblage, and the Rose Creek Fault has been mapped as the structural break between phyllites and chert-argillite on the south side of the Anvil Arch.

Airborne electromagnetic data show the presence of a conducting horizon coincident with the above graphitic unit and the "Rose Creek Fault" and joining the two. This conductor is very similar to that described in (4) above and is deduced to be another graphitic horizon that provides a structural-metamorphic, <u>not</u> stratigraphic, break between what are probably Group 1 and Group II equivalents.

In summary, it appears that the metasedimentary rocks of the Anvil Arch are the metamorphosed and intensely deformed equivalents of an Ordovician to Permian? graphitic chert-argillite-(minor limestone) assemblage, which has orthoquartizite, limestone, chert-pebble grit and conglomerate, and greywacke members perhaps increasingly in its upper part. Whether any or all of the mapped volcanics are the equivalent of the Anvil Range Group as defined (op. cit. 1972), is uncertain - spatial relationships north of Mount Mye suggest that some volcanics may be associated with the Devono-Mississippian chert-argillites and some with the Ordovician-Silurian.

These stratigraphic conclusions tie the Faro, Vangorda and Swim deposits in with the Tom deposit and recent Placer discoveries on the Yukon - Northwest Territories border, and generally with Devono-Mississippian Pb-Zn mineralization noted in the Cordillera (Sangster, G.S.C.).

Correlation of the above lithologies with those mapped by G.S.C. (op. cit., 1972) is as follows:-

Group I:	Anvil Range Group: (op. cit., 1972)
Unit 10	Unit 8c
Units 9, 9v, 9p, 8v, 8p	Unit 8b
Units 8t, 8ta, 7t, 6s, 6b	Unit 8a
Units 5g, 5, 6b, (±6s, 10?)	Units 7, 4 (±5, 6?)
Group II:	Unit 3, upper member:
Units 9, 8, 7.	Units 3a, 12 in part
Units 6, 10	Unit 3
Group III:	Unit 3, lower member:
Unit 1(2, 3, and 4)	Sulphide horizon
Group IV:	Units 2 and 3, lower member:
Unit D	Unit 2b
Unit C	Unit 2
Units B, Ba, A, Aa	Units 2, 3.

Both detailed studies of the Faro-Vangorda-Swim area agree that mineral deposits and showings are confined to one "Stratigraphic" horizon (op. cit., 1972 and D.S. Jennings, Exploration Report for 1972, Pelly River Mines). As shown above this horizon would be equivalent to Unit 1 on the north side of the Batholith. Despite arguments about the effect of the deformations on the stratigraphic succession, it is felt that the similarity of the metamorphic pile on both sides of the batholith, and the above control on mineralization noticed on the south side, make Unit 1 phyllites very favourable ground for exploration.

Structure:

This section is an expansion of the section given earlier, with emphasis on:

a) The timing of D_3 and D_4 structures.

b) The geometry of D_1 - D_5 structures on the property.

Reading of the section below may be simplified by re-iterating that the letter "S" refers to a plane, "F" refers to a line, and "D" refers to the stresses giving rise to these fabrics and lineations. Generally these are the axial plane of a fold, S (given by cleavage measurement), the β axis of deformation, F, (given by measurement of fold axial direction, mineral lineation, S-plane intersection, rodding, etc.), and the deformation, D, that caused the folding. For example: D_2 folds have an axial plunge, F_2 and an axial plane crenulation foliation, S_2.

F_5 is assumed to be the latest structural element because of its brittle nature and very uniform orientation - $060^o \pm 10^o$. The associated kink planes are steeply dipping to the north or south and where well developed in a given area often show a consistent sense of movement. Conjugate sets are rare. The effect of this deformation, D_5, on the layering of the metamorphic pile is negligible. However D_5 is also evidenced by brittle tension fractures, usually sub-vertical, 060^o, which are probably associated with large scale fractures which admitted hornblende porphyry dykes (Unit H), aplite dykes (Unit P) and coarse quartz-galena veins. The age of this deformation is probably Upper Cretaceous or Early Tertiary.

The relative chronology of the crenulations of S_2 is in doubt. Indirect evidence might suggest that the crenulations parallelling F_2 are associated with the Anvil Arch, since that arch is defined essentially by variations in the attitude of S_2 about an axis parallel to F_2, whereas the other set of crenulations parallel assymetric folds such as might develop through east - west- compression of a north - west trending arch. However detailed analysis of the Anvil Pit has apparently shown a north - south trending crenulation foliation, folded about an axis parallel to F_2. Hence in this mapping those crenulations parallelling F_2 were assumed later and designated F_4, trending $300^o \pm 20^o$, and crenulations trending $350^o \pm 30^o$, designated F_3.

On the north flank of the arch the deformation D_4, then, produced crenulation and folding, assymetric to the north, of S_2. The axial planes, S_4, of these folds have variable attitudes but are often sub horizontal, and in rare cases represented by a crenulation foliation. D_4 is only distinguishable from D_2 in that it affects D_2 structures. The northerly dip of S_2 on the north flank, and its southerly dip on the south flank of the Anvil Batholith define the D_4 Anvil Arch which is the most regional single structure in the area. Smaller D_4 structures are probably cascade or gravity folds off the arch, since they are generally assymetric away from the batholith (e.g. the D_4 Faro Anticline, D.S. Jennings, J. Heslop, Anvil Mining Corporation) which folds the Faro orebody. In the map area, the main effect of D_4 is to steepen the S_2 dip near the batholith and in places overturn it. Hence the calcsilicate gneisses (Units C, D) near the batholith are also steep dipping. D_4 is probably due to uprise of the batholith in the Cretaceous. Such uplift is evidenced by coarse immature sediments of P laeocene age.

D_3 folds, approximately north-northwesterly trending, are characterized by having short western limbs and long eastern limbs, and subvertical axial planes. On the southern flank of the arch they have shorter eastern limbs (D. S. Jennings, pers,. comm.) and hence these folds may be superimposed on a pre-existing Anvil Arch. Their effect on the gross layering of the metamorphic pile is only minor (an assymetric undulation) since no regional structures are developed. D_3 is probably of Cretaceous - Early Teritiary age.

In Group II, megascopic D_2 structures are defined by minor structures in foliated greenstone lenses and by rare phyllite outcrops in which the early foliation has a recognisable and consistent attitude. This has allowed the mapping of an anticline, assymetric to the south whose axial plane trace trends approximately ESE. This fold dies out on Italy Ridge (see fig. 2) after crossing the contact of Groups I and II. Group II greenstones in the South East Ridge define the lower limb of a recumbent to synformal D_2 anticline with vergence to the south. Hence, in Group II, large D_2 folds are open to close, inclined to recumbent, and have sub-horizontal plunge (fold description after Fleuty, 1964). In Group I, folds of D_2 origin are defined by variations in the early foliation, S_1, and are gentle to open, steeply inclined to upright, with sub-horizontal plunge. In Group III no major folds were observed or deduced, but isoclinal closures in quartz veining and the style of folding in Group II indicate that large, tight to isoclinal, recumbent folds with sub-horizontal plunge are probably present. In Group IV isoclinal minor folds in early gneissic banding and tight folds in vein quarz indicate that tight large scale folding is probable, with initially recumbent axial surfaces modified by D_4 as described above. On the southern flank of the Anvil Arch, the Faro deposit is deduced (D.S. Jennings) to lie on the upper limb of a very large (amplitude 4 miles) recumbent synformal D_2 fold nappe with vergence to the south. It is very probable that fold repetition and crestal thickening by 'minor' D_2 structures on this upper limb were responsible in part for localization and concentration of the ore. Data presented above with regard to the deformation of the Anvil Batholith places the age of D_2 at (late?) Mesozoic. This conclusion can be tested by petrographic analysis of the Triassic conglomerates to the south of the Faro deposit. Slaty cleavage described in these rocks should be S_2 rather than S_1. If pebbles of mica schist in the conglomerate have a crenulation foliation unrelated to the external fabric, then D_2 must be pre-Triassic.

As previously stated, the deformation, D_1 , and associated metamorphism that produced the early foliation is thought to be Pennsylvanian-Permian. Folds to which the foliation is axial planar are only seen in Group I rocks. However bedding traces on the early foliation (i. e. the lineation F_1) can be seen folded by D_2 in Group II phyllites on Italy Ridge and F_1 lineations may be common in Groups II, III, IV, without proof of their identity being available. As is often the case, thin bedded units (6s, 6b, 8ta) have not formed mesoscopic D_1 folds, but instead the whole unit has folded as a unit, and large scale folds can be deduced by variable attitude of bedding (S_o) and variable angle of bedding - cleavage intersection. On a regional scale, D_1 folds would appear to be recumbent and isoclinal as evidenced by the generally sub-horizontal S_1 attitude and recognition of possible horizontal inverted bedding (tops deduced from grading in sediments and tuffs, and pillow structure in volcanics). On the scale of this mapping, however, outcrops often show a high bedding - cleavage angle. This can be explained by a model in which D_1 folds have buckle folded noses and highly sheared limbs and an example of this style is seen at the north end of Italy Ridge (section 73-3 in pocket). Here bedded sediments of Unit 6b are folded into a large (amplitude 1,000 feet) D_1 "S" fold with a shallow easterly plunging axis and easterly dipping (gently folded into a D_2 synform) axial plane. This fold is bounded by highly sheared rocks in which (at the tectonicly higher boundary at least) S_O is parallel to S_1. These highly sheared boundaries are rich in orange carbonate, which seems to be associated with highly sheared rocks and tectonic dislocations throughout the map-area, especially at the contact between Group 1 and Group 11 rocks in the west. Here orange carbonate zones appear to truncate lithlogical trends in Group 1 and are inferred thrust traces. Extrapolating this hypothesis it may be assumed that orange carbonate-rich, highly-sheared rocks associated with topographic breaks represent syn-D_1 shear zones and thrust zones. The carbonate probably orignates from the volcanic rocks themselves as it commonly forms the matrix of pillow breccias and is associated with the other volcanic types. The only mesoscopic D_1 folds seen are defined by lenses of carbonate in volcanics. These folds are characteristicly rootless and of similar type.

F_1 orientations vary considerably from north - south in west to east - west in the east. Where folded by D_2 in Group 11, the primary lineation, F_1, makes a high angle with F_2. Wide variation in F_1 orientation may be explained by the initial heterogeneity and poor layering of the deformed volcanic pile. Calc-silicate gneisses in Group 1V with S_1 gneissic banding indicate a marked increase of metamorphic grade and deformational intensity of D_1 toward the south-west. Hence it is likely that the relatively much less competent rocks of Groups II, III and IV have suffered an intense D_1 strain, with isoclinal folding, probable shearing out of fold limbs, and in the case of the schists and gneisses, probable complete re-orientation (transposition) of primary compositional banding and bedding. This same conclusion has been reached by D.S. Jennings working on the south flank of the Arch. On either flank, large scale D_1 structures have not been proven in rocks strongly affected by D_2.

Metamorphism:

Metamorphic period 2 (see chapter "Metamorphism") is associated with intrusion of the early phase of the Anvil Batholith, (see chapters "Stratigraphy, "Structure"). Period 3 is a high temperature, low directed stress event that may have developed from 2 and be associated with intrusion of the high tectonic level porphyritic phase of the anvil Batholith. Coincidence of composition and site of intrusion of the above phases may indicate that period 3 followed period 2 fairly closely. However, volcanics dated at 117-100 m.y. are"demonstrably younger" than the batholith and hence period 2 could very possibly be pre-Cretaceous.

It is possible that the metamorphic periods 1 to 3 represent an orogenic continuum, beginning with high pressure, low temperature conditions due to obduction and initiation of subduction at a previously stable continental margin in the Carboniferous (as outlined in G. A. C. Special Paper No. 11, pp 67-68): going through typical Barrovian facies in the Permian; to high temperature, moderate pressure metamorphism in the early to middle Mesozoic, with associated syntectonic batholith emplacement; and finishing with high temperature low pressure facies and post-tectonic plutonism in the Late Mesozoic. Triassic displacement of 250-300 miles on the Tintina transform fault (G. A. C. Annual Symposium, 1972) probably marks a break in this continuum, however.

Mineralization:

A description of the mineralization intersected in hole K-72-7 is given in Jilson's summary of exploration activities for 1972.

A genetic model (op. cit., 1972) for the deposits and showings on the southern flank of the Anvil Arch favours a syn-sedimentary and volcanogenic origin. In this model metamorphism is thought to have had little or no effect on concentration or localization of metals (contrast similar metal content of known deposits with different metamorphic grade), whereas deformation (op. cit., 1972, p63) has concentrated mineralization by "slip folding" without mobilizing sulphides relative to silicates. The present author disagrees with the mechanism proposed above but agrees with the final result in part.

Recent research (J. G. Ramsay, personal communication) has indicated that crenulation foliation is produced primarily by chemical migration, due to pressure solution, from high stress environments to lower stress environments, and that slip is unimportant in the formation of associated folds. It is also generally acknowledged that incompetent layers in a competent layered sequence will undergo thickening in hinge zones during folding (by flowage from limb to hinge), and that initial fold wavelength is largely dependant on the thickness of the competent layers that control folding. Angular breccia of silicate material in sulphide matrix from the Faro pit indicates that while silicates were brittle, sulphides were essentially fluid, as might be expected under upper greenschist facies conditions. Core from the Champ showing, which exhibits a low metamorphic grade, contains pyrrhotite forming saddle reefs in the noses of D_2 crenulations - an example in which sulphides have behaved incompetently as compared to silicates. In the layering of Groups II, III and IV the wavelength and ultimate size of major fold structures will be controlled by the calcsilicate gneisses and greenstones. Where a sulphide layer or lens has a greater lateral extent than half the initial wavelength ($\frac{Wi}{2}$) of folding it will be dismembered into separate rootless hinge zone concentrations. Where Wi /2 is greater than the lateral extent of a sulphide body it is (highly) probable that the whole body will tend to be concentrated into the hinge zone of the resulting fold. Metamorphism and the pre-existing channelway - S_1 - will lubricate this movement of sulphide. Hence the most favourable location for ore on structural - metamorphic grounds is felt to be the noses of D_2 folds. In Group I metamorphic grade is low and pre-existing channelways do not exist. Furthermore it is felt that buckle folds with sheared limbs, rather than flexural slip and similar folds, are dominant in Group I, and mobilization of sulphides into low stress environments is not expected to be important in these rocks.

Within the area under consideration the mineral potential can be classified thus:-

Group IV:

Host rocks: Quartzose schist with bleached alteration halo and associated graphitic phyllite and calcsilicate gneiss.

Mineralogy: Quartz, pyrrhotite, pyrite, sphalerite, galena (chalcopyrite). Due to high metamorphic grade pyrrhotite may be an important constituent, possibly more than pyrite, making magnetometer surveys a useful exploration tool

Grain -size: Coarse-grained sulphides ($>$0. 3 mm. average), giving easy milling.

Structure and shape: Probably an elongate rootless isoclinal fold nose in a "megalithon" with probable modification by D_4. Elongation parallel to F_2 with very flattened tabular shape parallel to S_2.

Exploration tools: Geological, geochemical, electromagnetic and magnetic surveys, and testing of favourable correlations of the above with gravity surveys.

Group III:

Host rocks: Quartzose coarse phyllite, bleached alteration halo, associated graphitic phyllite and amphibolite/calcsilicate gneiss.

Mineralogy: As above but with pyrite greater than pyrrhotite.

Grain-size; Medium - coarse, 0. 2 - 0. 3 mm. average.

Structure and shape: Elongate parallel with F_2, and flattened in S_2. Probably outlining a rootless tight to isoclinal fold nose with S_2 axial planar.

Exploration tools: As above with less emphasis on magnetic methods.

Group II:

Host rocks: Quartzose? phyllite, bleached alteration halo, associated graphitic phyllite and greenstone/marble bands.

Mineralogy: As above with pyrrhotite less important, and probably less galena and more chalcopyrite.

Grain-size: Fine - medium, 0.1 - 0.2 mm. average.

Structure and shape: Elongate parallel with F_2. In section a sulphide body may outline a close to tight rootless fold with S_2 axial planar (compare Swim) or a mineralized zone may consist of numbers of such bodies of small size having been dismembered by deformation.

Exploration Tools: as above.

Group I:

A) Host rocks: Intermediate - acid volcanic material including breccias and tuffs with localization of mineralization at lithological contacts.

Mineralogy: Sphalerite, pyrite, chalcopyrite, pyrrhotite in altered volcanic matrix.

Structure and shape: Irregular?, buckle folded with host rocks in fold hinges or highly flattened in sheared limbs.

Tonnage and grade: Possibility of massive (80% sulphides) high grade zinc-copper orebody of limited size or perhaps large tonnage low grade deposit of "crackle -zone" type.

Exploration tools: Geology, geochemistry, gravity and induced polarization or electromagnetic methods depending on ratio of sphalerite to conducting sulphides and a total sulphide content.

B) Host rocks: Basic - intermediate volcanic material including pillowed and vesicular volcanics, breccias, etc., with localization of mineralization at lithological contacts (compare Cyprus Island).

Mineralogy: Chalcopyrite, pyrite, sphalerite, pyrrhotite in altered volcanic matrix.

Structure and shape: Largely unmodified by deformation due to competence of host rocks? May be a vein stockwork or dissemination of veinlets with high grade pods?

Exploration tools: Geology, geochemistry and I. P. or E. M. methods depending on total sulphide content and mode of occurrence.

C) Host rocks: Graphitic and/or cherty slates and shales, chert-pebble conglomerate and breccia, and in limestones with localization at facies changes(compare Tom deposit).

Mineralogy: Galena, sphalerite, pyrite, and gangue.

Grain-size: Fine to very fine?

Structure and shape: Concordant, bedded, stratiform mineralization probably folded in tight to open folds with S_1 axial planar.

Exploration tools: Geological, geochemical, E.M. and gravity surveys.

CONCLUSIONS AND RECOMMENDATIONS

1) The whole map-area and its strike extensions are concluded to have high potential for Pb-Zn-Cu mineralization.

2) At present, two rock-types are considered to have very high potential:

a) Units 8a and 7, which probably represented deformed intermediate pillow breccias and hyaloclastites, for Zn-Cu mineralization, on the basis of 1972 drill results.

Specifically, the tops of volcanic piles consisting of basal basic pillowed volcanics overlain by intermediate to acid pillow breccia, hyaloclastite? and sub-aqueous bedded tuff are considered favourable, by analogy with classic examples of Archean Zn-Cu deposits. The discovered mineralization may be in the tectonically inverted top half of such a pile. Structural effects may be limited to flattening of mineralized bodies in the plane of the early foliation, S_1.

b) Unit 1, coarse phyllites, for Pb-Zn mineralization, on the basis of results from the south side of the Anvil Batholith. Specifically, in Unit 1, mineralization is expected to be localized in quartzose phyllite, in or near graphitic phyllite, near greenstone amphibolite or calcsilicate gneiss. Special attention should be given to the inferred loci of D_2 hinge zones in potential host rocks.

3) Geological, geochemical (soil), electromagnetic and magnetic surveys should provide a basis for exploration within rock-types favourable for Pb-Zn mineralization, outlining targets to be tested by gravity survey and drilling.

4) Geological, geochemical (soil), electromagnetic and/or induced polarization, and magnetic surveys should provide a basis for exploration within rock-types favourable for Zn-Cu mineralization, outlining targets to be tested by drilling.

Respectfully submitted,

P.F. Lewis

P. F. Lewis.

APPENDIX I

References

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KANGAROO EXPLORATION CORPORATION

MOUNT MYE PROJECT

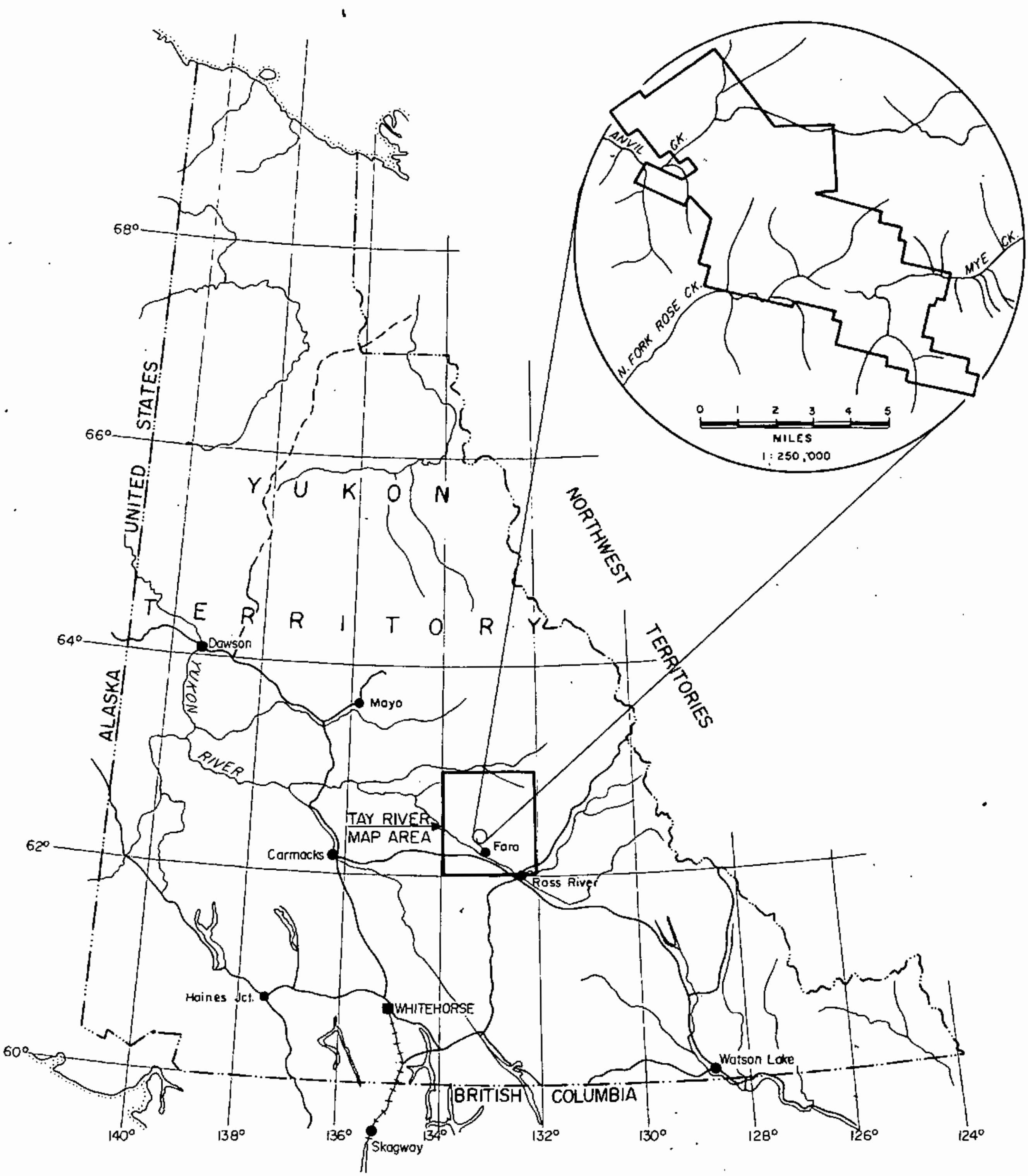
Whitehorse Mining District, Yukon Territory

GEOLOGY

By

P. F. Lewis

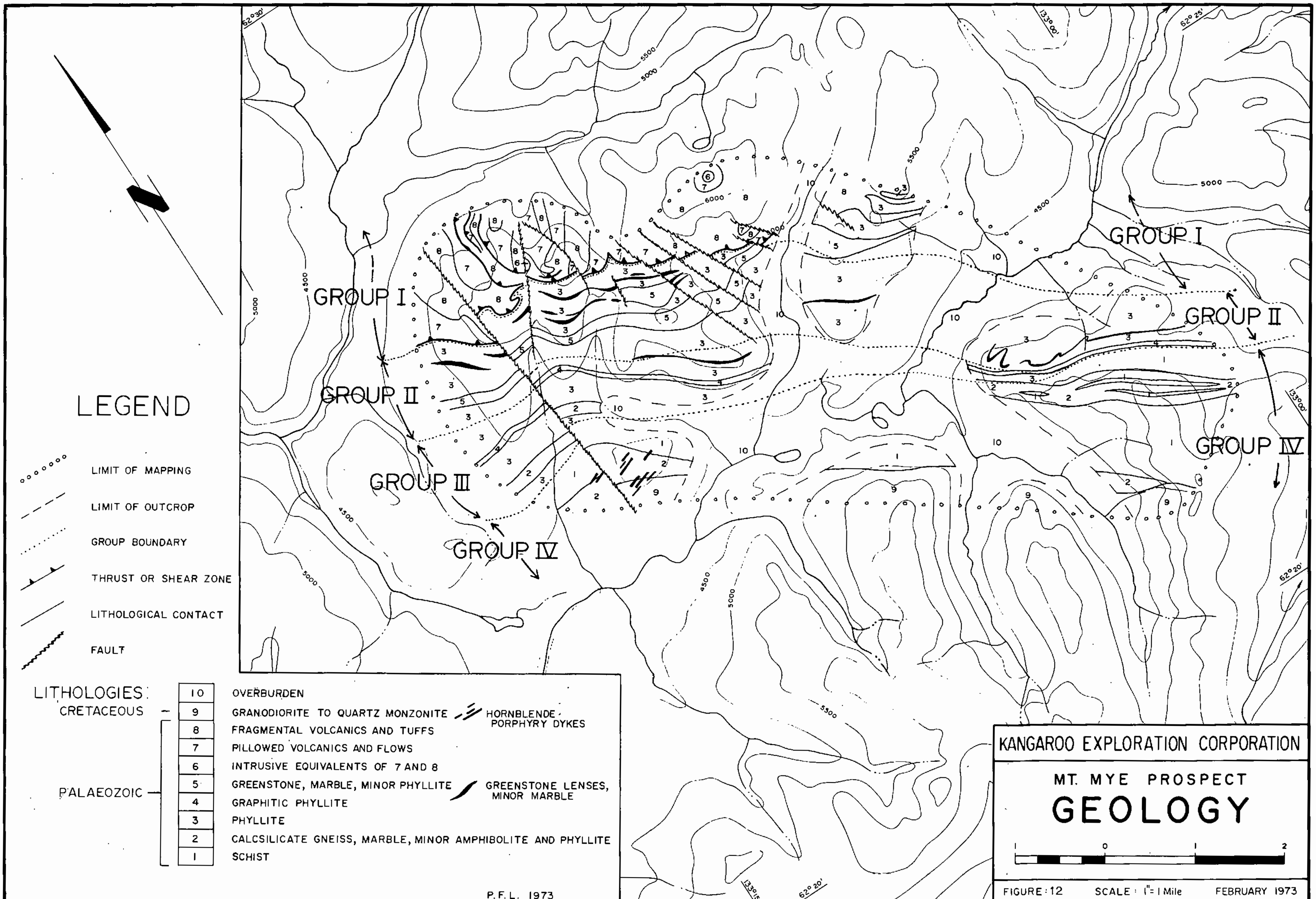
May 1973



KANGAROO EXPLORATION CORPORATION
MT. MYE PROSPECT
PROPERTY LOCATION MAP

YUKON

SCALE : 1" = 100 MILES


LEGEND
LIMIT OF MAPPING
LIMIT OF OUTCROP
GROUP BOUNDARY
THRUST OR SHEAR ZONE
LITHOLOGICAL CONTACT
FAULT
LITHOLOGIES:
CRETACEOUS
PALAEOZOIC
10 OVERBURDEN
9 GRANODIORITE TO QUARTZ MONZONITE
8 FRAGMENTAL VOLCANICS AND TUFFS
7 PILLOWED VOLCANICS AND FLOWS
6 INTRUSIVE EQUIVALENTS OF 7 AND 8
5 GREENSTONE, MARBLE, MINOR PHYLLITE
4 GRAPHITIC PHYLLITE
3 PHYLLITE
2 CALCSILICATE GNEISS, MARBLE, MINOR AMPHIBOLITE AND PHYLLITE
1 SCHIST
HORNBLENDE PORPHYRY DYKES
GREENSTONE LENSES, MINOR MARBLE
P.F.L. 1973
GROUP I
GROUP II
GROUP III
GROUP IV
62°30'
62°25'
62°20'
133°00'
133°15'
4500
5000
5500
6000
KANGAROO EXPLORATION CORPORATION
MT. MYE PROSPECT
GEOLOGY
1 0 1 2
FIGURE: 12
SCALE: 1" = 1 Mile
FEBRUARY 1973