6307

THE GEOLOGY AND GENESIS

OF PINGSTON CREEK SULPHIDES

CASEY CLAIMS 1 - 10

SLOCAN MINING DIVISION

LATITUDE 50°30' NORTH   LONGITUDE 118° WEST

NTS 82 K/5W and 82 L/8E

FOR OWNER: Mr. M. CUSICK

BY: DR. PETER LEVIN of
METALLGESELLSCHAFT

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LIST OF ILLUSTRATIONS

THE GEOLOGY AND GENESIS OF PINGSTON CREEK SULPHIDES

1. INTRODUCTION

This report is based on an eleven day reconnaissance mapping program carried out by Messrs. P. Leven, R. Dickinsen and M. McLaren, covering an area of about 20 km^2 in the Pingston Creek area east of North Arrow Lakes, some 85 km south of Revelstoke, B.C.

Exposed sulphide occurrences were indicated east and west of Pingston Creek. Access is by a well-maintained logging road (37 km) which starts 5 km north of Shelter Bay on Upper Arrow Lake at Highway 23. All occurrences can be reached by a network of minor logging roads with a four-wheel drive vehicle (Figures 1a and 7).

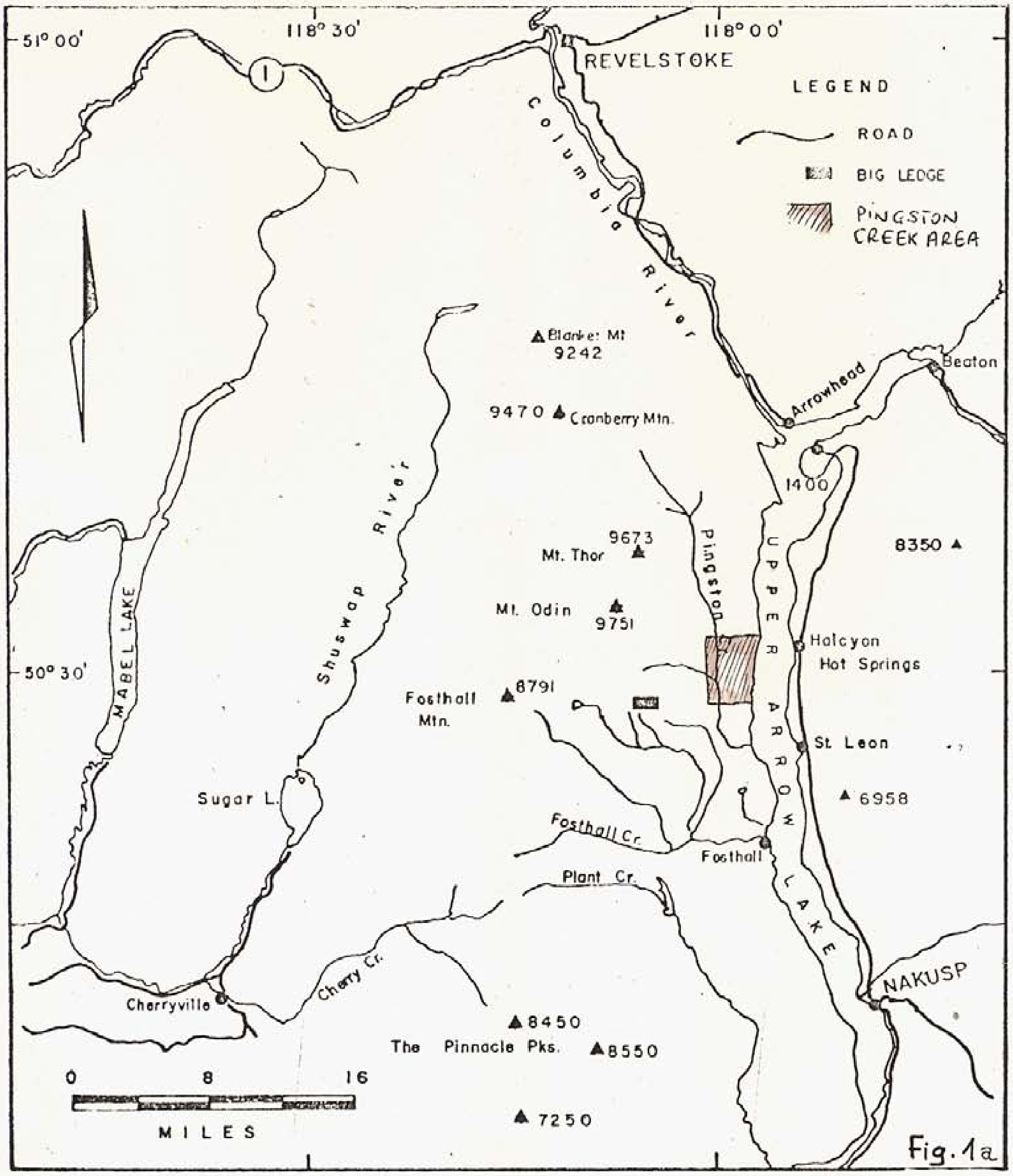
Most of the sulphide occurrences are covered by claims registered in the name of Mr. Mervin Cusick of Nakusp, B.C.

The sulphide mineralization east of Pingston Creek was discovered in 1957 as a result of logging activity, while sulphide showings west of Pingston Creek have been recorded since the end of the 19th century. They are on strike with Cominco's Big Ledge deposit which was discovered in 1892 and has been explored intermittently since then.

2. GEOLOGY

2.1 General Geology

The area investigated is part of the Shuswap Metamorphic Complex. "This complex contains rocks that have been raised to a state of high grade regional metamorphism. The age of the rocks and their correlation with formations beyond the complex is speculative, but the most recent work suggests that the metamorphic rocks include Proterozoic,

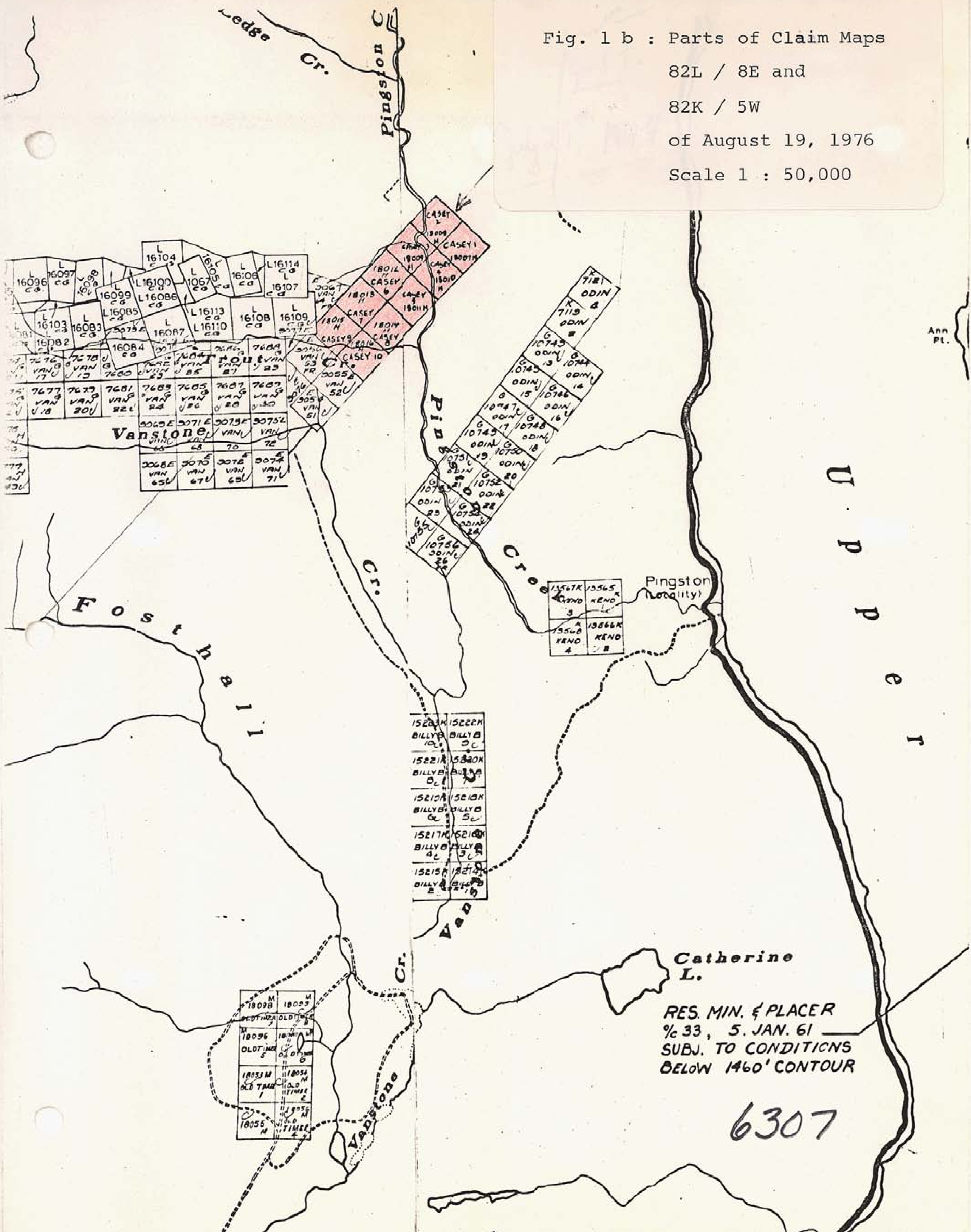


51° 00'
118° 30'
118° 00'
REVELSTOKE
LEGEND
ROAD
BIG LEDGE
PINGSTON CREEK AREA
Columbia River
Blanke: Mt 9242
9470 Cranberry Mtn.
Arrowhead
Beaton
1400
Shuswap River
Mt. Thor 9673
Mt. Odin 9751
Pingston
UPPER ARROW LAKE
8350
Halcyon Hot Springs
MABEL LAKE
50° 30'
Fosthall Mtn. 8791
St. Leon
Sugar L.
6958
Fosthall Cr.
Fosthall
Plant Cr.
Cherry Cr.
Cherryville
NAKUSP
8450
The Pinnacle Pks.
8550
7250
0 8 16
MILES

Fig. 1a

6307

Fig. 1 b : Parts of Claim Maps
82L / 8E and
82K / 5W
of August 19, 1976
Scale 1 : 50,000

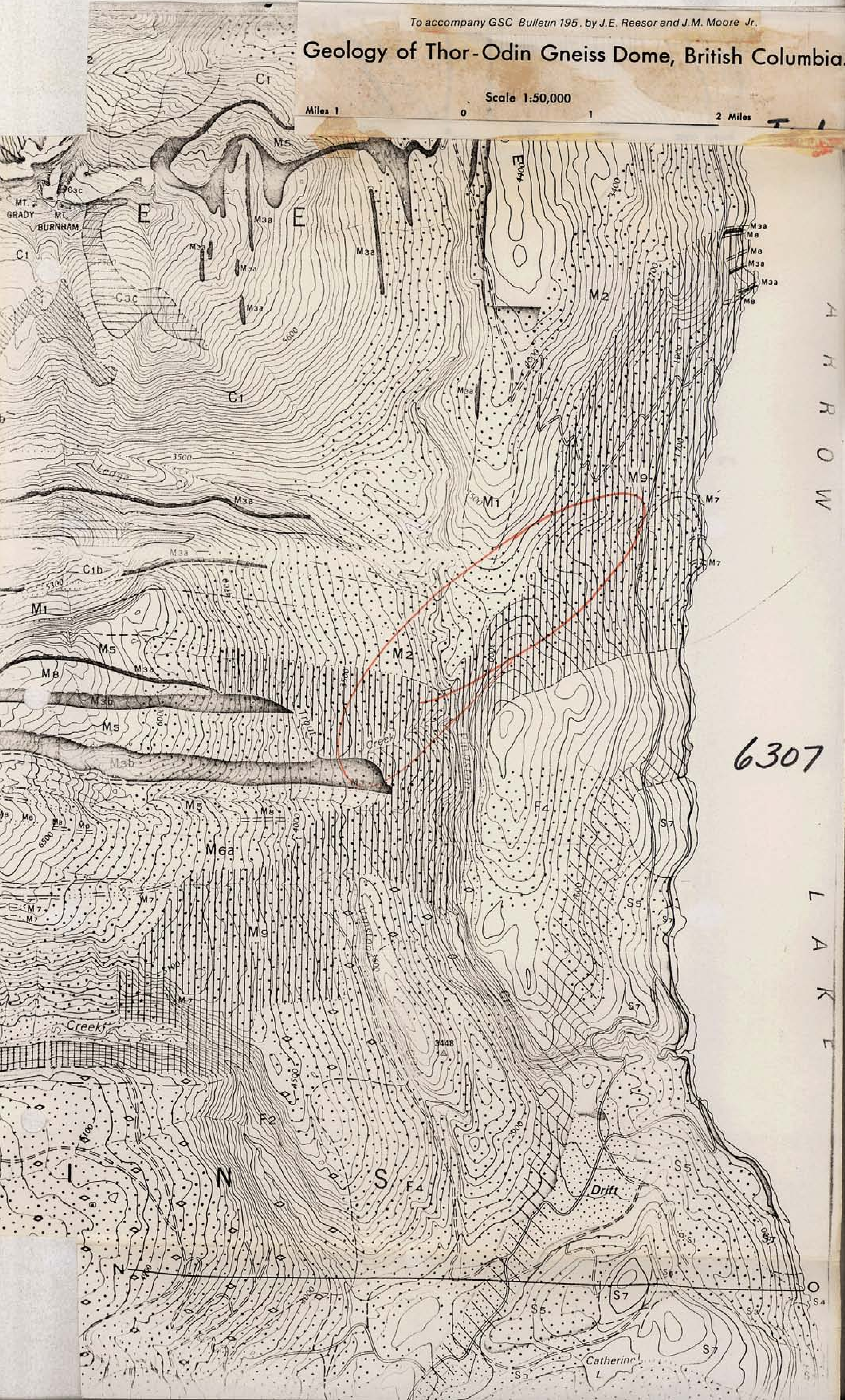


To accompany GSC Bulletin 195, by J.E. Reesor and J.M. Moore Jr.

Geology of Thor-Odin Gneiss Dome, British Columbia.

Scale 1:50,000

Miles 1 0 1 2 Miles



Paleozoic and possibly also Mesozoic formations. Structural studies have shown that the complex is composed of a series of gneiss domes with cores of veined augen gneiss and granitic gneiss enveloped by metasedimentary gneiss and schist. The outermost layers of gneiss and schist are riddled with layers and lenses of pegmatite and leucogranite. Three gneiss domes are found between Slocan Lake and the Monashee Mountains west of the Big Bend of the Columbia River". (FYLES, 1970).

The Pingston Creek area is underlain by a series of gneisses, marbles and quartzites of the metamorphic Monashee Group (presumably lower Paleozoic), which forms one of the mantling zones of the Mt. Odin Gneiss Dome.

2.2 Petrography of the Pingston Creek Area

The following major petrographic units can be distinguished in the Pingston Creek area:

2.2.1 Gneiss

Generally, the gneiss is a biotite-feldspar-quartz-paragneiss with quartz and feldspar variably dominant. Contrary to the observations of REESOR and MOORE, 1971, in the Big Ledge area, who describe sharply separated sub-units of biotite-feldspar-quartz-gneisses, there are multiple transitions in the Pingston Creek area, depending on the biotite-feldspar-quartz ratios. Grain size varies between 1 and 3 mm. A pronounced rhythmic sequence of biotite layers and quartz-feldspar layers is common, while other gneisses show a distinct augen gneiss texture. Pegmatites form generally concordant lenses and schlieren within the gneiss. Rare amphibolite lenses 1 mm to 3 cm thick can be observed and garnet-rich and sillimanite-rich zones also occur locally.

2.2.2 Pegmatite

Pegmatites occur as lenses which are concordant, but quite discontinuous, and tend to occur more commonly in certain horizons. In the north and the south of the mapped area, on the road along the shore of Upper Arrow Lake, a discordant (migmatitic?), 100 to 200 feet thick pegmatite occurs in gneisses just below the marble marker horizon M1 (Figure 2). The pegmatities consist of either predominantly bull quartz or pure feldspar. Sometimes tourmaline is present and very occasionally sulphides (maracasite, sphalerite, galena) were also observed (Point 49, Figure 7).

2.2.3 Quartzite

Only a few true quartzite beds occur in the sequence. They can be distinghished from the quartz pegmatites by the fine grain size and faint indications of sedimentary bedding texture. The thickness varies between 20 cm and 3 m. The color is usually white but, in one case, a bluish red, 10 cm thick quartzite bed forms a discontinuous marker horizon at the footwall of the marble horizon M4a (see Figure 5). Layers of muscovite and sillimanite interlayering with thin marble bands occur within the quartzite beds at a few locations.

2.2.4 Amphibolite

Dark grey-green amphibolite occurs in several horizons forming lenses and clusters of lenses from a few mm to several metres in thickness. These can sometimes be used as marker horizons.

Often thin marble, calc-silicate and quartzite bands are interlayered with the amphibolites. Amphibole crystals up to 6 cm long are weakly oriented parallel to the metamorphic s-texture.

2.2.5 Marble

Marble occurs in a number of horizons from a few millimetres to 30 metres thick. These vary from homogenous pure marble to calc-silicates and calcite-rich gneisses. However, these transition sub-units are less common than pure marbles and pure gneisses. Sometimes marble grades into calcarenite (points 22 and 49, Figure 7).

The grain size varies between 0.5 mm and 5 cm with an average of about 3 mm. The predominant mineral is calcite (white to grey, rarely pink), and less frequently dolomite. Accessory quartz, garnet, tremolite, diopside, sillimanite, muscovite, graphite (sometimes in dense clots) and phlogopite are present. Pyrrohotite, pyrite, sphalerite and galena are very rare.

One horizon (M1) shows a distinct boxwork texture. The outer boxwork is built up out of tremolite and diopside and filled with calcite. The marble horizons M2 and M4 are distinguished by their breccia texture (matrix calcite, fragments gneiss), the marble horizon M3 by conglomerates of quartz and rarer gneiss fragments in a calcite matrix.

The gneissic fragments in the breccia are partly oriented at an oblique angle to the metamorphic banding and illustrate a flexure fold structure.

2.3 Tectonics

The dominant tectonic element is a weak folding with a long wave length and an axis striking north-south. The strata therefore generally dip 20-50^{0} East in the area west of Upper Arrow Lake. Because the general dip and the morphological slope are more or less parallel, it was possible to trace the marker horizons of interest over quite large areas.

2.3.1 Folding

The following sequence of folding can be ascertained:

Phase Ia: The major structure is an anticline with an axis striking north-south to 10^{0} West. The apex runs along the mountain ridge between Pingston Creek and Upper Arrow Lake (Figure 3).

Phase Ib: The flank of the anticline of Phase Ia is folded into several weak synclines and anticlines, the intensity of which decreases towards the east. The axes of these minor folds strike north-south to 20^{0} West (Figure 3).

Phase IIa: The second stage folding creates more or less symmetrical folds on the east flank of the Phase Ia anticline, with axes trending 50 to 60^{0} East, and form very elongated "valleys" and "ridges" or canoe-type folds (Figure 4b). The limbs of these folds show small scale folding in cm to m dimensions, (Figure 4a) with incipient axial plane shear (Figure 4c).

Phase IIb: This is of similar style and age to Phase IIa, although weaker and with axes striking 60^{o} West which is the complimentary direction to Phase IIa in a conjugate system.

Phase III: A narrow, elongated area between points, 54, 45, 49 and 50, shows a pronounced, locally overturned folding, with an axis striking 10 to 40^{o} East and a plunge of 20^{o} to the northeast.

2.3.2 Regional Distribution of Tectonic Styles

The weak folding of Phase Ia and Ib, as described in Chapter 2.3.1, gradually tightens towards the north and south with development of axial plane cleavage in the north only. Three structural regions can be distinguished from north to south.

Region A: Region A is located north of points 32 and 28. The intensity of the folding of Phase I, with axes striking 20^{o} West, strongly increases towards the north. However, it never reaches the stage of overturned folds. Shortening is achieved by shearing and overthrusts in the fold closure area, with thrust planes dipping about 20^{o} Southwest.

Region B: Region B lies between points 32 and 13 and is the area where the sulphides are exposed. Region B is characterized by weak interference folding.

Region C: Region C is located south of point 13. The intensity of the Ia and Ib fold phases increases so that towards Big Ledge to the west, the intensity reaches the stage of upright to overturned folds.

3. MINERALIZATION

3.1 Mineralogy of the Ore Types

Ore Type I: This is a massive sulphide type occurring in outcrops and is composed of a fine-grained, homogeneous sulphide mass of mainly pyrrhotite with rarer magnetite and pyrite. Sphalerite and galena are seen only rarely in hand specimen. Rounded and angular inclusions of fragments of feldspar, quartz, biotite and tremolite are frequent. The grain size is quite fine compared to the recrystallized marbles.

The following sub-types can be distinguished:

Ore Type Ia: massive sulphides without inclusions.

Ore Type Ib: massive sulphides with rounded fragments of quartz (conglomerate).

Ore Typc Ic: massive sulphides with angular to rounded fragments of pegmatites and gneisses.

Ore Type Id: massive sulphides with rounded fragments (conglomerate) of massive sulphides.

Ore Type II: Pyrrhotite, pyrite, sphalerite and galena occur as a matrix in quartz rich, calcareous gneisses.

Ore Type III: Pyrrhotite, pyrite, sphalerite and galena occur in marble with graphite and hematite.

Ore Type IV: Marcasite, pyrite, sphalerite and galena occur in pegmatite vugs between quartz crystals.

3.2 Stratigraphic Positions of the Mineralized Horizons

The mineralized horizons, marbles, amphibolites and quartzites, together with gneisses and pegmatites, form a sequence about 2,200 metres thick which is part of a 6,000 metre thick gneissic pile (Figure 2).

3.2.1 Marble Marker Horizons

M1: a series of marble beds, the thickest of which is 60 cm to 1 m thick, and displays a typical boxwork texture. The boxwork consists of sillimanite, diopside and tremolite filled with calcite.

M2: a marble sequence with gneissic breccia fragments up to 30 c long.

M3: a marble sequence with boulders of quartz, sometimes gneisses.

M4: a marble sequence with two horizons, which are characterized by gneissic breccia fragments up to 60 cm in diameter.

M5: a pure, homogeneous marble.

M6: a homogeneous, partly sandy, quartz-rich marble.

M7: a marble sequence with gneissic breccia fragments in the uppermost part.

M8: marble, locally with small gneissic boulders.

3.2.2 Amphibolite Marker Horizons

The following amphibolite horizons with marker qualities were observed:

(a) a horizon 35 m below marble horizon M1,

(b) a horizon 50 m above marble horizon M1,

(c) two horizons in the footwall of marble horizon M4,

(d) one horizon in the footwall and one in the hangingwall of marble horizon M6,

3.2.3 Stratabound Mineralization (Figure 5)

Stratabound mineralization occurs in six horizons (S1 to S6):

(a) S1 and S2 are horizons of the Ore Type II, they lie within the footwall and hangingwall of marble horizon M2.

(b) S3 and S6 are horizons of the Ore Type II, lying in the hangingwall of marble horizon M3 and in the footwall and hangingwall of M6.

(c) S5 is associated with marble horizon M5 (Ore Type III).

(d) S4 is a series of mineralized horizons of Ore Type I in the hangingwall of marble horizon M4.

3.3 Mineralization in the S4 Sulphide Horizon (Figure 5)

Because of the possible economic potential of the Ore Type I massive sulphides, which only occur within the sulphide horizon S4, this horizon and its footwall and hangingwall were mapped in detail.

Marble Unit M4 - can be subdivided into four sub-units M4a to M4d:

M4a - is a marble, which contains fragments of gneiss up to a size of 5 cm (average size 1 cm) and a high muscovite content. The gneissic fragments are well sorted by size.

M4b - is a marble, in which rather isolated gneissic fragments up to 50 cm can be observed. The highest and lowest sections of this marble sub-unit are sandy (quartz grains).

M4c - is a rather homogeneous marble with mostly rounded gneissic boulders, some graphite, and with an increasing quartz content towards the southwest.

M4d - is a homogeneous, nearly pure marble.

Sulphide Horizon S4 - can be subdivided into three horizons S4a to S4c:

S4a - is usually built up out of Ore Type II. It has a punctured appearance and was given the field name "hole horizon". At point 47, it changes into Ore Type Ib. Stratigraphically, it lies between marble sub-units M4a and M4b.

S4b - is made up of Ore Type II in the north and of Ore Type Ib and Id (point 38) in the south. Stratigraphically, it lies between marble sub-units M4b and M4c.

S4c - consists of Ore Types Ia, Ib (point 24), Ic and II (points 49, 22). Stratigraphically it lies between marble sub-units M4c and M4d.

The marble series M4 and the sulphide series S4 has a total thickness of about 15 m. The best marker characteristics can be attributed to the marble sub-unit M4b (coarse gneissic breccia within the marble), amphibolite layers in gneisses in the footwall of marble sub-unit M4a and to a very typical augen gneiss with pegmatitic schlieren, in the hangingwall of marble sub-unit M4c.

3.4 Regional Facies Distribution of S4 and M4

This chapter is based on detailed mapping at 18 points (Figure 5) and more general mapping along strike between these points. The best reliability is around points 1, 2, 5, 19, 24, 29 and 33. South of these points, no mineralization was found at the stratigraphically equivalent positions.

An isopach map was not drawn because the thickness has almost certainly been changed by tectonic influences. However, trends can be recognized by studying the distribution of thickness within a single horizon (Figure 6).

The horizon S4a represents a limited cycle of mineralization that trends 10^{0} East and has a maximum thickness around point 47. The sulphides of this central zone are of Ore Type Ib, while towards the fringes the sulphides become progressively more sandy and calcareous (Ore Type II).

The horizon S4b exists in two separate areas, a northern zone of Ore Type II and a southwestern one of Ore Types Ib, Ic, Id.

The horizon S4c forms two parallel, elongate areas connected by a "bridge". At the centre (point 24) the Ore Types are Ib and Ic, whereas towards the rims a transition to Ore Type II takes place.

The marble horizons M4a to M4d also exhibit a facies change boundary towards the northwest. The boundary line runs northeasterly where the breccia content is at a maximum. The breccias tend to be replaced by conglomerates towards the south.

The same holds true for the amphibolites between the marble horizons M4 and M5. They show a facies boundary in the northwest which trends parallel that of the marble horizons M4a to M4d.

The quartzite horizonsbetween M4 and M5 exhibit a maximum thickness around the points 33 and 54 and are reduced towards the southeast. The boundary line has a northeasterly trend as in the other units.

The pegmatitic horizons are most abundant when directly associated with Ore Types Ia to Id (points 2, 4, 5 to 10, 47, 38).

3.5 Sulphide Genesis

The mapping results, as described in Chapters 3.3 and 3.4, indicate that paleographically the area investigated lies close to an old shoreline. This is indicated by the thinning of the quartzite horizons from one direction and the thinning of the marble horizon from the opposite direction. Another indication lies in the distribution of the breccia fragment types of gneiss and quartz in the marbles, and of boulders in the sulphide horizons. The elongated distribution of the three S4 sulphide horizons parallel to the postulated coastline, can be interpreted as channel fillings in an intertidal zone. The boulders of sulphide within this sulphide type and the rapid facies changes from Ore Type I to Ore Type II (points 24 to 22, 38 to 37, 47 to 9107647) would support this conjecture.

4. SUMMARY AND CONCLUSIONS

(a) The area investigated is underlain by a sequence of pure and impure marbles containing breccia and conglomerate fragments, amphibolites, quartzites, calcite-rich and calc-silicate-rich gneisses, within a series of more or less homogeneous biotite-quartz-feldspar gneisses.

(b) The tectonic style shows a progressive tightening of folds to the north and the south into more intensely folded terrain, where tectonic shortening by folding is taken up by overthrust faulting.

(c) The mineralization is dominantly in the form of stratabound sulphides.

(d) The exposed massive sulphide mineralization belongs to three stratigraphically different horizons.

(e) The extent of the mineralized horizons is limited, due to rapid facies changes to sandy, sulphide-rich gneisses and rapid thinning.

(f) Facies indicators suggest a channel filling close to an old shoreline as a genetic model for the sulphides.

(g) No economic mineralization is present within the three sulphide horizons observed.

(h) The style of folding excludes enrichment in fold nose areas of the type common at Ruddock Creek.

Peter [illegible]

5. REFERENCES

FYLES, J.T. (1970) : The Jordan River Area near Revelstoke, B.C. B.C. Dept. of Mines and Petroleum Resources Bulletin No. 57, p. 64

RAHAM, G.O. (1967) : Geology of the Big Ledge Zinc Deposit, B.C. M.S. Thesis, Calgary , 90 p.

REESOR, J.E. and MOORE, J.M. (1971) : Petrology and Structure of Thor-Odin Gneiss Dome Shuswap Metamorphic Complex, B.C. Geol. Survey of Canada, Bulletin 195, 149 p.

APPENDIX I

STATEMENTS OF QUALIFICATION

STATEMENT OF QUALIFICATION

I, Peter Levin, with residence at 7 Hochstrasse, Baden-Baden, West Germany, declare:

1. that I graduated from the University of Heidelberg, West Germany, with a main diploma in geology and mineralogy in May 1973.

2. that I graduated with a Ph.D. in economic geology and mineralogy from the University of Heidelberg in September 1975.

3. that since 1973 I have been employed as an exploration geologist in Germany, Peru, Canada, and Chile.

4. that I am presently exploration geologist for Metallgesellschaft AG of Frankfurt a.M., West Germany.

5. that I was participating in the reconnaissance mapping program of Cyprus Anvil Mining Corporation and Metallgesellschaft Canada Ltd. in the Pingston Creek Area in September/October 1976 and have written this report and compiled the drawings.

Peter Levin

Dr. Peter Levin

Vancouver, B.C.
April 15, 1977

STATEMENT OF QUALIFICATION

I, Robert A. Dickinson, with residence at 1395 Ottawa Avenue, West Vancouver, B.C., declare:

1. that I graduated from the University of British Columbia with a B.Sc. degree in honours geology in 1972 and a M.Sc. degree in Business Administration in 1974.

2. that since graduation I have been employed as an exploration geologist in British Columbia, Saskatchewan, the Yukon and Northwest Territories, and Washington, U.S.A.

3. that I am president and exploration geologist of United Mineral Services Ltd. whose office is located at 1326 - 510 West Hastings Street, Vancouver, B.C. V6B 1L8.

4. that I have no interest in the Casey Claims whatsoever.

5. that I was part of a contract team to Cyprus Anvil Mining Corporation and Metallgesellschaft Canada Ltd. participating as an exploration geologist during the period September 28 to October 15, 1976, collecting data on which part of this report is based.

R.A. Dickinson

Vancouver, B.C.
April 15, 1977

STATEMENT OF QUALIFICATION

I, Murray McClaren, with residence at O'Byrne Road, R. R. #3, Sardis, British Columbia, declare:

1. that I graduated from the University of British Columbia with a B.Sc. degree in geology.

2. that since graduation I have been employed as an exploration geologist in British Columbia and Arctic Islands.

3. that I am vice-president and exploration geologist of United Mineral Services Ltd.

4. that I am a member of the Geological Association of Canada and a member of the Society for Geology Applied to Mineral Deposits.

5. that I have no interest in the Casey Claims whatsoever.

6. that I was part of a contract team to Cyprus Anvil Mining Corporation and Metallgesellschaft Canada Ltd. participating as an exploration geologist during the period September 28 to October 15, 1976, collecting data on which part of this report is based.

M. McClaren

M. McClaren

Vancouver, B.C.
April 15, 1977

APPENDIX II

STATEMENT OF COSTS

STATEMENT OF COSTS

Geological work

September 28 to October 15, 1976

Salaries

United Mineral Services Ltd.	
(R.A. Dickinson & M. McClaren)	
2.5 days preparation @ $ 110 per day	$ 275.00
3.0 days field work @ $ 125 per day	375.00
11.0 days field work @ $ 250 per day	2,750.00
Dr. P. Levin (metallgesellschaft) field work, interpretation of results, preparation of report and drawings	
28 days @ $ 100 per day	$ 2,800.00

Other

Equipment / Rental	$ 65.00
Maps / Airphotos	148.57
Prints / Enlargements	268.77
Assays	22.00
Travel expenses	198.15
Total cost :	$ 6,902.49

F. W Wellmer

Friedrich-W. Wellmer
Exploration Manager - Western Canada
Metallgesellschaft Canada Ltd.

STATEMENT OF WORK

ON THE CASEY CLAIMS

Of 11 days field work 4 days were spent on the Casey Claims. Therefore costs applied to the Casey Claims are pro rata

$$(4/11) \times 6,902.49 = 2,510.00 \$$$

To clarify the stratigraphic position of the sulfide horizons on the Casey Claims and the tectonic style investigations had to be extended outside of the claims. These observations outside of the claims have to be looked at in context with the Casey Claims area. The report therefore covers all mapping and all observations.

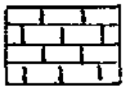
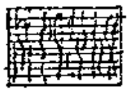
Friedrich-W. Wellmer

Friedrich-W. Wellmer
Exploration Manager - Western Canada
Metallgesellschaft Canada Ltd.

APPENDIX III

STATEMENT OF WORK

INDEX FOR FIG. 2 - 7

	gneiss or gneissic texture
	marble
	quartzite or sandy / quartzrich
	pegmatite / pegmatoid
	augengneiss
	breccia
	box work texture

red	sulfides
orange	disseminated sulfides
blue	marble / calcareous
green	amphibolite
yellow	quartzite / quartzpegmatite

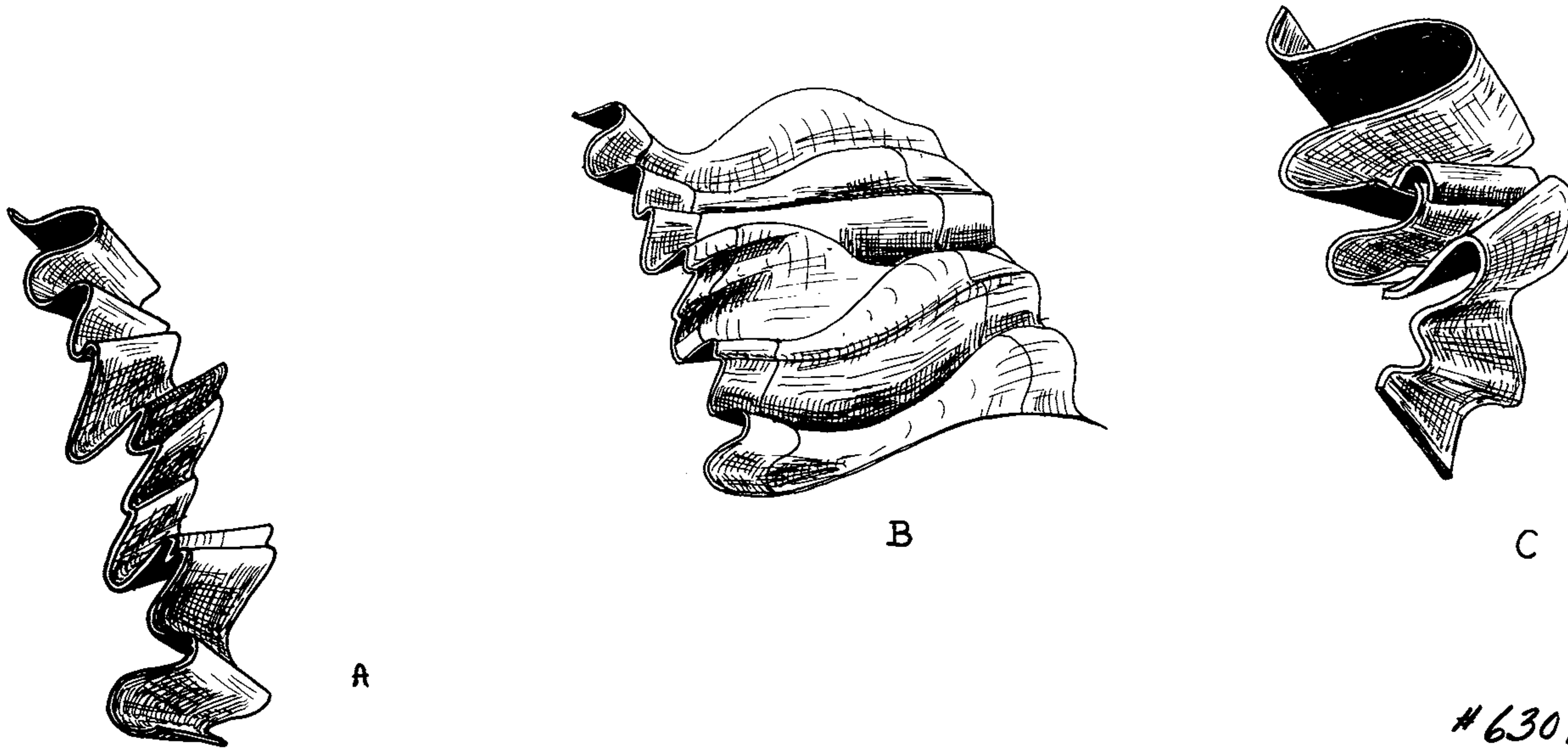
ATTACHMENTS

Figure 2 - 7

Fig. 2 : Explanation

Profile A : Along isopach line 2000 feet between outcrops 30 and 10 (see fig. 7)

Profile B : Along Upper Arrow Lake at the altitude of 1500 feet (see fig. 7)



A B C

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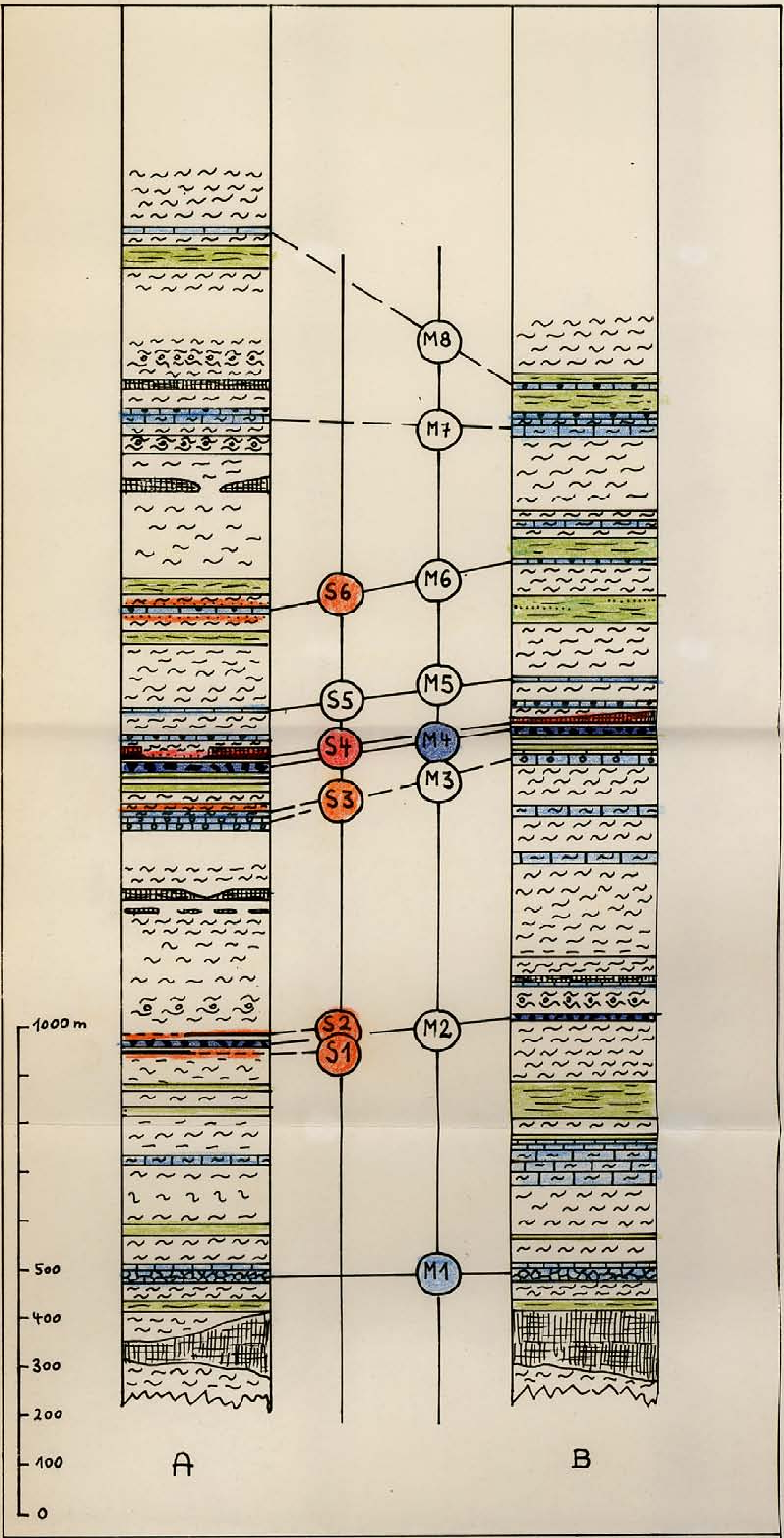
Fig. 4



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LEVIN P. Levin

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Fig. 2

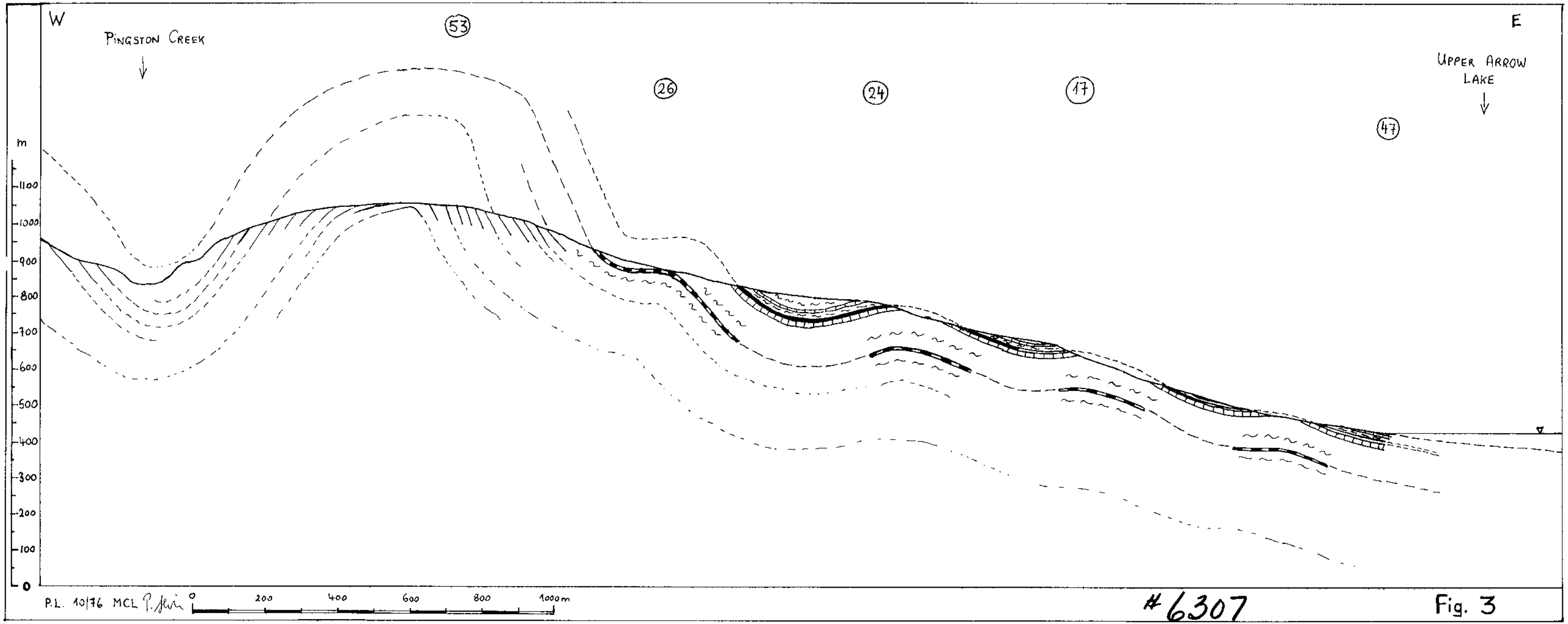
W
E
Pingston Creek
Upper Arrow Lake
53
26
24
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Fig. 3

UPPER ARROW LAKE / PINGSTON CREEK

FIG. 5

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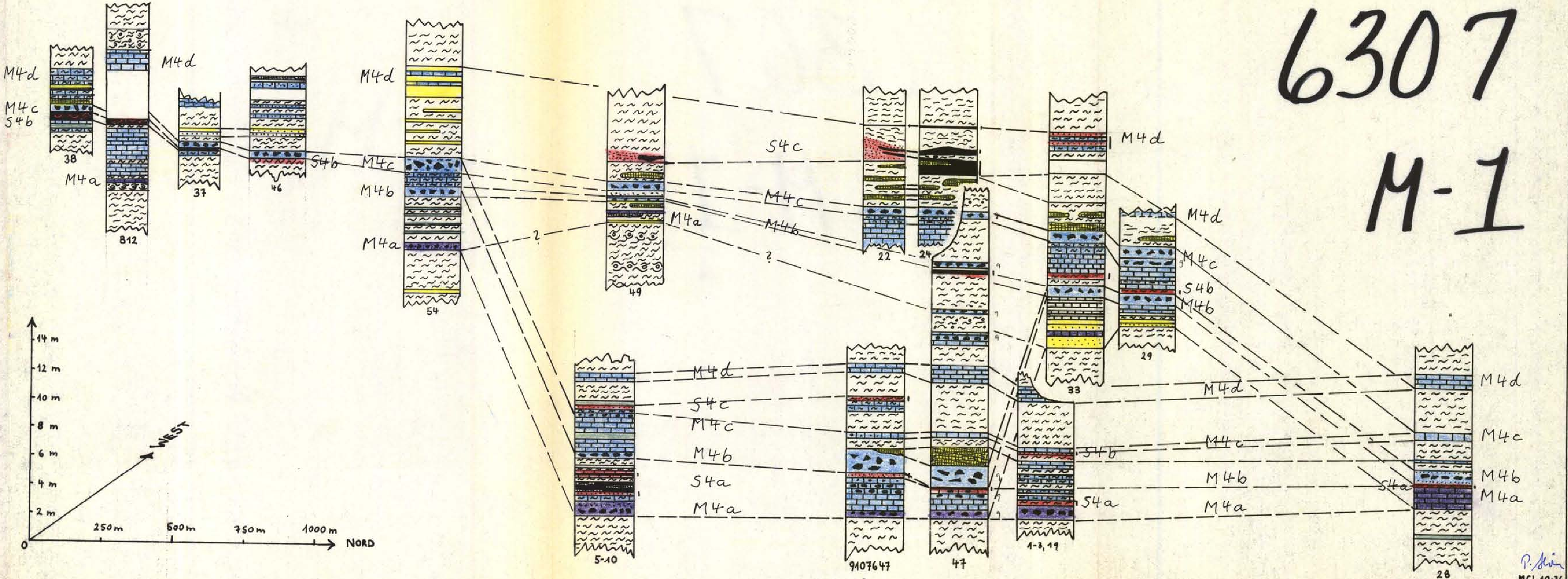
M-1



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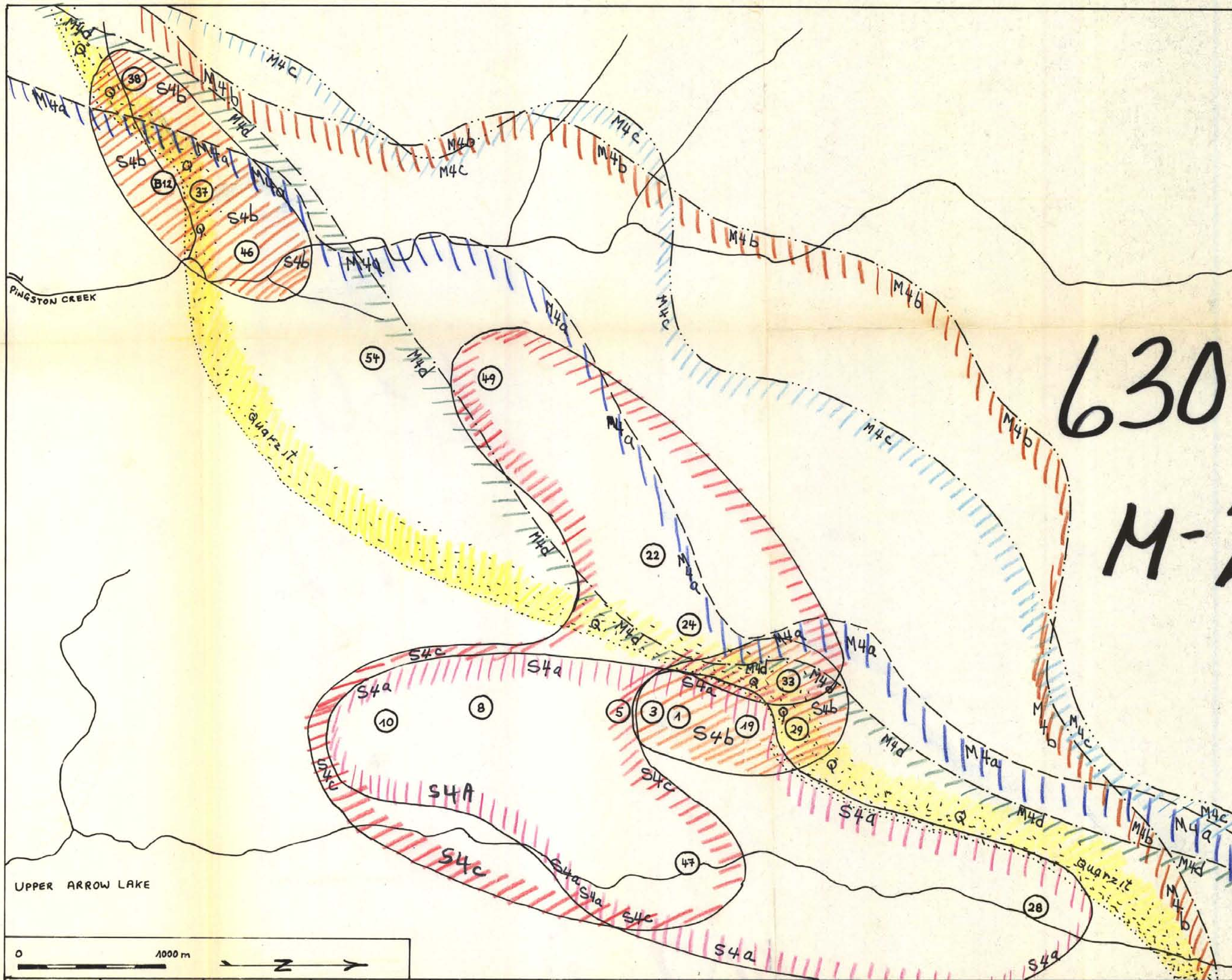
LEVIN



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M-2

MCL 10/76
LEVIN

Fig. 6

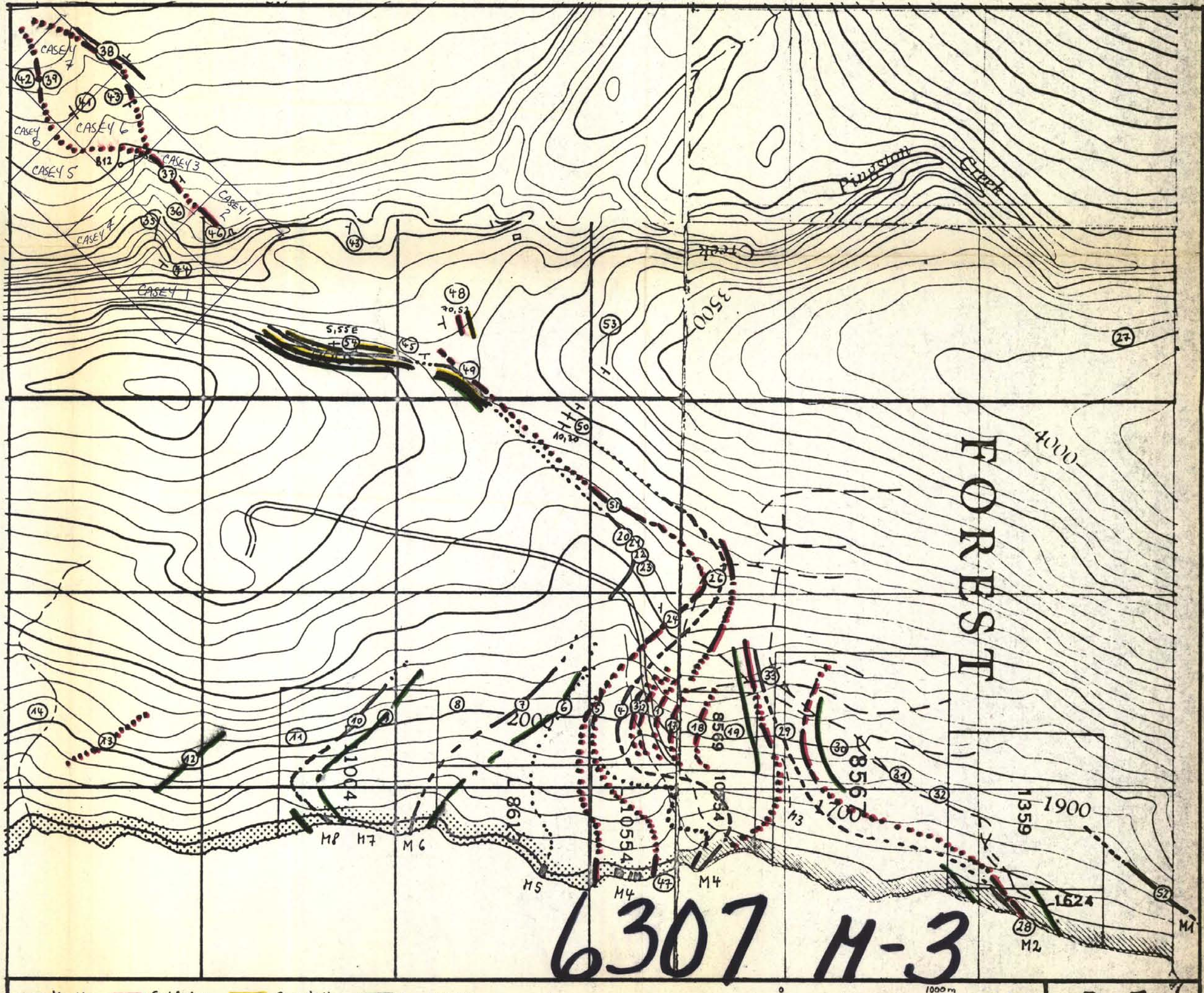
CASEY 7
CASEY 6
CASEY 8
CASEY 5
CASEY 3
CASEY 2
CASEY 1
Pingston Creek
Creek
3500
4000
FOREST
2000
1004
8613
10554
8569
1054
8567
1700
1359
1900
1624
M1
M2
M3
M4
M5
M6
M7
M8
6307 M-3
Marble
Sulfides
Quartzite
Amphibolites
0
1000m

Fig. 7