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GEOLOGICAL REPORT  
ON THE  
COTTONBELT Pb/Zn OCCURRENCE  
60 MILES N OF REVELSTOKE, B.C.

NTS 82 M 7

by

Dr. Peter Levin

Sept. 1976.

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1. INTRODUCTION

Metallgesellschaft Canada Ltd. and United Mineral Services Ltd. performed during the period of September 8th to September 19th, 1976, a geological study of 15 square kilometers in the GRACE MOUNTAIN area, approximately 60 miles north northwest of Revelstoke, B.C. (fig. 1). This study included detailed geological mapping, a structural analysis of the area and an examination of sulfide rich sections.

In addition to the geological mapping a magnetometer survey was conducted over 14.5 kilometers of line in order to aid in geological mapping of covered areas.

The purpose of the investigation was to better understand the geological controls, the tectonic deformation and the mode of occurrence of the sulfide mineralization found within the Grace Mountain area.

Sulfide mineralization was first discovered in the area during the early 1900's. The COTTONBELT property was subsequently staked in 1910 and has been worked intermittently since. The most recent examination of the area was done during the years 1968 to 1973 by Great Northern Petroleum Limited.

At present, the claims within the vicinity of Grace Mountain include seven crown granted mineral claims as well as the Vegas and Nevada mineral claims held by Messieurs Leo and George Adams of Kamloops, B.C. and the D; T; Snake Eyes; Cotton and Black Jack mineral claims held by United Mineral Services Limited.

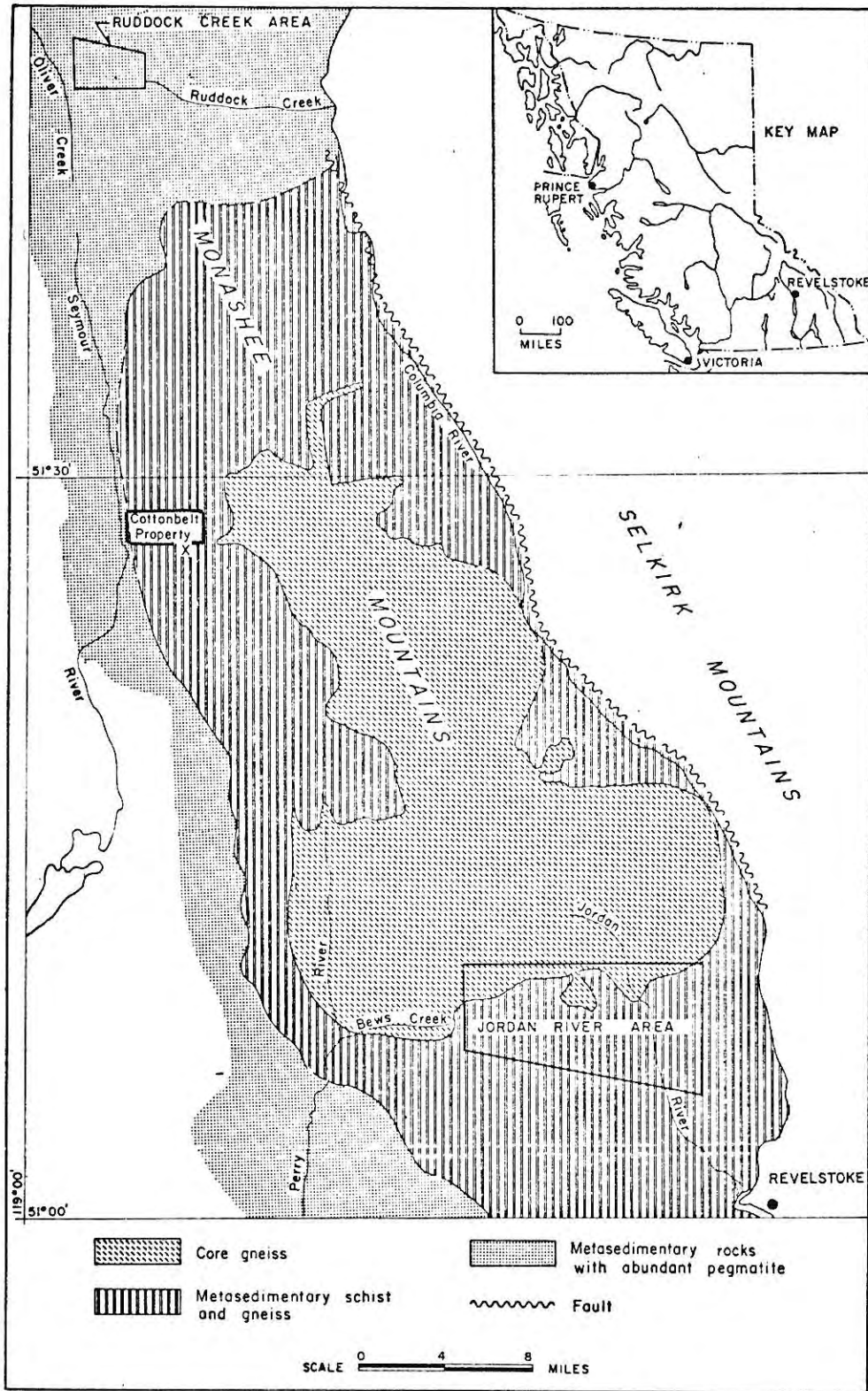
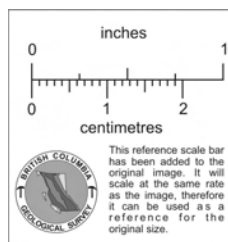


Figure 1. Index map showing the Frenchman Cap dome



## 2 . GENERAL GEOLOGY

" The Grace Mountain area lies within the Shuswap Metamorphic Complex. This complex contains rocks that have been raised to a high 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, 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 Grace Mountain area is on the northwestern flank of the Frenchman Cap Dome, which is the most northerly of the three. The area includes the outermost core gneiss and is mainly within the overlying metasedimentary gneiss and schist (Fig.1).

The metasedimentary rocks include quartzite, mica schist, quartz feldspar and calc-silicate gneiss and minor amounts of marble. They fall within the amphibolite facies of metamorphism and are complexly folded.

The lithologic sequences within the Grace Mountain area are folded into one syncline and two anticlines. The southwestern anticline is overturned to the northwest. The fold axes strike northwest-southeast. The tectonic framework within the Grace Mountain area appears to have been developed within the area that has been affected by the Frenchman Cap Gneiss Dome and a small well developed gneiss dome lying approximately 11 kilometers to the north of Grace Mountain.

## 2.1 Lithology of the Grace Mountain Area

The succession of metamorphic rocks in the Grace Mountain area (refer to figure 2) include quartz-feldspathic paragneiss(?); marble; calc-silicate gneisses; fine to medium grained biotite-quartz-garnet gneiss; micaceous quartzite; amphibolite and granulitic quartz-feldspar gneiss.

Pegmatitic lenses occur throughout the succession but are most abundant in the more strongly folded portions of the succession.

Rocks within the core zone of the Grace Mountain syncline are internally folded and foliation within this succession does not necessarily follow bedding.

Rocks on the flanks of the core zone are lithologically more homogeneous and foliation is commonly parallel to the bedding direction.

### 2.1.1 Granulitic Quartz-Feldspar Gneiss

These rocks display a wide range of textures and proportions. Mineralogically these gneisses are composed of quartz, feldspar (orthoclase and plagioclase) with a wide ranging fraction of biotite, muscovite, sillimanite, kyanite and garnet. Granulitic fabrics such as regular planar schistosity (as determined by coarse quartz with finely crystalline quartz and feldspar layers) are present. Coarser fractions often contain xenoblastic garnet and prisms of kyanite and/or sillimanite lie in the plane of schistosity. Magnetite is a minor constituent in these rocks.

The thickness of this unit varies at different sections of the Grace Mountain syncline and has a gradational transition into rocks of different mineral assemblages.

### 2.1.2 Amphibolite

A garnet amphibolite underlies the granulitic quartz feldspar gneiss and appears to be a laterally continuous unit within the sequence. The amphibolite is composed essentially of hornblende and plagioclase. It is medium to coarse grained with subhedral garnets up to 1cm in diameter occurring in segregated layers.



### 2.1.3 Quartzite

A light coloured quartzose gneiss is characterized by the presence of greater than 90% quartz and minor amounts of muscovite and occasionally a chloritic mica. The rock has a fine to coarse granular texture with micaceous layers parallel to foliation. This unit appears to be discontinuous to the south of column 14 (fig. 2) but has been noted in areas to the north of column 14.

### 2.1.4 Biotite-Quartz-Garnet Gneiss

The biotite-quartz-garnet gneiss encloses the calc-silicate and sulfide units (see chapter 2.3). This unit is fine to medium grained with segregation layering and lineation normal elements in the rock fabric. The parallel structures are disturbed by the presence of porphyroblasts of garnet (up to 0.5 cm in diameter).

The biotite is found as coarse flakes (up to 0.1 cm ) aligned within a fine grained quartzose matrix. In proximity to calc-silicate units the biotite-quartz-garnet gneiss can be calcareous.

### 2.1.5 Calc-Silicate Gneiss

Several thin horizons (see in particular column 17, fig.3) both below and above the sulphide horizon are composed of calcite, diopside, quartz and in some cases have accompanying garnet. The calcite is medium grained and comprises up to 70% of the rock. Euhedral pale-green diopside porphyroblasts comprise the remainder of the rock while a pink (grossularite(?)) garnet may be present.

### 2.1.6 Marble

The most persistent and distinctive unit in the field is a marble horizon which serves as a marker unit. The marble unit is white to grey and is composed of carbonates of which medium to coarsely crystalline calcite predominates. Foliation within the unit is outlined by flakes of pale-yellow phlogopite and

fine-grained graphite (?) inclusions within the calcite. An almost colourless to a very pale golden brown diopside is found as granular layer within the unit. These porphyroblasts are found up to 3 cm in length.

Underlying the marble unit are several variable lithologies. On the western limb of the Grace Mountain syncline the marble unit may be gradational into a unit with calcite, biotite and diopside cementing clasts of diverse lithologies. On the eastern limb of the Grace Mountain syncline, the marble unit is underlain by a quartzite unit.

#### 2.1.7 Quartzo-Feldspathic Paragneiss (?)

This unit forms the predominant unit underlying the marble horizon on the western limb of the Grace Mountain syncline. The unit is coarse to medium grained with a mineral composition of quartz, feldspar and accessory hornblende and biotite. This unit forms a conformable continuation of the succession that has been described above.

#### 2.1.8. Pegmatitic Lenses

The term pegmatitic refers to those granitic rocks having appreciable proportion of orthoclase and quartz greater than 2 cm in size. Gradation in size of the mineral components is present and accessory minerals such as tourmaline and muscovite are common.

The pegmatitic lenses occur throughout the section but are most prominent in the more intensely deformed portions of the section.

#### 2.1.9 Summary

A stratigraphic framework is present in the gneisses of the Grace Mountain area. Lithological dissimilarity of units and demonstratable continuity of layers constitutes the characteristics of the metasedimentary sequence in the Grace Mountain area. Granulitic quartz-feldspar gneiss forms the core unit while the remainder of the sequence is composed of meta-sedimentary and metavolcanic rocks.

The mineral assemblages indicate metamorphism of the amphibolite facies.

Pegmatitic lenses composed of coarse grained orthoclase-quartz and accessory muscovite and tourmaline occur throughout the succession and are most abundant in the core unit.

## 2.2 Tectonic Structure

Two tectonic elements are distinguishable within the Grace Mountain area. These are fracture tectonics and fold tectonics. Both the fracture and fold tectonics reflect a southwest-northeast structural trend as indicated by the fold axes and conjugate fracture sets.

The folding consists of a large prominent syncline with an axial plane trace passing across Grace Mountain. An anticline adjoins the syncline to the northeast and another adjoins the syncline to the southwest.

The syncline is asymmetric and is a continuation of a northeasterly overturned fold. The syncline is the main structure exposed within the Grace Mountain area and can be traced along a strike length of seven kilometers. The core of the syncline is composed of internal drag folds that have locally been sheared in a northeasterly direction.

The axis of the syncline plunges southeast at the southeastern end of the syncline, is horizontal at Grace Mountain and plunges to the northeast at the Cottonbelt (Appendix 1 : locality 6). The limbs of the syncline change to a more horizontal attitude towards the northwestern direction.

In the region where the plunge changes from the southeast to the northwest a supplementary set of NE-SW striking folds has been developed. This fold set has resulted from a later phase of minor folding.

The structural style of the Grace Mountain area is related to the development of the Frenchman Cap Gneiss Dome and another smaller unmapped gneiss dome situated 11 kilometers north of Grace Mountain.

### 2.3 Lead-Zinc-Copper-Sequence

The lead-zinc-sulfide mineralization in the studied area is predominantly stratabound. These horizons are geometrically and genetically related with a carbonate rich sequence of gneiss. There are found different transitional types between massive sulfides and disseminated lead and zinc and between carbonate rich gneiss and marble.

#### 2.3.1 Mineralization

The common ore minerals are magnetite, pyrrhotite, galena, sphalerite; pyrite and chalcopyrite are rare; a silver sulfosalt from the McLeod N location has not been studied yet; the gangue minerals are: calcite, garnet, diopside, dolomite, tremolite, sillimanite, andalusite etc. The grain size of the ore minerals is varying between 50  $\mu$  and 3 cm. Sphalerite shows mostly a smaller grain size than galena. Intensive inter-growths exist probably between magnetite and sphalerite.

There are three types of metal-rich horizons:

- massive sulfide/oxide
- rhythmic layers of ore minerals and carbonates/silicates
- disseminated sulfides/oxides

The metal contents of the mineralized horizons are not yet well known; sulfide channel samples are not available in all locations. Channel samples with predominantly sulfidic ore minerals were taken from the locations 1, 2, 4, 5, 6, 7, 12, 13.

Location	Silver oz/t	Cu %	Pb %	Zn %	As %	Sb %	Hg %
7	1.3	0.02	5.30	0.60	0.01	0.01	0.01
6	1.9	0.01	8.00	2.90	0.01	0.01	0.01
2	1.1	0.01	4.10	0.50	0.01	0.01	0.01
1	0.59	0.01	2.55	0.35	0.01	0.01	0.01
5	0.57	0.01	2.20	0.34	0.02	0.01	0.01
4	0.18	0.02	0.57	0.40	0.01	0.01	0.01
13	5.2	0.33	12.40	10.30	0.01	0.02	0.01
12	1.3	0.03	3.33	4.65	0.01	0.01	0.01

*all  
1.5m  
2m thick  
2m thick*

HORIZON	MINERALS	TEXTURE	REMARKS
A	CuFeS <sub>2</sub> , PbS, FeS <sub>2</sub> , quartz	thin layer with/ in quartz	horizon is outcropping only in 3 locations; only sulfide horizon in gneiss without marble content
B	PbS, ZnS, FeS <sub>2</sub> , FeS, carbonates	sequence of sulfide rich horizons with interbedding gneisses	the thickness of the sulfide rich layers is varying (lens like); the layers are forming a horizon of a more or less stable thickness
C	PbS, ZnS, FeS, FeS <sub>2</sub> , carbonates	massive sulfide like textures	inclusions of rounded light red garnets in the ore
D	PbS, ZnS, Fe <sub>3</sub> O <sub>4</sub> , FeS, FeS <sub>2</sub> , carbonates	sedimentary like features	tremolite, diopside and red-brown garnets as layers in the ore; carbonates mostly in big crystals (1-5 cm)
E	calcite, dolomite, phlogopite, graphite, sillimanite, andalusite	coarse grained homogeneous marble	thickest marble unit of stable thickness; few inclusions of calc-silicates; on the top of the unit is a phlogopite rich gneiss breccia with calcite matrix
F	calcite (dolomite), diopside chlorite (?)	fine grained	diopside in irregular small thin crystals; colour of the unit blue-green; small sulfide contents (FeS <sub>2</sub> , PbS)
G	calcite, quartz, Chlorite (?)	medium grained	the colour is white, green and grey in stratabound bands; not homogeneous; biotite rich gneiss layers with hornblende crystals
H	calcite, quartz, andalusite	medium grained	the unit includes big concentrations of andalusite crystals of a size between 1 cm and 12 cm; contents of graphite crystals in thin layers
K	calcite, dolomite, few calc-silicates	coarse grained homogeneous marble	stylolitic stratabound bands esp. on the contact with the hanging and the footwall

The maximum of the lead and zinc contents occurs at the locations 13, 12 and 6. Generally lead is higher than zinc; copper and silver are low.

The samples were taken as channel samples perpendicular to the stratification, repeated three times and mixed. The length of the channel samples is 2 m in the locations 12 and 13 and includes the horizons C,D and H (fig. 11); in the other locations the length of the channel samples is 1.5 m and includes the horizons B,C,D,G, and H.

### 2.3.2 Stratigraphic Position

The sequence of the sulfide rich and carbonate rich horizons A to K has a thickness of approximately 40 m. It is built up of a homogeneous 2 m thick marble horizon (no E in fig. 11), overlain by a sequence of diopside-biotite-garnet-quartz-calcite-gneiss 9 m in thickness, which itself is overlain by a sequence of 9 m in thickness of biotite-muscovite-garnet-quartz-diopside gneisses. In between both sequences of gneisses a remarkable sequence 1 to 6 m in total thickness of 4 sulfide rich horizons (A to D) and 4 carbonate rich horizons (predominantly marble) is intercalated. This unit is unique within a series of more or less homogeneous gneisses with a thickness of about 500 m.

## 3. RESTORATION OF FOLDED METAL SULFIDE HORIZONS

( Palinspastic Model)

The style of the fold structures in the Grace Mountain area makes it possible to determine the original unfolded configuration of the metal sulfide horizons between the northeastern and southwestern outcrop lines (see Appendix 1). Transferring the information from the stratigraphic

columns (fig. 11) to the palinspastic map enables a reconstruction of the approximate thickness and extensions of the sulfide (fig. 12) and carbonate (fig. 13) horizons. Of particular note in the reconstruction is that both the metal sulfide and carbonate horizons have a similar length configuration. The maximum thickness of the carbonate and sulfide horizons is found to lie approximately in the centre of cross-section C-D (fig. 5).

The palinspastic maps (fig. 12 and 13) show a north-south elongation of the metal sulfide and carbonate horizons which probably reflects a paleogeographic feature.

The assays of each locality (chapter 2.3.1) are indicating a very similar elongation considering the grade of lead and zinc in the horizons B, C and D. The ratio of Zn to Pb probably is dependent on the position of the locality in the basin. The nearest locality to the suggested centre of the basin is 12, showing a relation Zn: Pb 1 (fig. 14). This ratio decreases from 1.39 (12) to 0.83 (13) to 0.36 (6) to 0.7 (4) to 0.12 (2) and to 0.11 (7) in relation to the distance of each location from the assumed centre of the basin.

#### 4. SUMMARY AND CONCLUSIONS

- The rocks within the Grace Mountain area are predominantly composed of a variety of gneisses which include a calcareous gneiss and a marble unit.
- The sedimentary features of the metamorphosed sediments are relatively well preserved.
- The main structure is an asymmetric syncline with superimposed minor folds that were developed during a later phase of deformation.

- The structural style of the area is related to the development of large and small gneiss domes located outside of the study area.
- The calcareous gneiss sequence contains the sulfide horizons.
- The metal content of the sulfide horizons is variable and includes pyrrhotite, pyrite, magnetite, sphalerite, galena and chalcopyrite.
- It is suggested that the sulfide outcrops exposed within the Grace Mountain area (Appendix 1: 1 to 10 and 11 to 13) constitute a continuous metal sulfide horizon.
- The maximum thickness of these horizons is located in the central portion of the Grace Mountain syncline. This situation increases the probability of a tectonic thickening of the metal sulfide horizons (fig. 5).
- The projected surface location of this suggested thickened sulfide zone is shown in Appendix 1(72.5 - 01.65); and is 350 m west of Bass shaft (Appendix 1: locality 2).
- The thickened area lies at an elevation of about 1.250 m a.s.e., therefore there is a minimum drilling distance of 600 m to encounter the thickened sulfide zone.
- The major elongation of the metal sulfide "C" horizon is 4.8 km; the minor distance is 1.4 km. The major elongation of the "D" horizon is 3.2 km; the minor distance is 1.0 km (fig. 12 and 13).

The area encompassed by the metal sulfide "C" horizon is 6.7 square kilometers and "D" horizon encompasses an area of 3.2 square kilometers. Both of these horizons are located within the same stratigraphic interval (fig.11) and constitute one sulfide unit.



- The mineralized area is deemed to be a favourable environment for the existence of an economic concentration of metal sulfides because of the geologic factors which can produce a primary and secondary enrichment of the metal sulfides.

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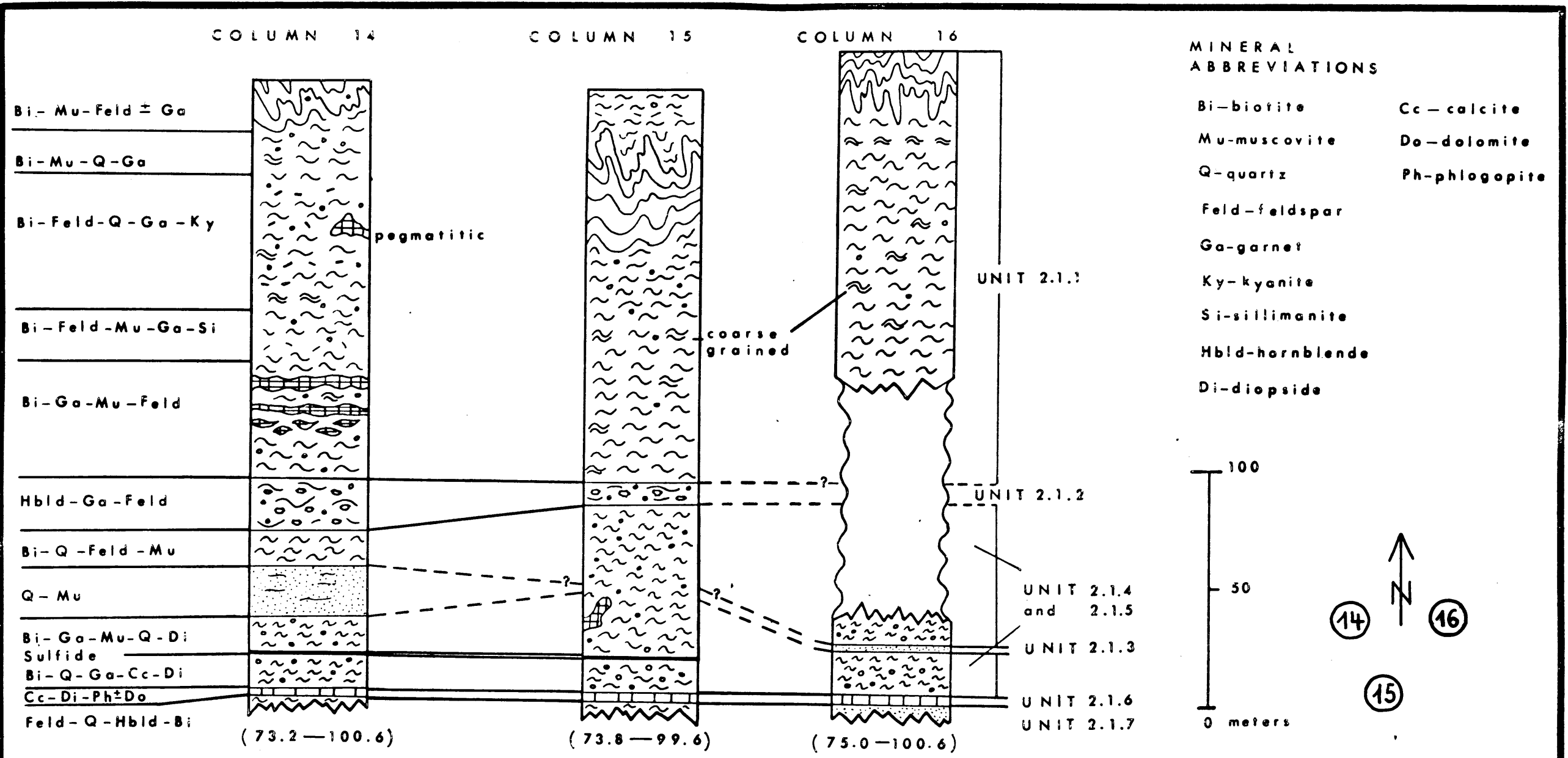
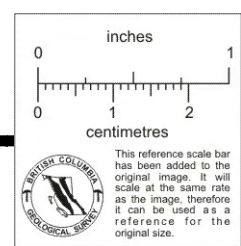
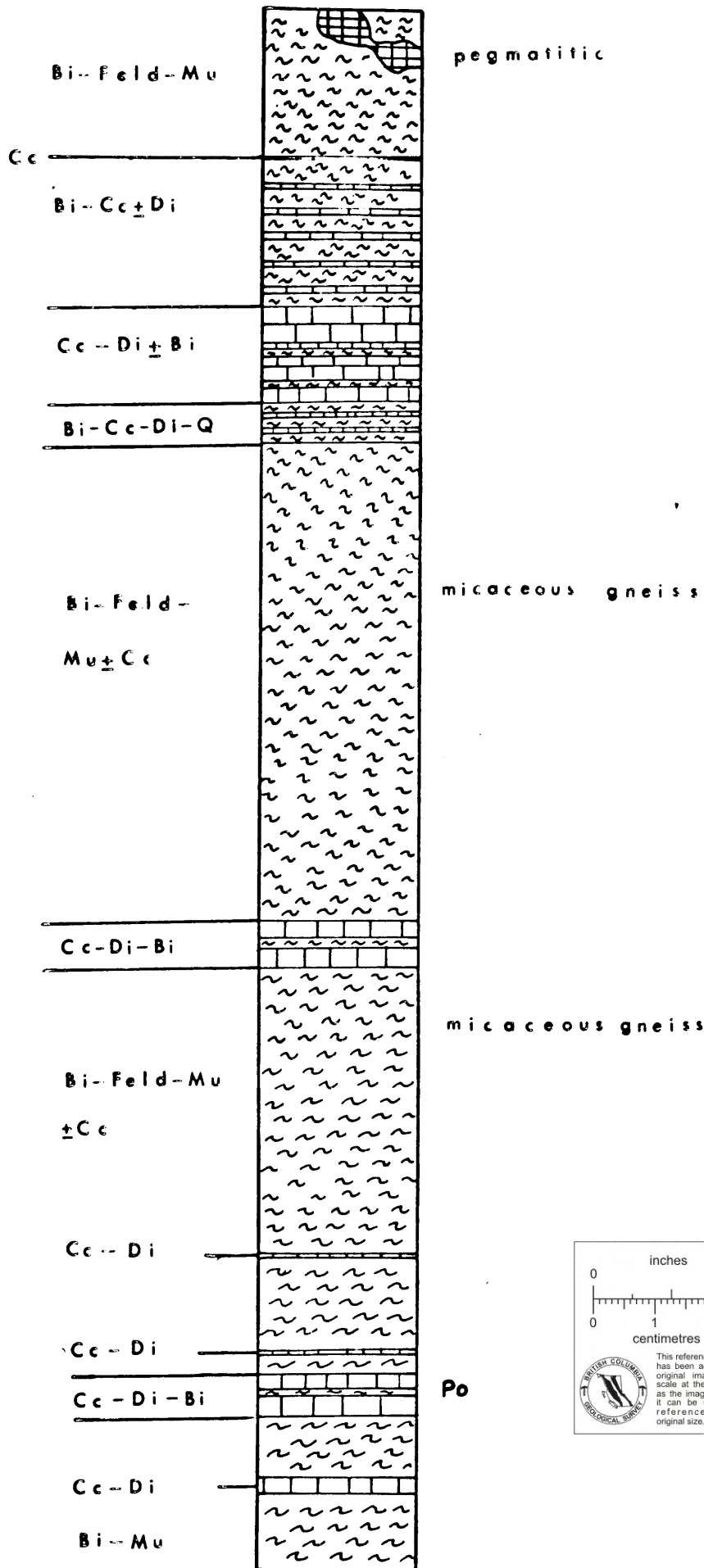


FIG. 2



COLUMN 17



(71.3 - 4.5)

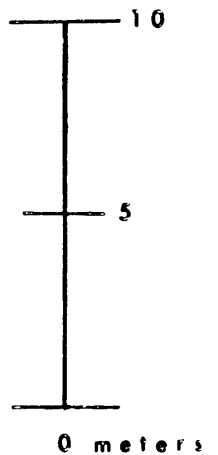
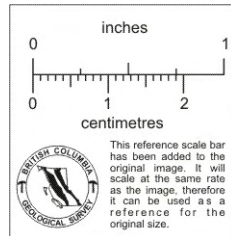
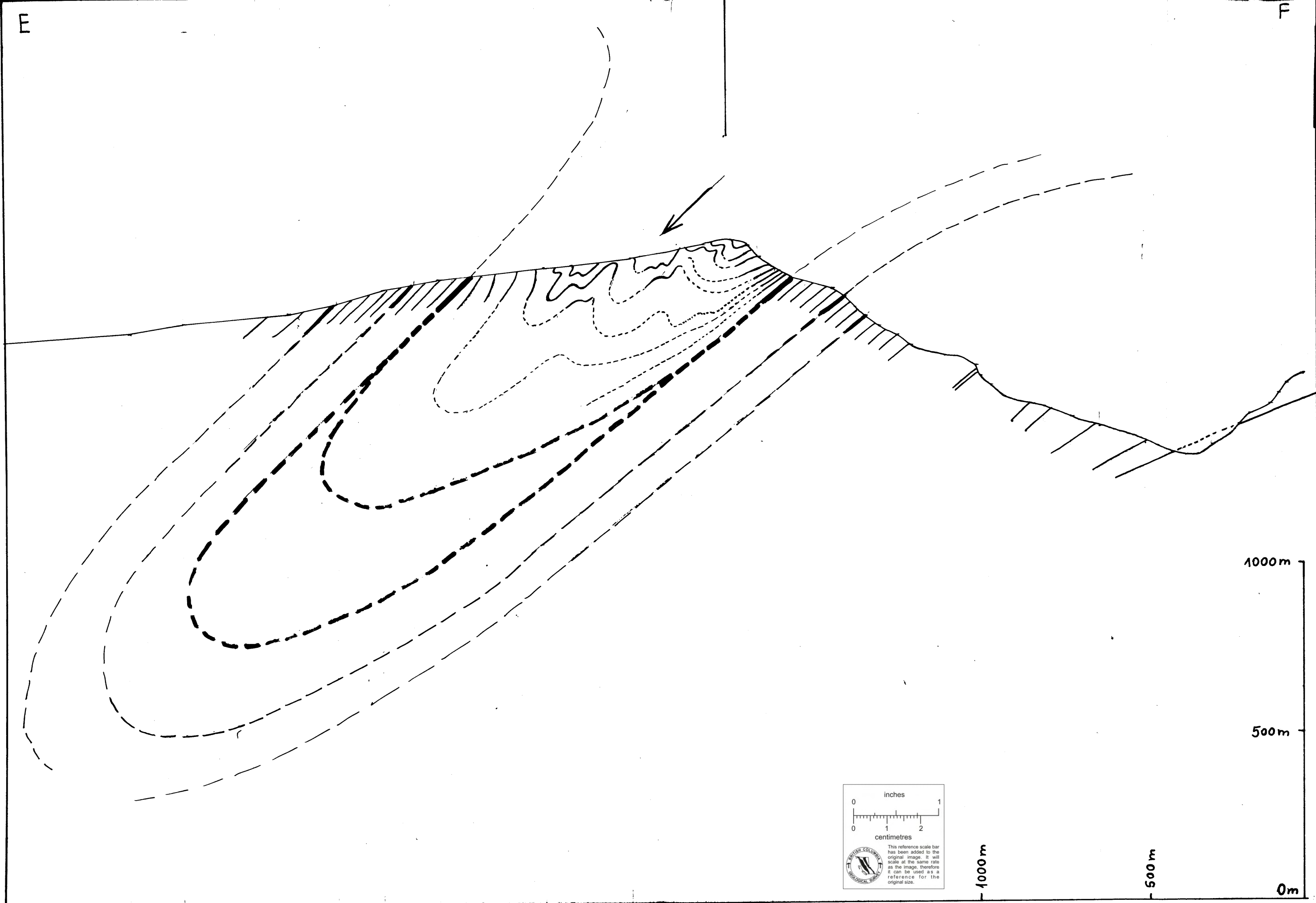


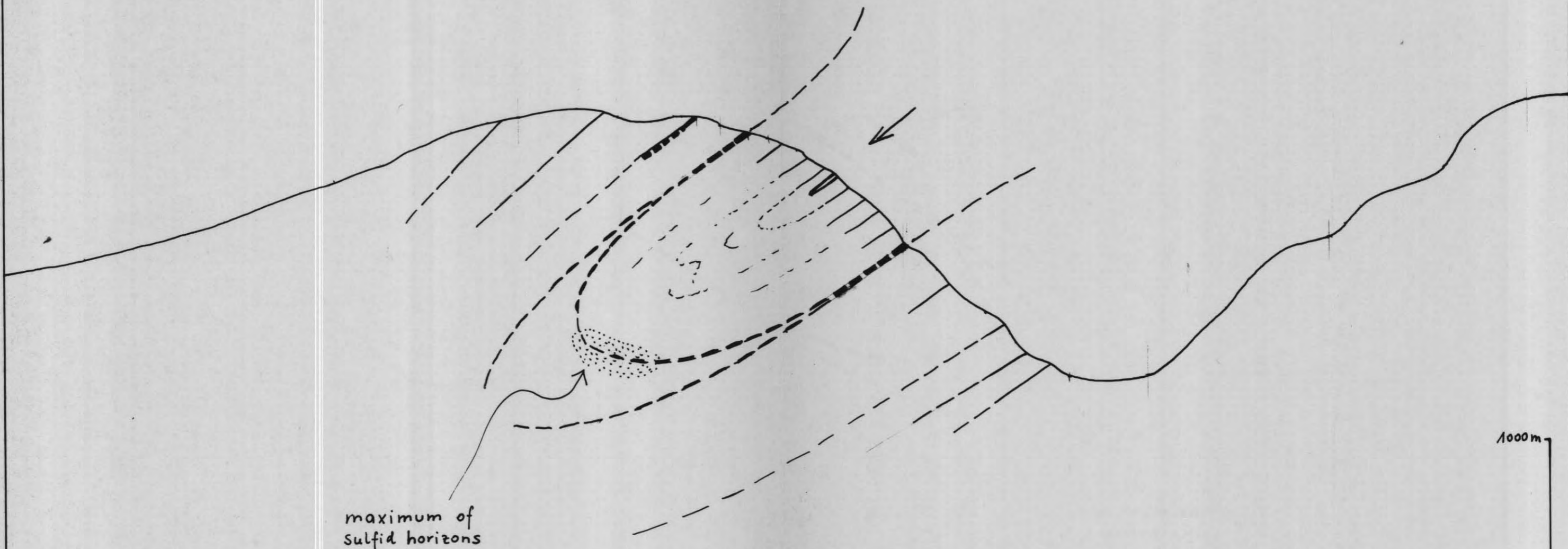
FIG. 3

9176 Mc



C

D

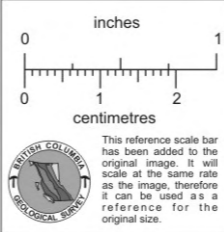


maximum of sulfid horizons

1000m

500m

0

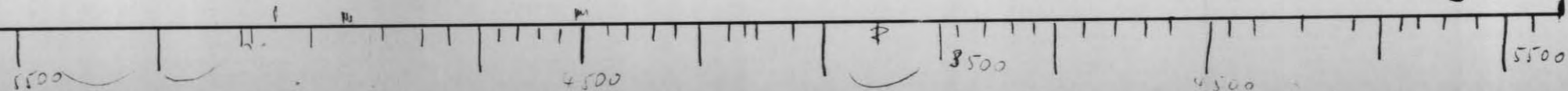


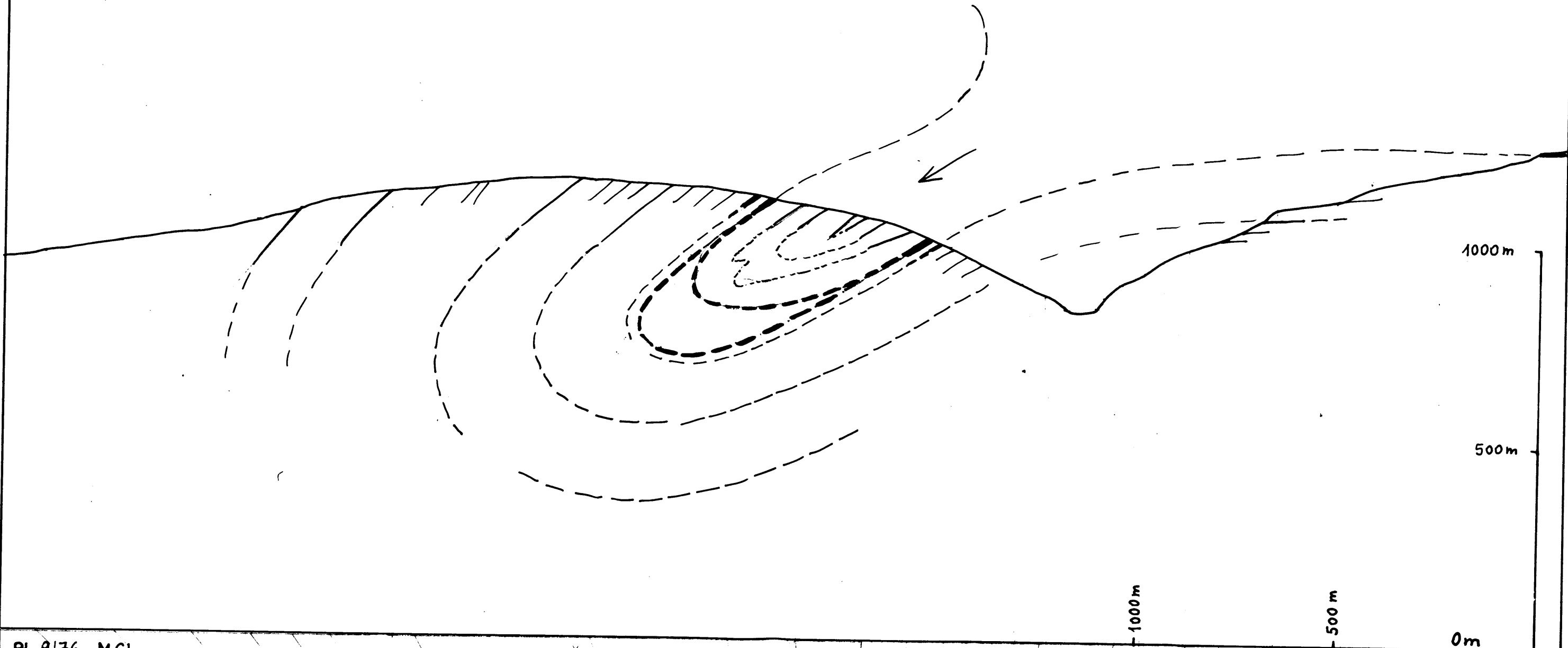
1000 m

500 m

PL 9/76 MCL

Fig. 5

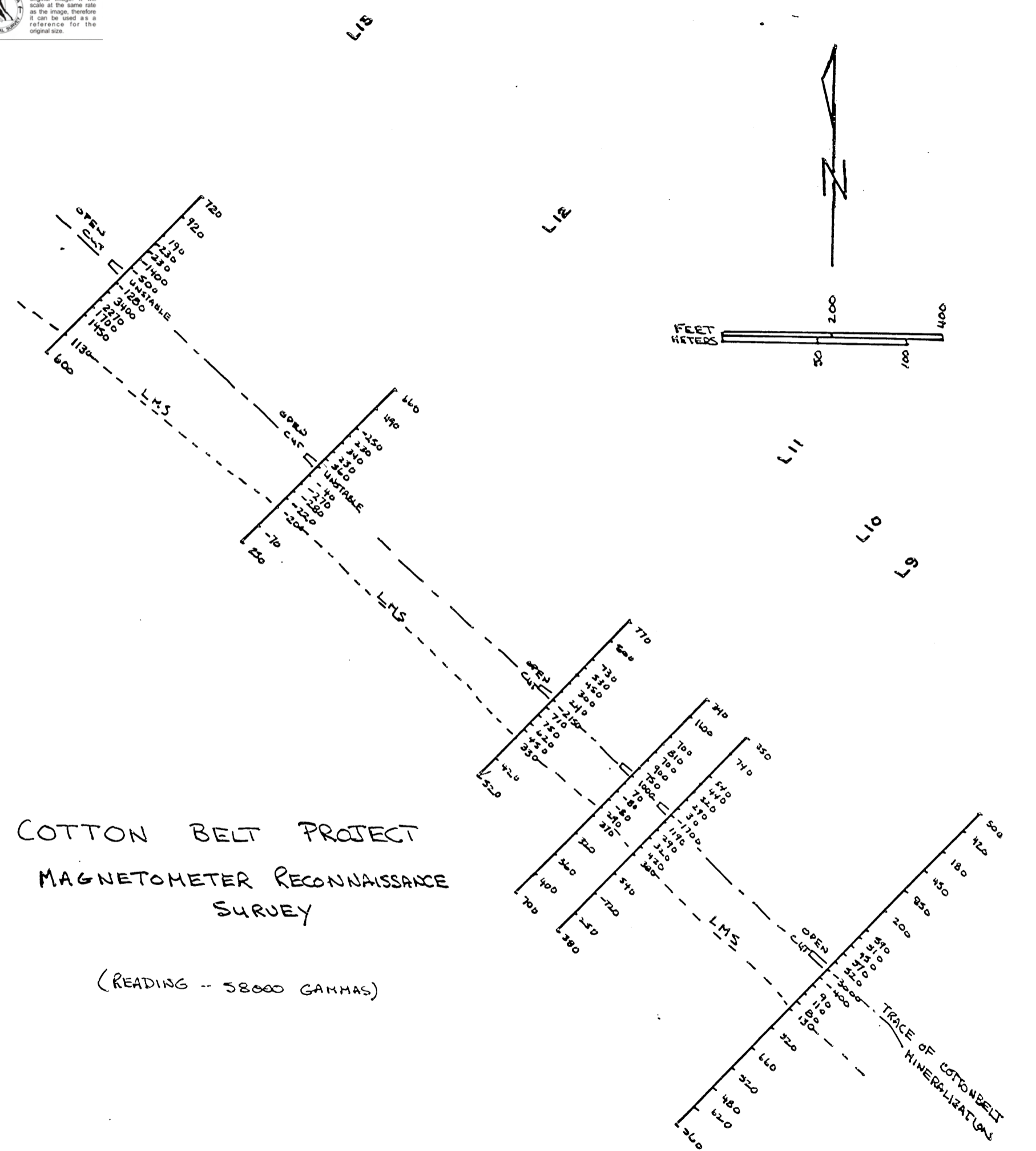
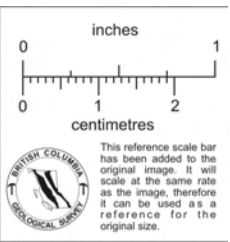




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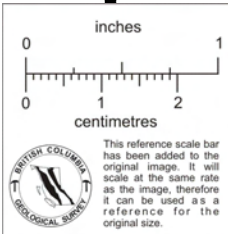
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Fig. 6



COTTON BELT PROJECT  
MAGNETOMETER RECONNAISSANCE  
SURVEY

(READING -- 58000 GAMMAS)



COTTON BELT PROJECT  
MAGNETOMETER RECONNAISSANCE  
SURVEY

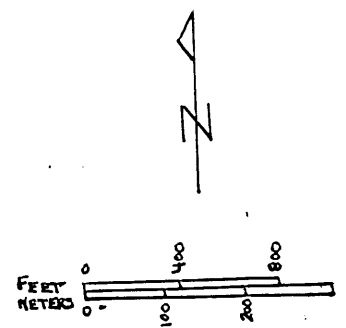
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- 600 - 800
- 400 - 599
- 200 - 399
- 0 - 199
- < 0 GAMMAS

71

04

04

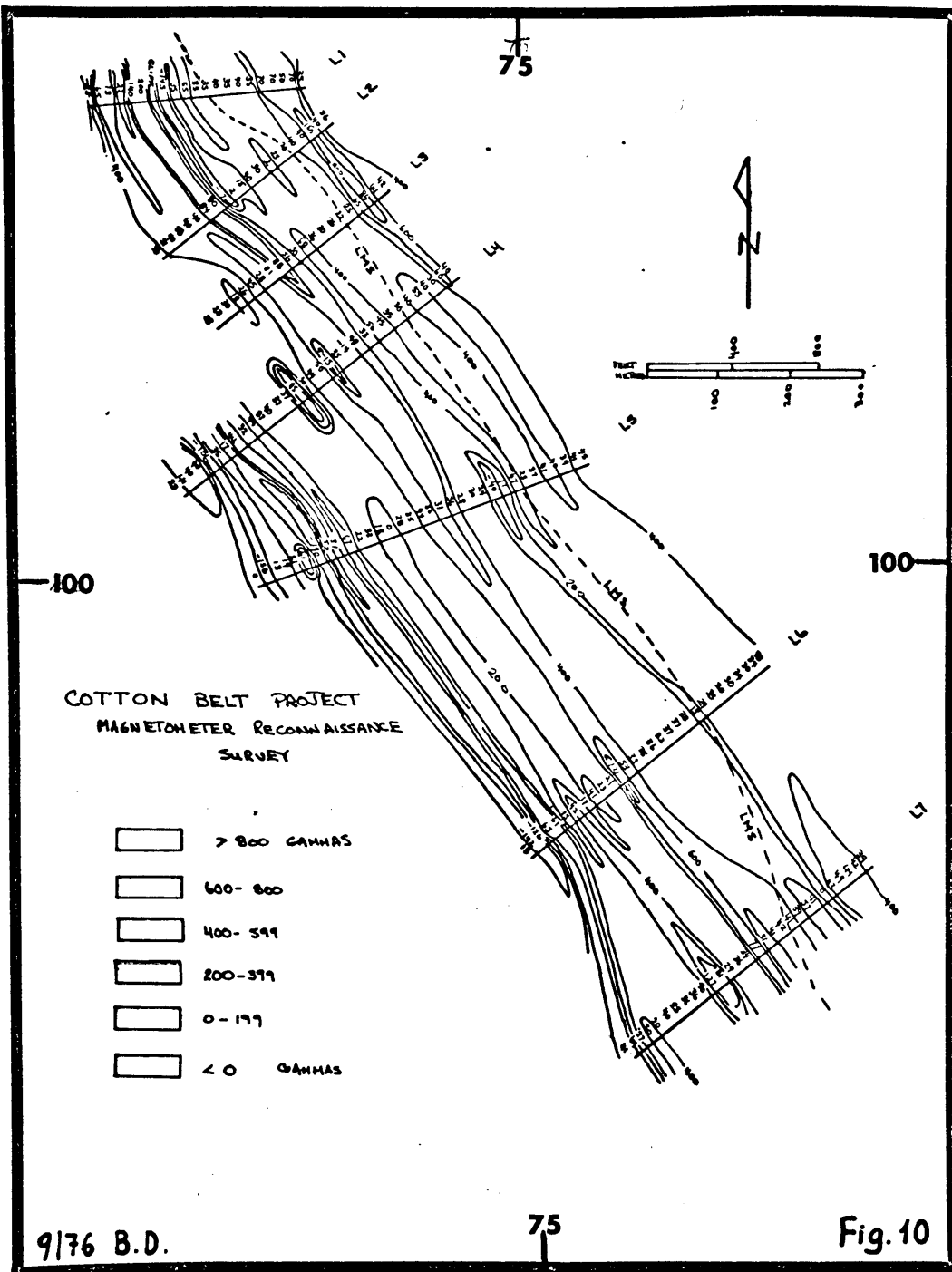
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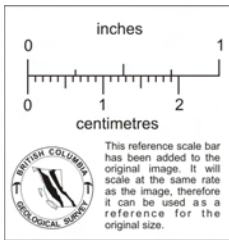
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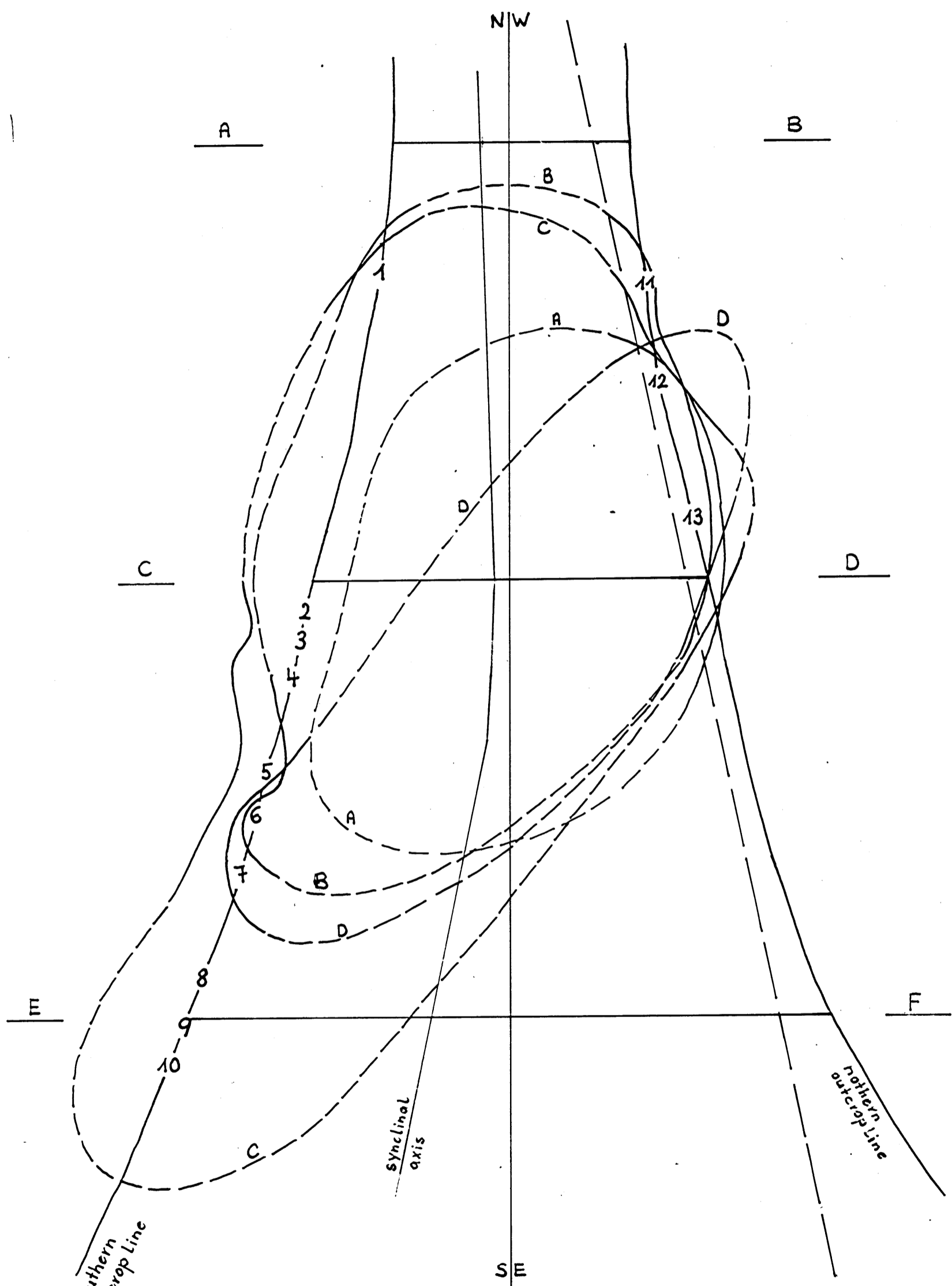




COTTON BELT PROJECT  
MAGNETOMETER RECONNAISSANCE  
SURVEY

- > 800 GAMMAS
- 600- 800
- 400- 599
- 200- 399
- 0- 199
- < 0 GAMMAS





0 500 1000 m  
 PL 9/76 MCL

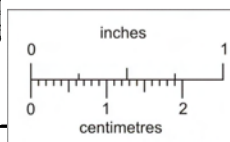
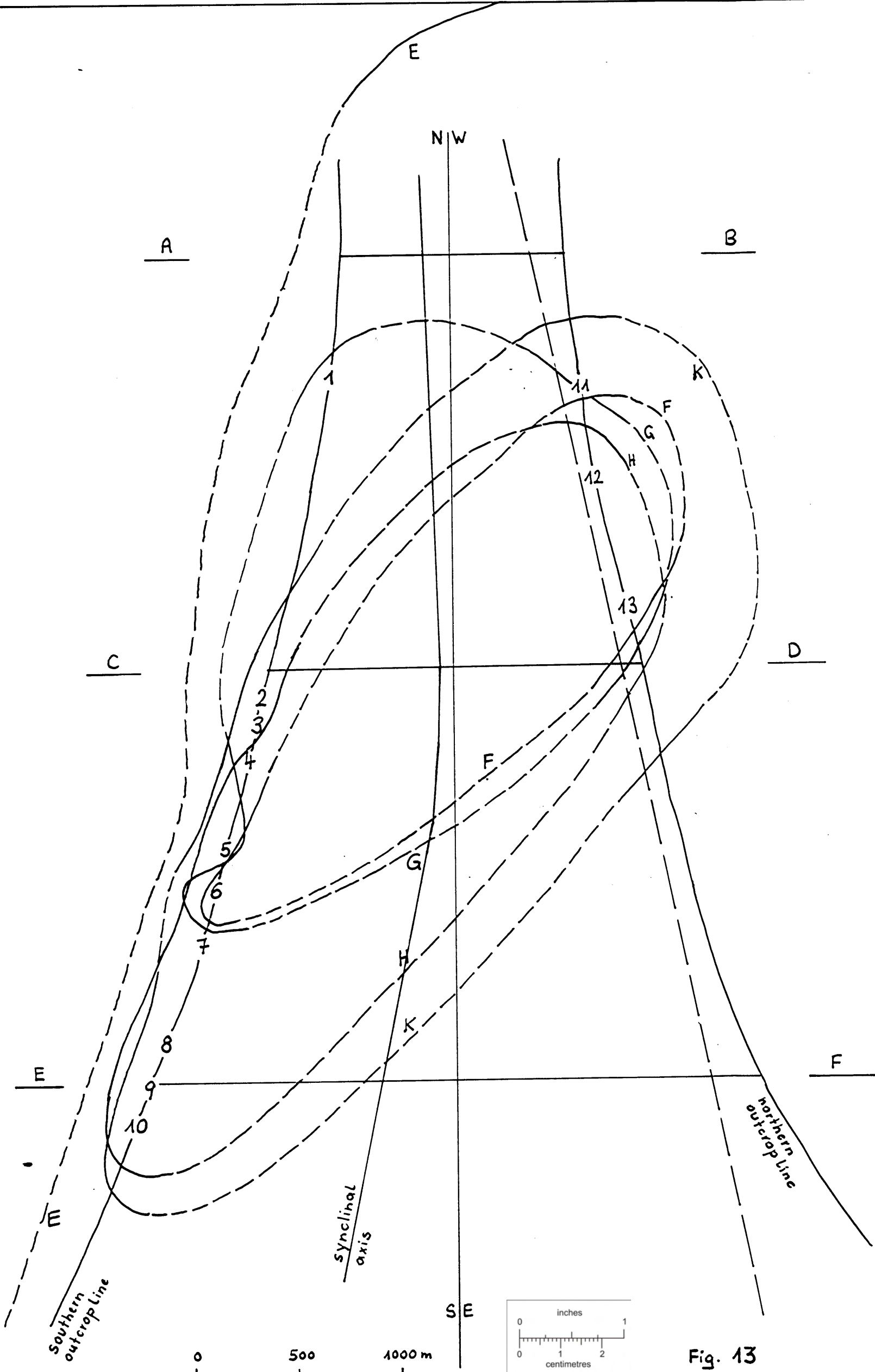


Fig. 12

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.



0 500 1000 m  
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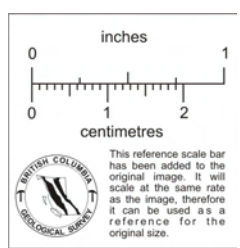
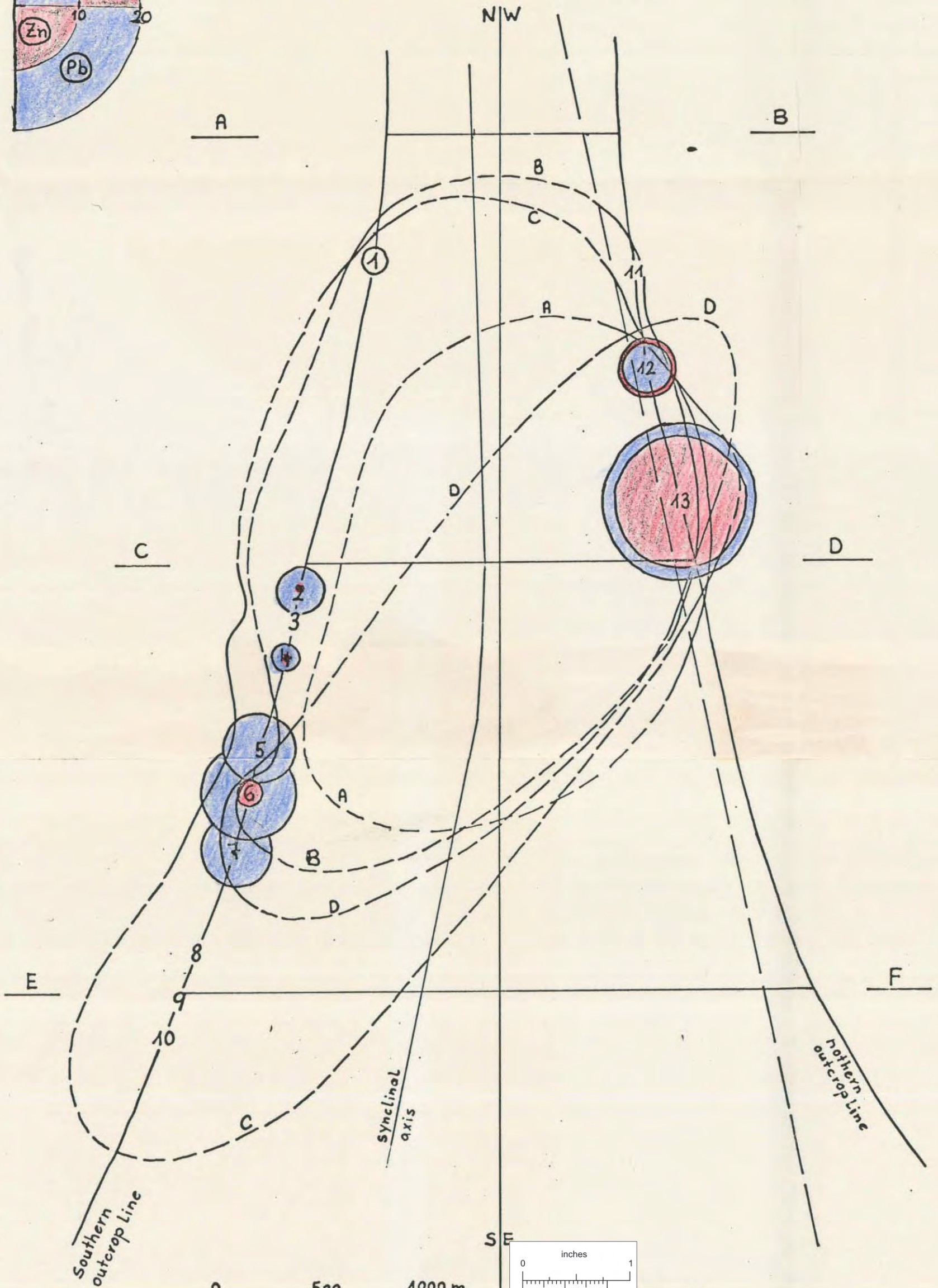
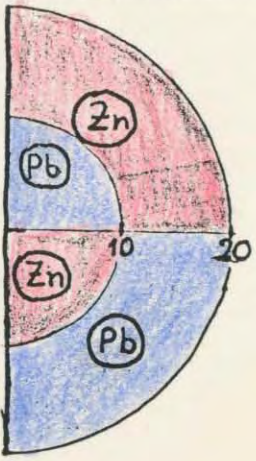


Fig. 13



0 500 1000 m  
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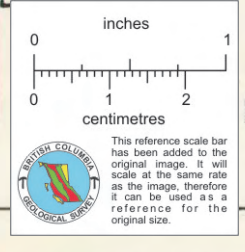


Fig. 14

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

Fig. 7 } in this  
Fig. 11 } pocket

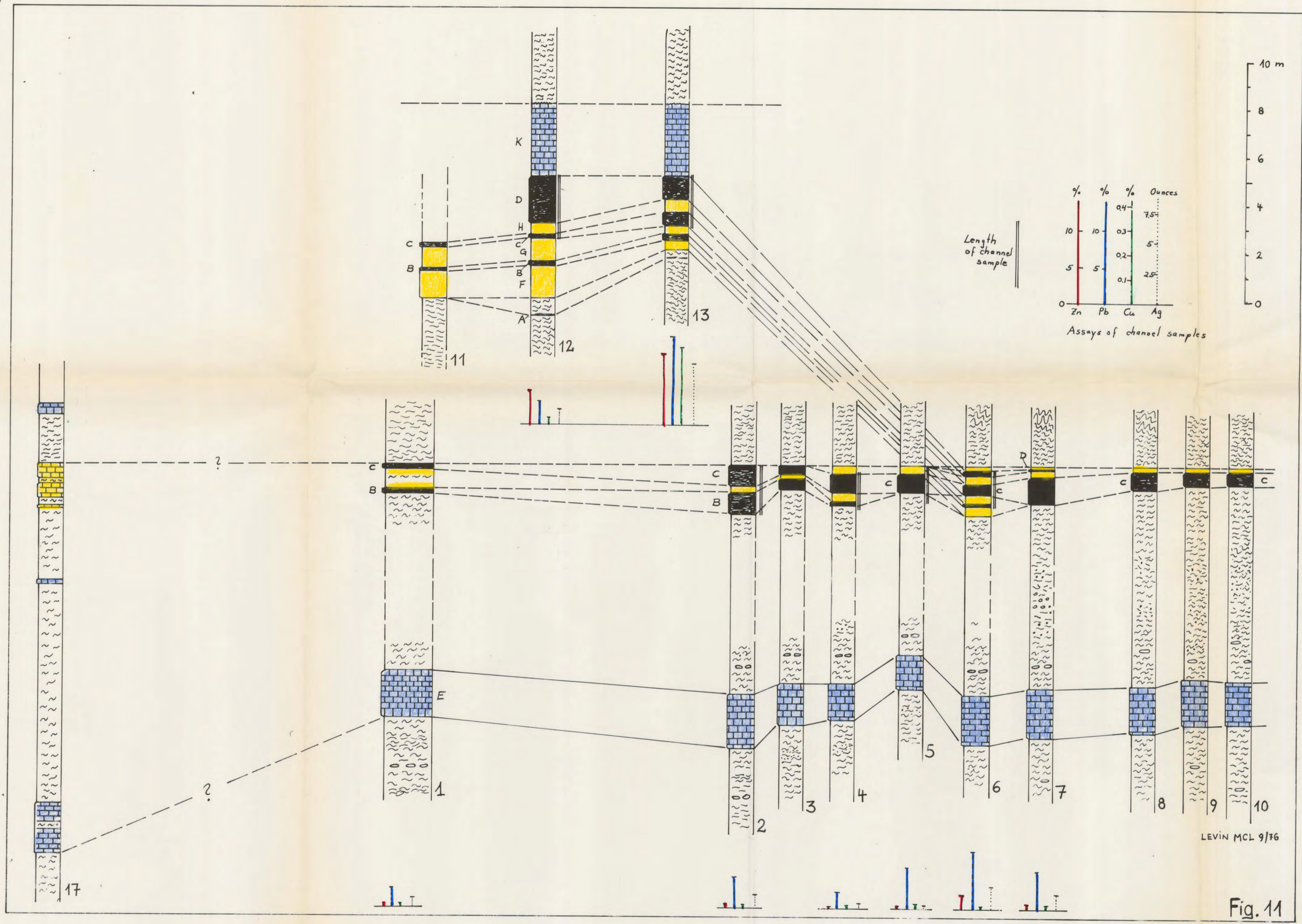
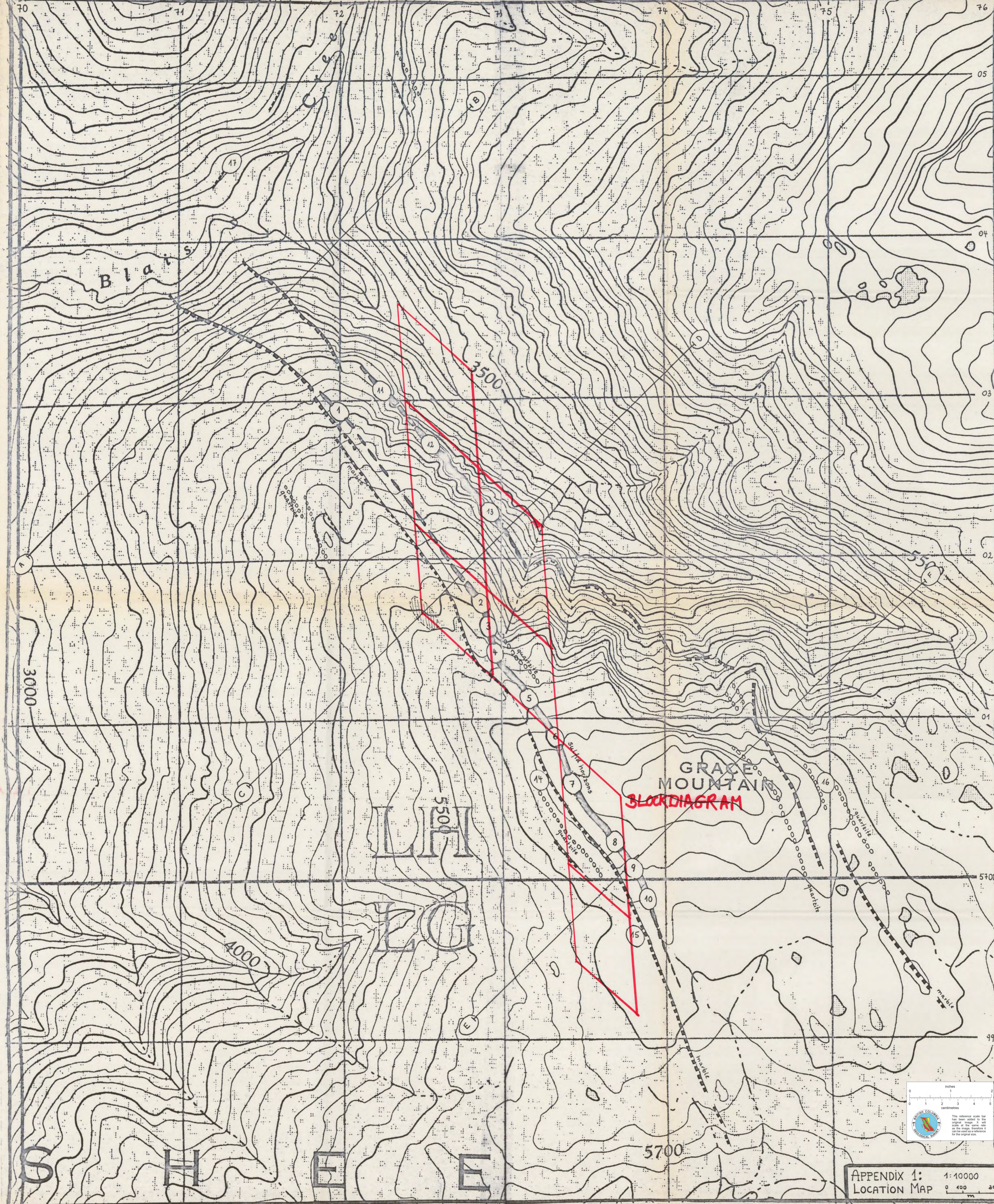


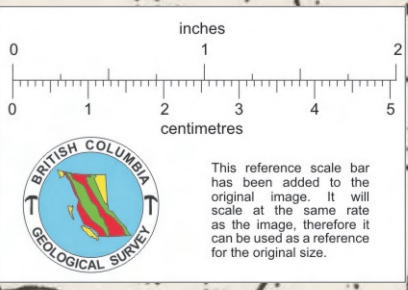
Fig. 11



Blair

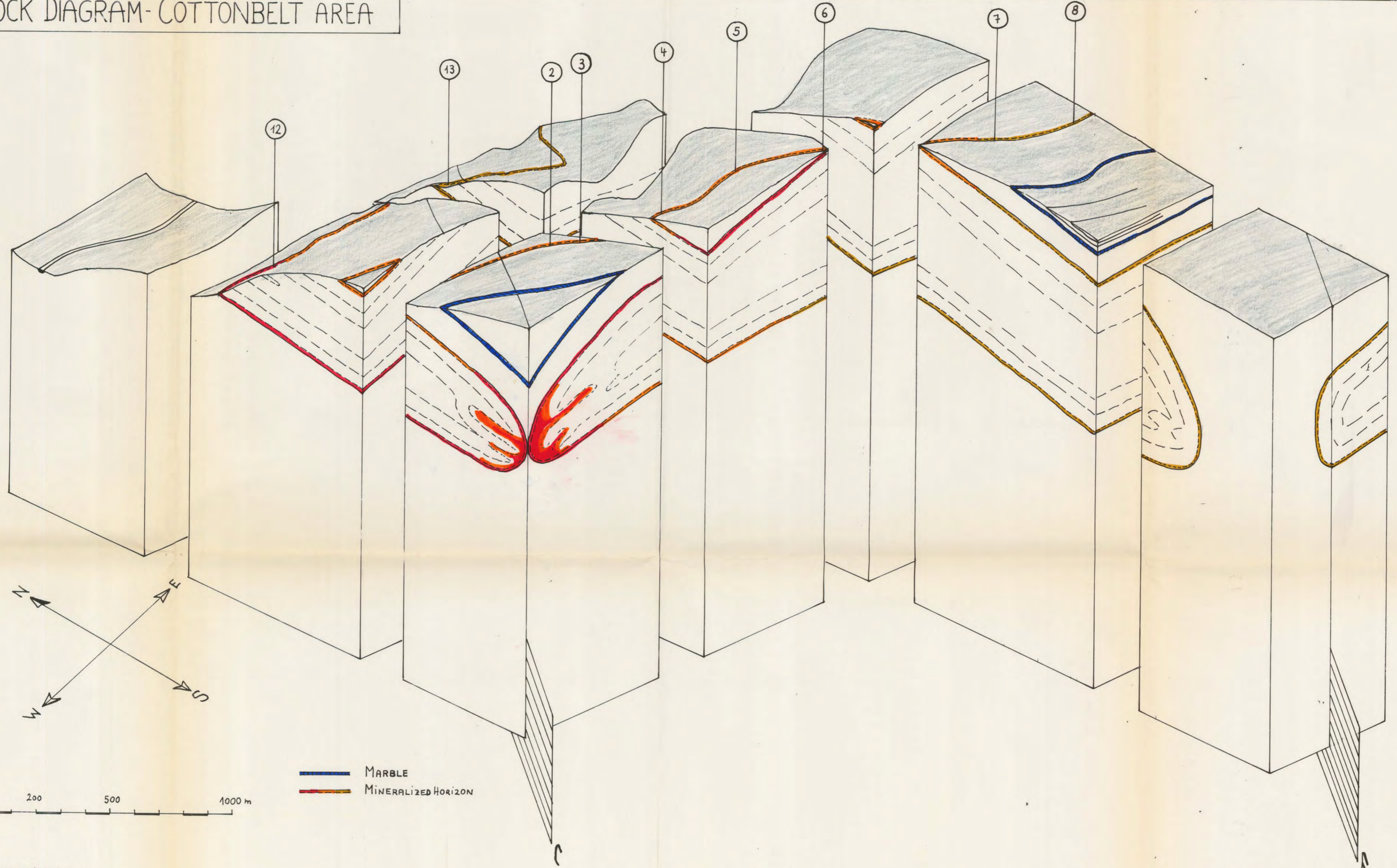
SHREVE

GRACE MOUNTAIN  
BLOCKDIAGRAM



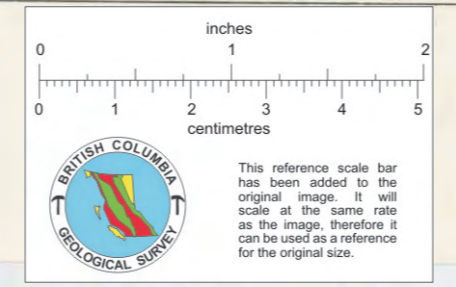
APPENDIX 1: 1:10000  
LOCATION MAP

# BLOCK DIAGRAM - COTTONBELT AREA

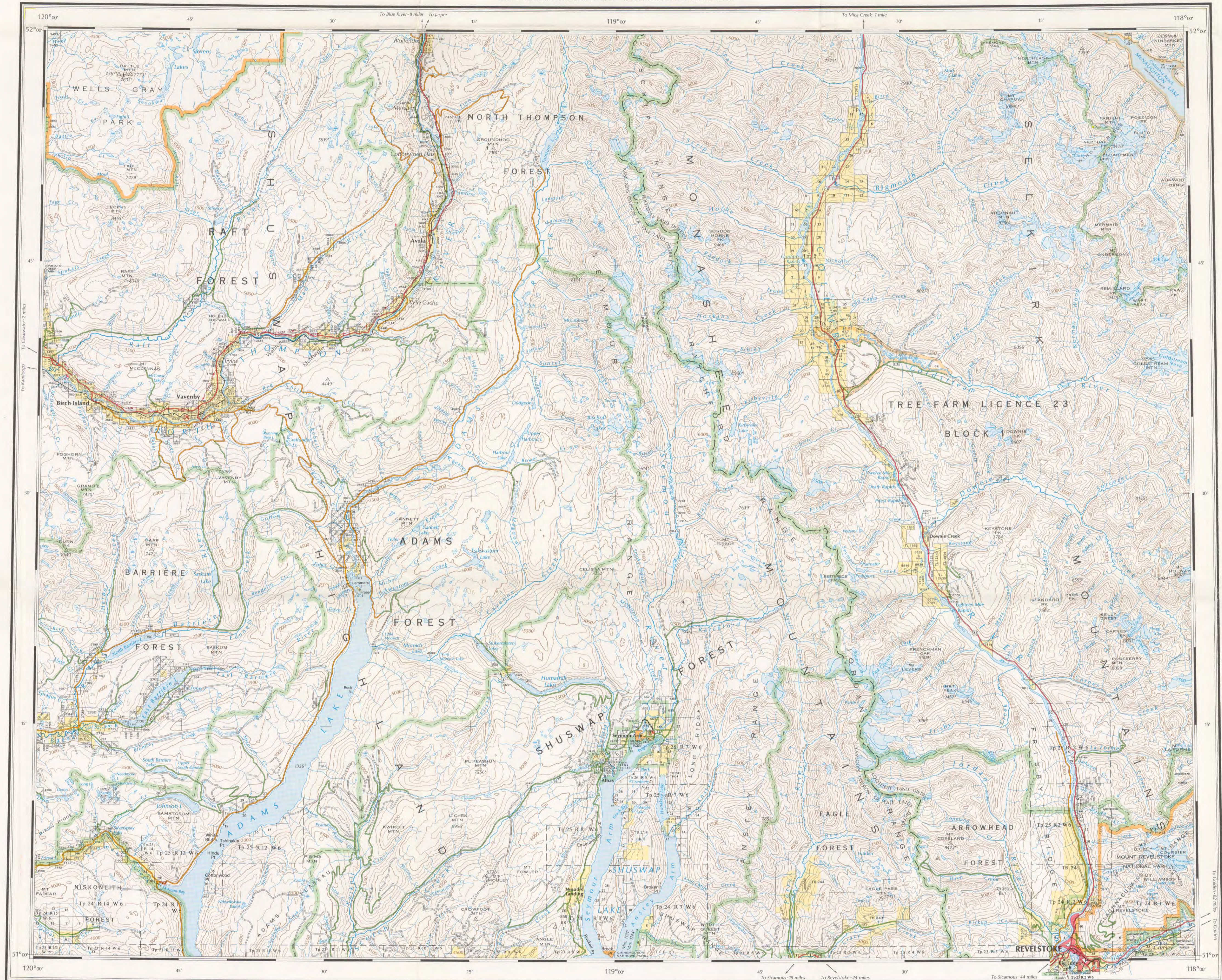


MCL 10/76 LEVIN

Fig. 7







Second Status Edition compiled and produced by the Map Production Division, Surveys and Mapping Branch, Department of Lands, Forests, and Water Resources, Victoria, B.C., 1973.

Lands on this map may be zoned as agricultural land reserves. Enquiries should be made to the appropriate Regional District office.

District land lots, 5 acres or less, may not be shown due to the scale of this map. For detailed information see Departmental Reference Map.

District land lot numbers - 1034 Section numbers within Townships - 34 Sub lots within District lots - SL 34

Mineral claims are not shown on this map.

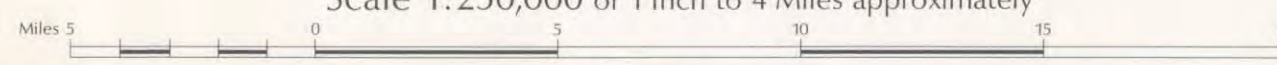
Land Commissioners' Offices are located in Kamloops and Revelstoke.

REFERENCE

- RESERVED LANDS**
- Boundaries: Park (less than 40 acres)
  - Forest
  - Tree Farm Licence
  - Water Supply
  - Other Government Reserves
- SURVEYED LANDS**
- Vacant Crown Land
  - Alienated or covered by application under the Land Act
  - Flooded areas which are Crown Granted
  - Timber or Park Lease, Licence, or Timber Berth
  - Indian Reserve
  - International or Intergovernmental Boundary and Monument
  - Land District Boundary
  - Municipal Boundary
  - Campground (Government)
  - Alpine (Operating)
  - Historic Monument
  - Post Office
  - School
  - Hospital
  - Settlement or Locality

**SEYMOUR ARM**  
 BRITISH COLUMBIA

Scale 1:250,000 or 1 Inch to 4 Miles approximately



Magnetic Declination approximately 23°20' East at center of map, 1974.  
 Decreasing approximately 3" annually.

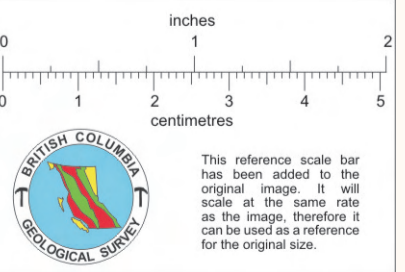
Universal Transverse Mercator Projection

Maps and indexes with price lists may be obtained from the Map Production Division, British Columbia Lands Service, Parliament Buildings, Victoria, B.C.

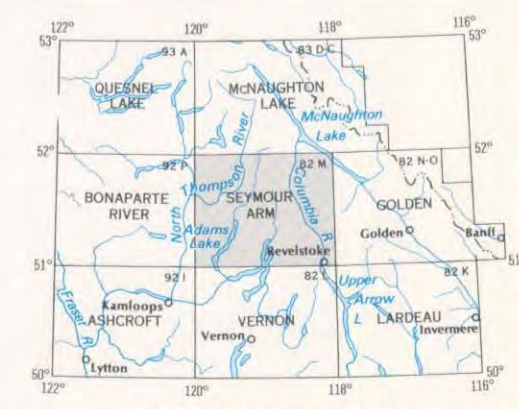
LITHOGRAPHED IN CANADA BY W. M. GARDNER'S QUEEN'S PRINTER, VICTORIA, BRITISH COLUMBIA

REFERENCE

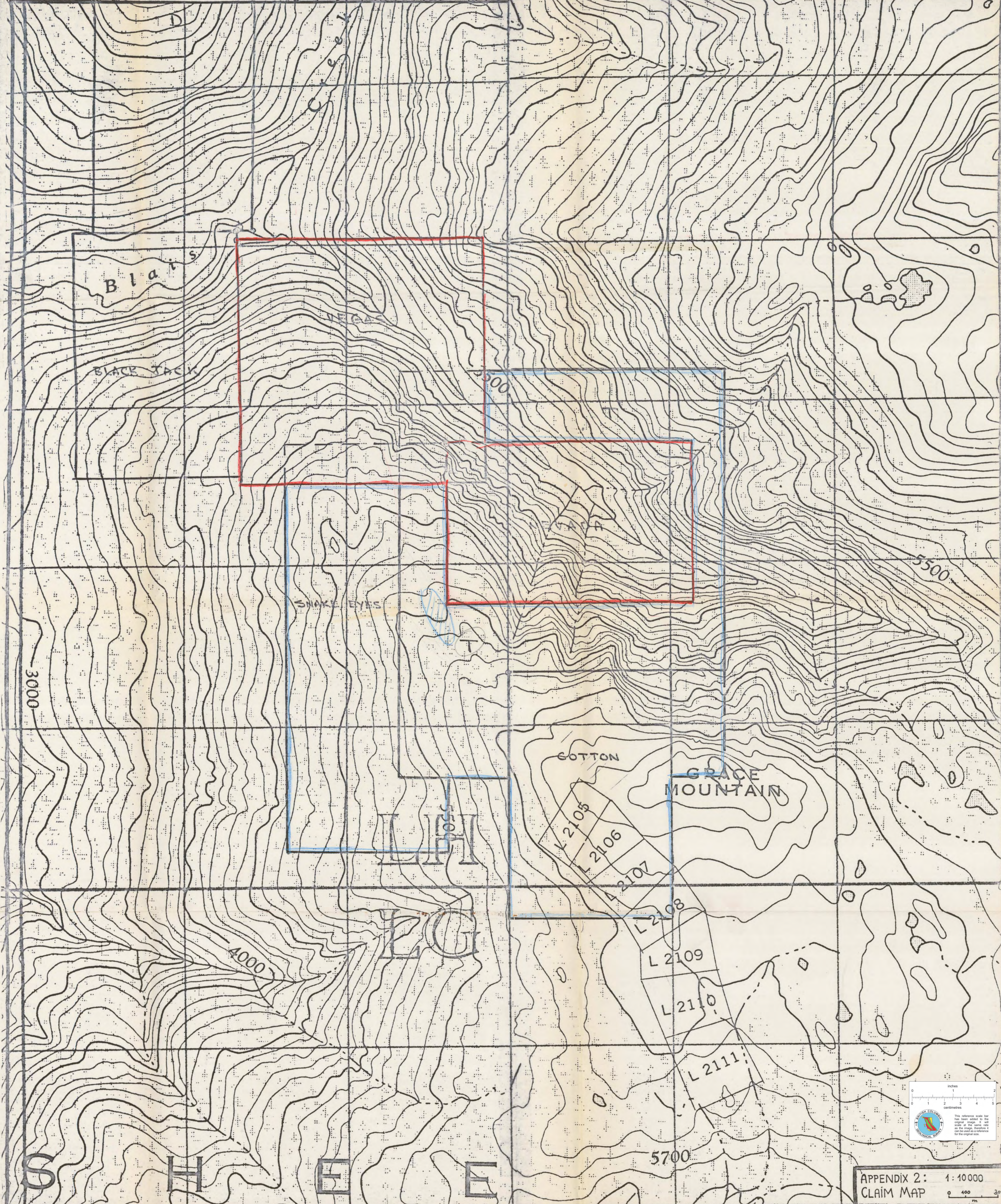
- Roads:** Hard Surface   
 Loose Surface, Main   
 Loose Surface, Secondary   
 Rough
- Trail**
- Highway Route Number**
- Railway**
- Power Line (Main)**
- Lighthouse**
- Survey Control Station (Main)**
- Elevation in feet above mean sea-level**
- Continuous Interval 500 feet**
- Swamp or Marsh**
- Intermittent Lake or Seasonal Inundation**
- Mud, Sand, or Gravel**
- Glacier or Icefield**
- Dike**
- Customs Office**
- Communications Tower**
- Forest Service Lookout**
- Seaplane Landing (With Facilities)**
- Airport or Airstrip**



This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.



INDEX TO ADJOINING MAPS



Blais

Creek

BLACK TACK

SHAKE EYES

COTTON

GRACE MOUNTAIN

3000

4000

5000

5500

L 2105

L 2106

L 2107

L 2108

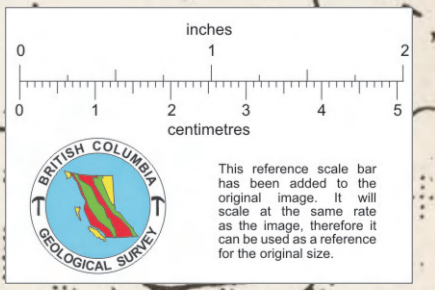
L 2109

L 2110

L 2111

5700

S H E E



APPENDIX 2: CLAIM MAP 1:40000