GEOLOGICAL AND MINERALOGICAL STUDIES AT THE WEST GORE STIBNITE-GOLD PROPERTY, HANTS COUNTY, NOVA SCOTIA

by

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Submitted in partial fulfillment of the requirements for the degree of Bachelor of Science with Honours in Geology, Dalhousie University, Halifax, Nova Scotia, Canada

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ABSTRACT

The West Gore mine was the major producer of antimony in Canada from 1882 to 1939, and it is listed among the gold deposits of Nova Scotia. However, the last comprehensive geological report on the camp dates to 1939. This thesis attempts to provide an up-dated geological description of the West Gore deposit on the basis of a compilation of data from unpublished and published reports and limited field and laboratory work by the author.

The deposit consists of a steep quartz-stibnite complex vein that trends approximately 120°. Stibnite (Sb_2S_3), native Sb and scarce native gold are the ore minerals that occur in a gangue of quartz and arsenopyrite.

The host rocks consist of slates and minor quartzite of the Halifax Formation (Meguma Group) of Ordovician age, and at least 25 km from the nearest outcrop of Devonian granitoid rocks. The West Gore vein system truncates (and is therefore younger than) the regional metamorphic fabric of the Meguma Group and interbedded quartz-arsenopyrite-gold veins.

Hydrothermal alteration associated with the ore has resulted in strong sericitization of the otherwise chloritic slates. The mineralization appears to have consisted of a combination of open space filling, replacement and remobilization. The first major mineral to crystallize was quartz, followed by movement and brecciation and introduction of stibnite and native antimony, that filled spaces and replaced other minerals. Free gold appears to be limited to the intersection of the steep vein with older, interbedded quartz-arsenopyrite-gold veins at depth.

Fluid inclusion studies yielded anomalously high homogenization temperatures and were inconclusive but may suggest that the fluid inclusions in the quartz leaked during tectonism or that they represent boiling of hydrothermal solutions.

The setting of the West Gore orebody is compared with known Sb-W deposits in Lower Paleozoic black shales elsewhere in Nova Scotia, the Middle East and Western Europe. The possibility of a granitic body at depth and the metasediments as a source for the metals are briefly discussed.

ACKNOWLEDGEMENTS

Firstly I would like to thank Dr. Marcos Zentilli for suggesting this topic and for his expert guidance. Dr. Simon Hanmer was also very helpful, with his advice on structural problems. Dr. Paul Schenk kindly let me use his microscope/camera equipment and for this I am very grateful. Thanks should also go to Bob MacKay for his instruction on the use of the microprobe and to Robert Grantham of the Nova Scotia Museum for making the Museum's collection available to me.

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CHAPTER 1

INTRODUCTION

General Statement

In the late nineteenth and early twentieth century antimony and gold were mined at West Gore, Nova Scotia. At that time it was the largest antimony mine in Canada and the only one to have gold as accessory mineral. No major geological work has been done at the mine in the last 20 years. This thesis attempts to provide an up-to-date and integrated view of the geology and mineralogy of this deposit on the basis of field observations, limited laboratory work and previous knowledge.

Geography

The West Gore deposit, latitude 45°05'N, longitude 64°47'W, is located in Hants County approximately 1.5 kilometres southwest of the village of West Gore. The N.T.S. coordinate system places this deposit in area 11E 4W on the Kennetcook Map sheet.

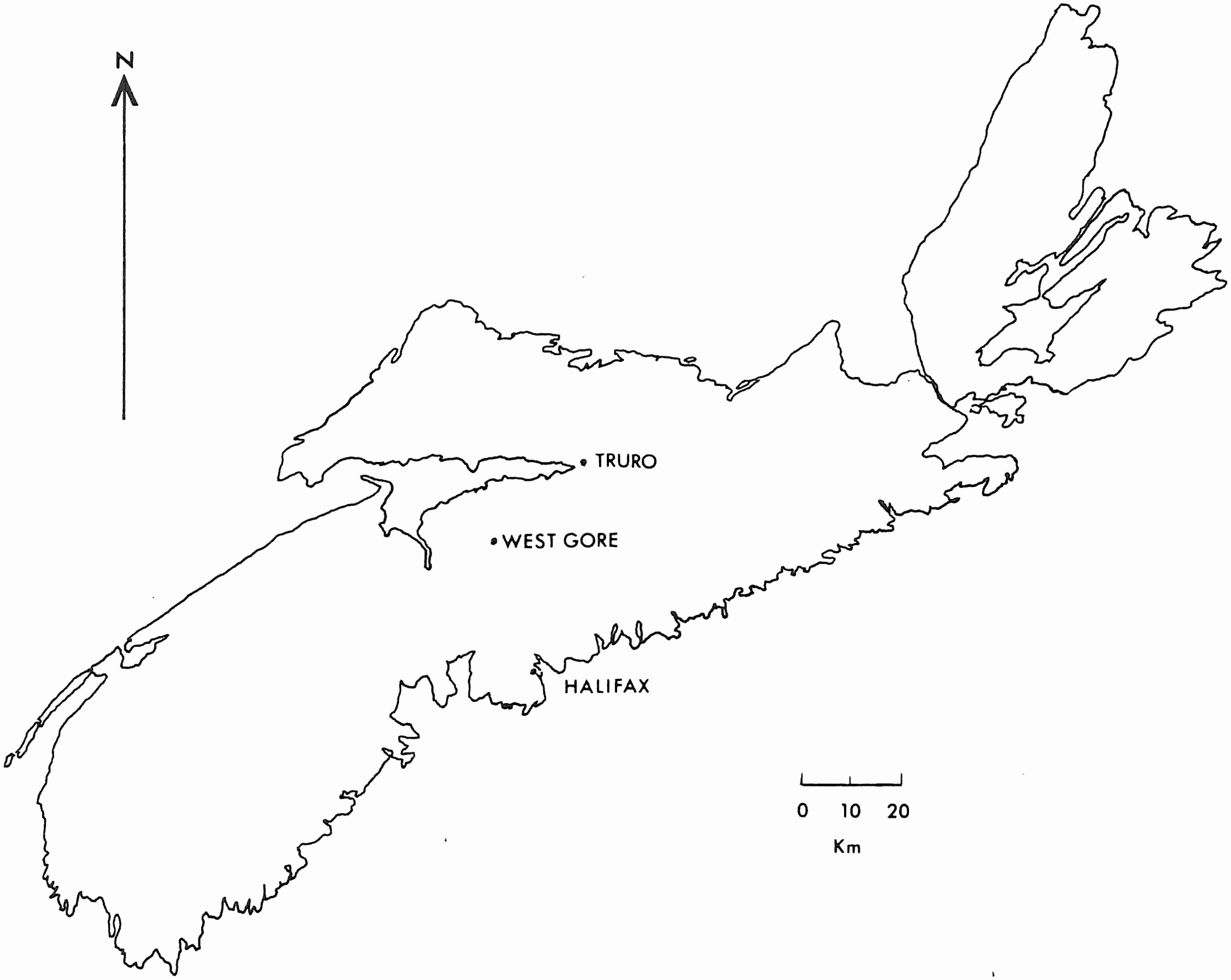
The main workings are readily accessible via a public road which, although in a state of poor repair, is usable for automobiles. West Gore is connected to the main arteries of Nova Scotia by a network of paved all weather secondary highways.

The population density in this area is very low. The village of West Gore has no more than a few hundred people with the rest of the population living on a few large isolated farms in the surrounding countryside. The nearest population centre supplying all major services is Truro, some 70 kilometres to the east.

The area surrounding the main workings is heavily overgrown by predominantly coniferous forest except for an area of previously cultivated land which is now unused. The area is crossed by two large brooks trending approximately northwest and by a number of smaller streams which combine to provide ample drainage of the land.

When this area was visited in late fall both these brooks had significant rates of flow. Relief is moderate for the most part, with a gentle slope of the land to the northwest predominating. The above mentioned brooks have steep walled valleys for much of their length with falls as high as 18 metres occurring several places. These brooks probably have water year-round with the possible exception of very hot dry periods.

Figure 1. Location map of West Gore, Nova Scotia


N
TRURO
WEST GORE
HALIFAX
0
10
20
Km

Mining History

The information in the following paragraphs has been summarized from the assessment files of the Department of Mines of Nova Scotia.

In 1883 antimony was first discovered as float on the farm of John Macdougall. This find stimulated interest in the area and trenching was immediately begun. The first trenches were excavated across the regional strike of the underlying rock and nothing of interest was found. It was only when trenching was carried out parallel to strike that quartz veins containing antimony were discovered.

In 1884 the first mining operation began with the sinking of 2 shafts approximately 36 metres apart and 53 m deep in a north-westerly-trending vein which varied in width from 10 to 45 cm. In 1889 another shaft was sunk on a parallel lead 400 m to the southwest, a third shaft was sunk on the main lead and one of the existing shafts on the main lead was deepened to 73 metres.

In 1892 the auriferous nature of the ore was discovered, adding great value to the ore.

The mine was closed down in 1900 and reopened in 1903 when the Dominion Antimony Company was formed. At this time mining was seriously undertaken, the first two shafts on the main lead were deepened to 131 and 85 metres respectively, and the third shaft was deepened to 55 metres. This new era of high production lasted until 1908 at which time a concentrating mill was completed and operated for a short while. During 1908 there were problems concerning ownership of the mine and as a result of litigation proceedings the mine was shutdown.

In 1909 the mine was taken over by St. Helen's Mining Company. Work resumed in 1910 and continued to 1917. During this time development work on the shafts continued, most notably with the deepening of the main shaft to 256 metres, and the subsequent development of 8 mining levels.

In 1927 a parallel ore body was discovered approximately 150 metres to the north and as a result of this find W. M. Flowers sank a 14 metre shaft on this vein in 1928. Another period of nonactivity followed this until 1936 when mining rights were obtained by Chester Berggren. A new 14 metre shaft was sunk and a small amount of stoping was done as well. The dumps were also picked over by hand at this time, the operation being profitable until 1939. Some repair to shafts and new exploration was carried out in 1944 with no success and as a result of this the mine was reported as not economically viable.

During the 1950's and 60's several diamond drilling programs were initiated, none reported new discoveries of ore and many were plagued with heavy core losses due to the friable nature of the local slate.

Reports of tonnages of ore mined and concentrate shipped are contradictory at best. A report filed after all the mining activity was over stated total ore production was 45,324 metric tonnes with predicted average grades being between 11 and 23 percent antimony and between 16 and 24 grams gold per tonne. Available records show that the ore was considered to be one of two grades; either 45 percent or greater antimony or 20% or greater antimony. Most of the lower grade ore was stockpiled in the waste dump area. In 1944, even after the dump had been reworked and processed, a survey by Packard (1944, NSDM file) showed antimony percentages to be over 2 percent in most samples with many having gold values over 2.4 grams per tonne. This seems to indicate that the higher values for the average antimony and gold content are true. At the time of writing (spring 1980) the antimony property's mineral rights are held by Avard Hudgins of Truro, N.S.

Previous Geological Work

The West Gore mine is within the area mapped on a scale of 1 inch to 1 mile by Faribault in 1908. Unfortunately he did not publish a detailed map of the West Gore district itself as he did for many other actively producing areas at the time.

In 1939 the mine area was mapped in detail by a provincial government party under the direction of G.V. Douglas. A geology map at 200 feet to the inch was produced for the whole area by plane table and a larger scale map of 20 feet to the inch was produced for the workings on the southern-most vein.

I. M. Stevenson of the G.S.C. described the West Gore deposit and mapped the surrounding geology in 1958. His results appear in Memoir 302 of the G.S.C. His was the last major report made on the West Gore deposit.

Purpose and Scope of this Thesis

The West Gore deposit was one of the most important antimony mines in this country. The gold found along with the stibnite also made this deposit one of the most unusual gold mines in the province. Despite this, geological information on this deposit is scarce and scattered.

The purpose of this thesis is: to assemble all data on the history of the West Gore Mine, and to assemble previous geological work and upgrade it with field observations by the author. A better understanding of the mineralogical and structural relationships has been achieved. It is hoped that this study may serve as a basis for more research in the future.

This thesis is intended only to represent a pilot project for the West Gore deposit. There was no time to perform detailed studies of individual aspects of this deposit so an overview of the whole deposit was written.

Methods and Organization of this Thesis

Field work for this thesis was carried out in the autumn of 1979. Mapping was done on two major streams and their tributaries which cross the property. Samples were taken in part from the streams and outcrops but most were taken from the dumps in the mining area. Slabs were cut and polished to study textures. From these 9 thin sections, 5 polished sections and 4 doubly polished sections were prepared.

The thin sections were examined using a transmitted light microscope to determine mineralogy and its variation with distance from the fault zones. Microstructural relations were also noted to help with interpretation of local structures. Polished sections were used to identify the opaque minerals by way of reflected light microscopy and microprobe analysis. Doubly polished thin sections were used in the fluid inclusion studies. Computer plotting and contouring methods were also used to analyze structural data collected during mapping.

Fieldwork was limited by the thickness of glacial till covering the area which confined outcrops to the stream valleys. Another limiting factor is the age of the workings; all the shafts are too old to be entered safely, many trenches which exposed much of the geology in the mine area are filled in and many descriptions of the geology from when the mine was operating are unreliable.

This thesis consists of 8 chapters which are organized as follows:

- Chapter 2 describes the mineralogy of antimony, its mode of occurrence, economic considerations and its distribution in Nova Scotia
- Chapter 3 describes the regional geologic setting of the deposit.
- Chapter 4 describes the geology of the deposit on a local scale.
- Chapter 5 describes the mineralogy and texture of the rocks and their variation around the deposit.
- Chapter 6 describes the fluid inclusion studies in quartz.

- Chapter 7 discusses possible modes of origin for the deposit.
- Chapter 8 discusses research and exploration for antimony in the future in Nova Scotia.

CHAPTER 2

MINERALOGY OF ANTIMONY

Native Antimony and Stibnite

Antimony occurs most commonly as stibnite (Sb_2S_3) and to a lesser extent native antimony. At West Gore stibnite crystals take the form of radiating needles, however it may occur as tabular crystals or granular masses. Its chemistry is generally exact with little variation from Sb_2S_3 (71.69% Sb metal). It is readily identified by its hardness (2) and grey blue colour. It resembles galena but it may be distinguished by its lower density (4.63). In reflected light it has a strong white lustre and considerable reflection pleochroism. Stibnite crystals are very easily deformed, they will readily bend in an environment of slowly increasing stress and will be broken if stress is applied quickly. This may be recognized by a conspicuous wavy extinction (Ramdohr 1969). Stibnite's tendency to be easily deformed makes it an excellent indicator of structural deformation of the rock it is associated with. Stibnite is usually deposited by hydrothermal processes and commonly is found in association with scheelite and/or cinnabar in strataform ore bodies (Maucher 1976). However in West Gore both these minerals are lacking. Other associated minerals are pyrite, maracasite, arsenopyrite, berthierite, and gold. All of these are present at West Gore except maracasite and berthierite.

Native Antimony (Sb) occurs in a pure state at West Gore although in other deposits it may be combined with arsenic forming allemonite. Antimony has a hardness of 3-3.5 and a density of 6.7. It is normally tin white and shows very high brilliant white reflective colours. Antimony generally forms fine grained granular masses. Its occurrence is relatively rare and when found it is usually with stibnite. It is thought to occur as a result of supergene processes created by descending solutions reacting with stibnite (Ramdohr 1969). Antimony is often associated with arsenic, stibnite, smaltite, ruby silver, galena and arsenopyrite. Of the above stibnite and arsenopyrite are present at West Gore.

Economic Importance

At present Canada produces approximately 5 percent of the world's antimony metal. Most of the production is from a large deposit at Lake George, New Brunswick. Antimony is also recovered as a by-product of lead smelting at Trail, B.C. and Belledune, New Brunswick. Demand for antimony is generally good with the major market being lead acid battery manufacture where the antimony is used as an alloy to strengthen and inhibit corrosion of lead.

Technological advances are reducing the amount of antimony needed for batteries but its property of shrinking when heated and its capacity as a fire retardent may cause an increase in its demand for the manufacture of printing type and fire proof material (George 1977). Antimony is also used in the production of antifriction bearings, plastics, tracer bullets, pipes, paint, and solder. The current price for antimony metal (September 1979) is 304-319 cents per kilogram (Canadian).

Other Antimony Occurrences

West Gore is the only large deposit of antimony which has been found in Nova Scotia. There are small showings of antimony minerals at Trafalgar (Guysborough County), Dollar Lake (Halifax County), Kennetcook (Hants County), and Lansdowne (Digby County). No work has been done on any of these occurrences except at Lansdowne. There the occurrence was in the form of jamesonite and was found in the bed of Walsh's Creek. The country rock is highly deformed state of the Halifax Formation and the occurrence was believed to lie in a fissure although no concrete proof was found.

In 1951 Conwest Exploration drilled 2 rather unsuccessful diamond drill holes, one of which intersected a

30 centimetre thick quartz vein which contained jamesonite and massive arsenopyrite. This hole bottomed in coarse grey granite at 46.5 metres depth.

For the location of antimony occurrences in Nova Scotia see Figure 2.

CHAPTER 3

REGIONAL GEOLOGY

The West Gore deposit lies in the area of Central Nova Scotia which is underlain by rocks of the Meguma Group. In this area the Meguma Group is in contact with intrusives of Devonian age and a series of younger carboniferous sediments.

Stratigraphy

The Meguma Group is a large mass of sediments consisting of Upper Cambrian-Ordovician quartz metawacke turbidites interstratified with black slates underlying approximately 125 x 10^3 km^2 of southwestern Nova Scotia (Schenk 1978).

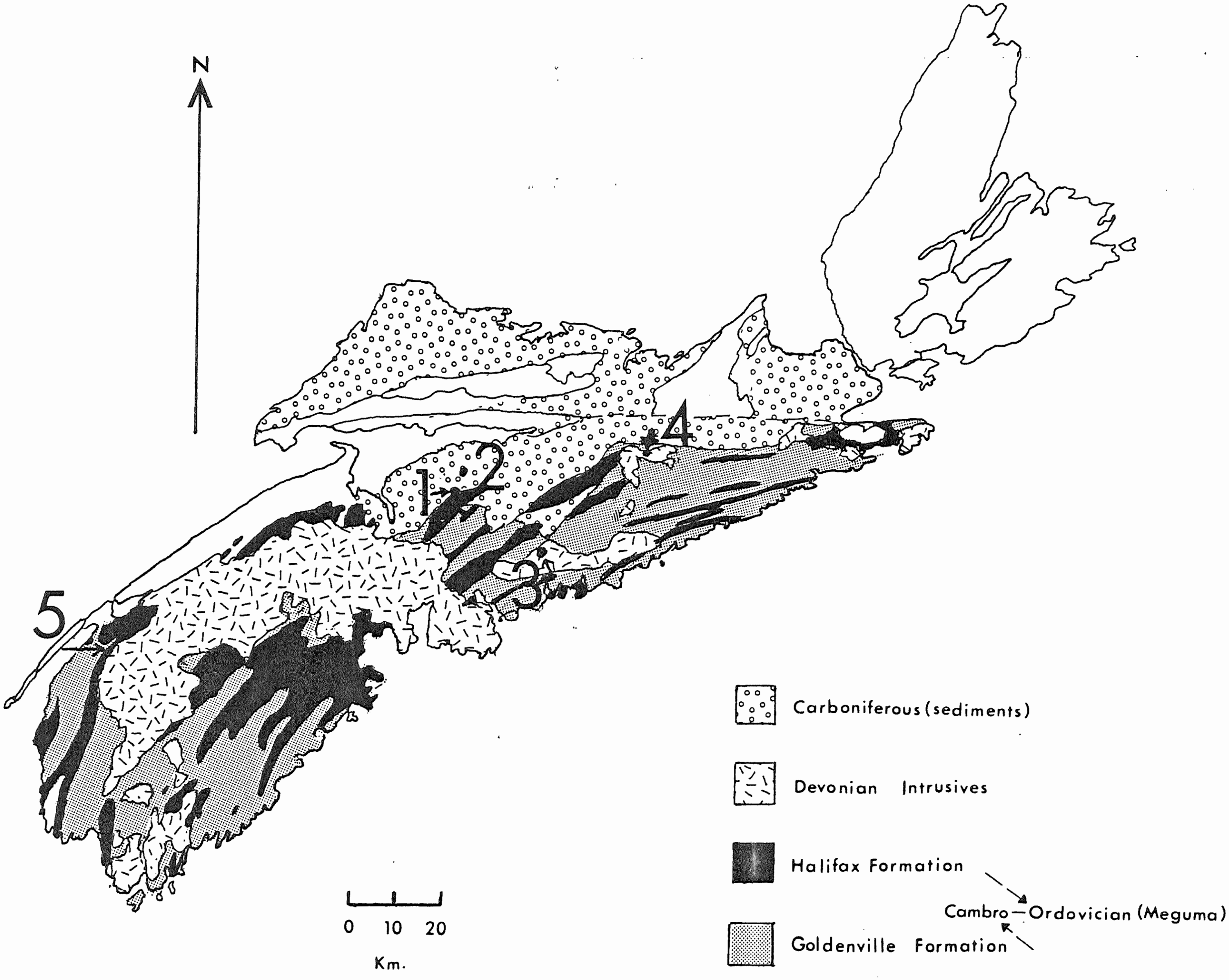
Estimates of the thickness of this group vary considerably. Faribault in 1913 (1914) estimated the thickness to be about 9 kilometres and Schenk (1978) reports a possible thickness of over 14 kilometres.

The Meguma Group has been divided into two formations; the Goldenville Formation and the Halifax Formation. The Goldenville Formation consists mainly of metawacke but may also contain interbeds of slate. It comprises approximately

Figure 2. Generalized Geology Map of Mainland Nova Scotia

Occurrences

1 West Gore, Hants County
2 Kennetcook, Hants County
3 Dollar Lake, Halifax County
4 Trafalgar, Guysborough County
5 Lansdowne, Digby County


N
1
2
3
4
5
0 10 20
Km.
Carboniferous (sediments)
Devonian Intrusives
Halifax Formation
Goldenville Formation
Cambro—Ordovician (Meguma)

two-thirds of the total thickness of the Meguma. The only primary structures easily visible are bedding and graded bedding but ripple marks, crossbedding and scour and fill marks are locally visible. The Goldenville Formation is conformably overlain by the Halifax Formation which is a sequence of slates, siltstones and argillites with locally interbedded metawacke. The slates of the Halifax Formation are thinly bedded and vary in colour from light grey to black. Bedding is the only primary sedimentary structure seen commonly, although graded bedded, scour and fill marks, crossbedding and ripple marks are also found (Taylor and Schiller 1966).

Schenk (1978) considers the Meguma Group to be a eugeoclinal complex of a deep sea fan and overlying continental rise. The sediments which were deposited are thought to be derived from a region of metamorphosed igneous and sedimentary rocks in the southeast (Schenk 1970).

Fossils found in the Halifax Formation near Wolfville have been identified as Dictyonema Flabelliforme giving a Tremadocian age to the slates. The Goldenville Formation has been dated using detrital muscovite and by identification of some poorly preserved graptolites. The combination of these has indicated an Aegean age for the Goldenville Formation (Harris and Schenk 1976). This indicates that the Meguma is largely Lower Ordovician in age with Cambrian and Middle to Upper Ordovician strata possibly present (Harris and Schenk 1976).

In the vicinity of West Gore the Meguma Group is unconformably overlain by a sequence of Mississippian and Pennsylvanian beds. These beds comprise the Horton Group, a sequence of grey to red sandstone plus shale and conglomerate of continental origin and the Windsor Group which is a series of marine limestones, evaporites, and continental conglomerates.

Intrusives

In the Devonian there was a period of mountain building called the Acadian Orogeny. As a result of this there was intrusion of granitic material into many areas of Nova Scotia. These batholiths now underlie approximately 10,000 km^2 of Nova Scotia. An age of intrusion of approximately 370 Ma has been found by Rb/Sr dating (Clarke and Halliday in press).

The nearest granitic batholith to West Gore is about 25 kilometres to the southwest.

Metamorphism

The Meguma Group has been metamorphosed both regionally, by the Acadian Orogeny, and locally by the intrusion of the Devonian granites.

Regional metamorphism has elevated the whole Meguma Group to Greenschist facies. Individual isograds are not apparent except in some isolated areas where the biotite isograd can be seen (Taylor and Schiller 1966). The metamorphism occurred at a temperature between 300°-500°C with a corresponding pressure of about 6000 bars (Taylor and Schiller 1966). Reynolds and Muecke (1978) have estimated the time of regional metamorphism of the Meguma Group to be approximately 410 Ma.

The intrusion of granites in the Mid-Devonian resulted in contact aureoles in the Meguma varying from .4 to 2.4 km in width. The metamorphism is of hornblende hornfels facies due to a temperature of 550°-700°C and water pressure of 1000-3000 bars (Taylor and Schiller 1966).

Structure

The area of Nova Scotia underlain by the Meguma is characterized by long high angle folds which trend southwest to northeast, forming long domelike structures. Fyson (1966) reports that the axial culminations of these domes do not appear to be aligned as might be expected if cross folding occurred. He suggests instead that the curve of the folds' hinge lines may be due to variable extension of argillite beds present. The crests of these folds are the site of heavily explored interbedded gold-quartz veins. The folding has resulted in a very strong cleavage in the Halifax slates and to a lesser amount in the quartzites of the Goldenville Formation.

Extensive faulting occurred during or after the above mentioned deformation resulting in 2 main directions of offset (Fyson 1966). A northwest-southeast trending sinistral fault direction is common throughout the Meguma, it intersects the interbedded quartz veins in the fold crest as well as the cleavage in the slates. The other direction of faulting which occurs in the Meguma is a dextral slip of small proportions which occurs along the cleavage planes striking northeast. In the eastern portions of the Meguma the fold axes swing toward east-west and the faulting along the associated cleavage planes may be genetically related to the Chedabucto Fault (Fyson 1966).

Fyson (1966, p. 992) gives a summary of tectonic events which affected the Meguma Group.

"(1) Horizontal maximum compression variable in direction, northwest-southeast to north-south in map region; vertical extension, accompanied by F1, folding, regional metamorphism and the early development of steep S1, cleavage foliation. Early Middle Devonian?

(2) Maximum compression becoming constant in a direction approximately east-west .... accompanied by dextral slip along northeast-striking foliation .... Later sinistral faulting and F_2 S kinking (?) in steep zones aligned northwest.

(3) Emplacement of Mid-Devonian Granite and contact metamorphism. May have started during the sinistral faulting.

(4) Continuation or repetition of east-west compression, further S kinking and sinistral faulting dextral movements along northeast striking foliation and east striking faults. In part, Post-Middle Carboniferous.

(5) General horizontal extension, formation of few recumbent kinks, normal faulting."

The present study suggests that the West Gore deposit is related to structures formed during the second stage of Fyson (1966).

Pleistocene Geology

As is the case in much of Nova Scotia, the West Gore area is covered by glacial deposits consisting of boulder clay and till which have been deposited by the last period of glaciation. The deposits may be in the form of drumlins, eskers, kame deposits, or more commonly, as thick till deposits. In the West Gore area, these till sheets are present but their thickness is not great.

CHAPTER 4

GEOLOGY OF THE DEPOSIT

Due to the aforementioned limitations (namely glacial and vegetation cover) a more detailed picture of the local geology could not be compiled by conventional mapping. For this reason data compiled by previous workers had to be incorporated. The following paragraphs draw freely from Douglas (1939) and personal observations are added where relevant.

Lithologies

The West Gore antimony deposit is situated in quartz filled fissures in slates of the Halifax Formation. The slate is in fault contact with Horton Group sediments 1.5 kms to the northwest.

The Halifax slates in this area are dark grey green to almost black. Bedding is not visible throughout most of the area due to the presence of a closely spaced cleavage. On McInnis Brook, bedding is faintly visible as a silvery coloured banding which cuts the cleavage. The cleaved slate is extremely friable.

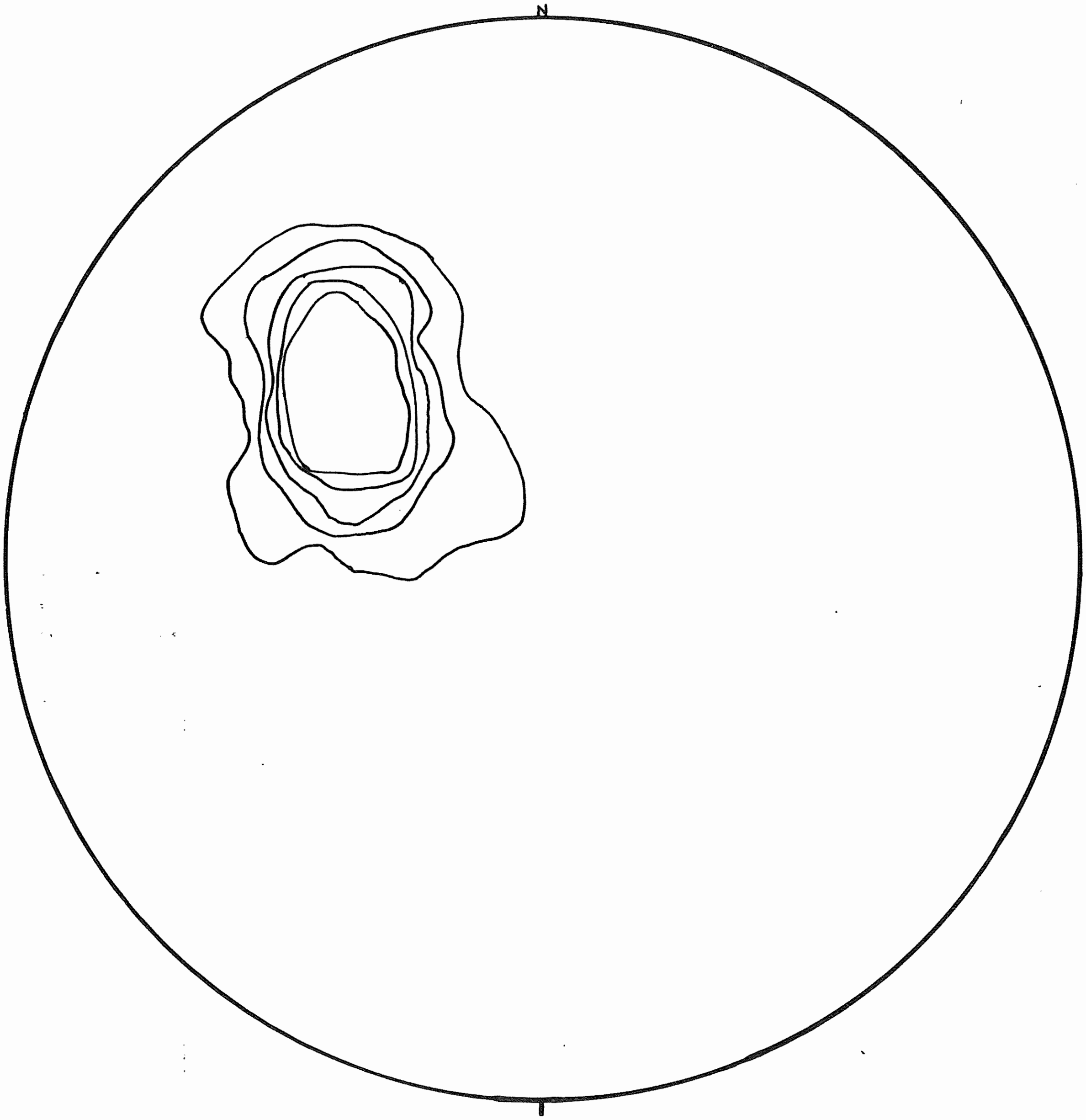
Interbedded within the slate are quartzite beds that range from a few centimetres to 3 metres in thickness. The occurrence of these beds is generally rare. However, they do appear in Sandford and McInnis Brooks flanking the deposit along the regional strike of the area. Douglas (1939) has suggested that one of these quartzite beds intersects the fissure vein where the antimony deposit is found and is responsible for the ore being deposited at that spot. This is a reasonable suggestion because slate and quartzite have very different competencies, and during deformation the quartzite could have failed, causing the formation of open spaces by brecciation.

Structure

The West Gore antimony deposit lies on the south flank of a northeasterly trending anticline whose crest crosses McInnis Brook a few metres east of the fault contact with the Horton sediments (Figure 7).

Assuming the cleavage in the slates is axial planar, poles to 136 measured cleavage directions were plotted on an equal area net and contoured in order to find the most probable orientation of the axial plane of the fold (see Figure 3). The resulting plot shows a very strong point maxima indicating the probable orientation of the fold's

Figure 3. Computer contour plot of poles to 136 cleavage planes. (Lower hemisphere, equal area projection.) Contour Interval 1, 5, 10, 15, 20,% Contour Values - percent of piercing points of poles per 1 percent area of stereonet. Maximum percent piercing points per 1 percent area = 57.4. The pole piercing the centre of the area of maximum percentage gives the average value of all the poles. The average value is the pole to a plane striking 040° and dipping 41°SE.


N

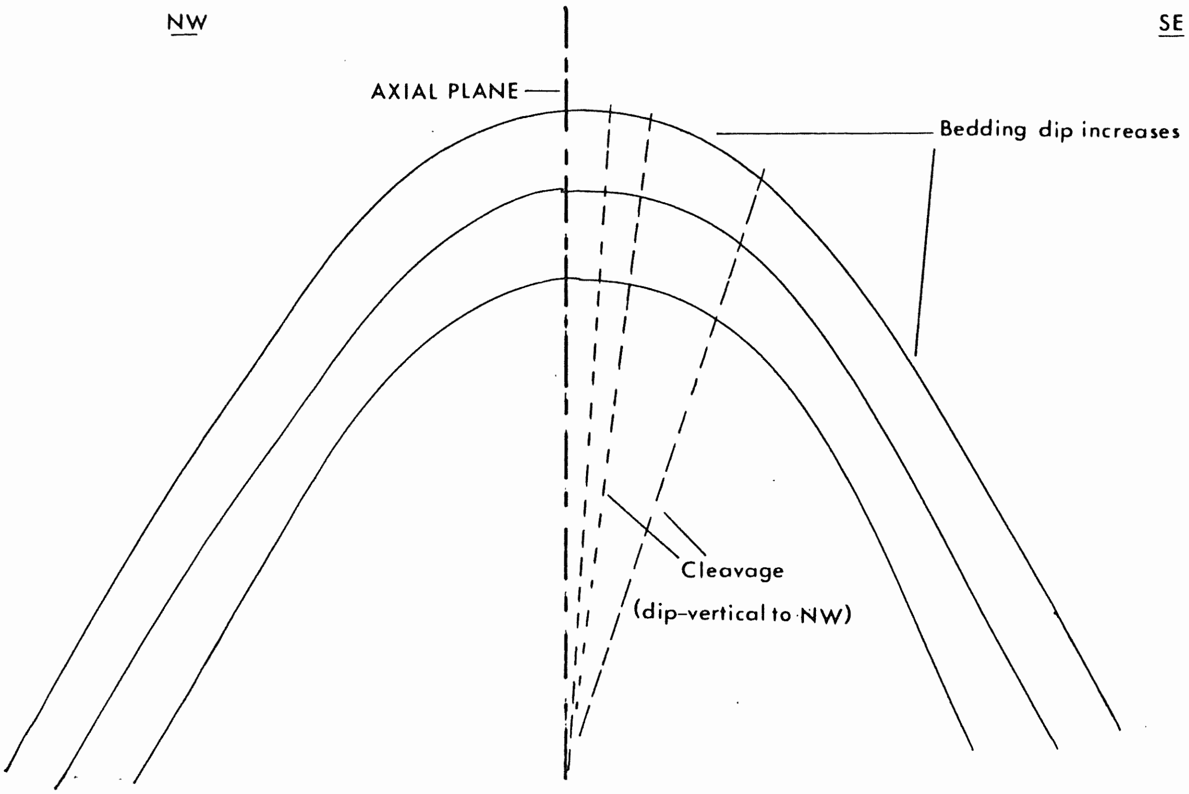
axial plane is 041°/40SE.

Stevenson (1958) noted steeply inclined bedding (approximately 40° southeast) very close to and parallel with the anticlinal crest reported by Douglas. In fact, he recorded the dip of bedding to be 40 to 50 degrees southeast over the whole area. In areas where bedding was visible the author found bedding orientations similar to those of Stevenson. If these observations are correct then it seems that the West Gore anticline is not a simple upright or slightly inclined (maximum 20°) fold as Fyson (1966) states most of the major anticlines in the Meguma are. In an upright fold the bedding should be near horizontal when it is close to the fold crest and its dip should increase with distance away from the crest (see Figure 4A).

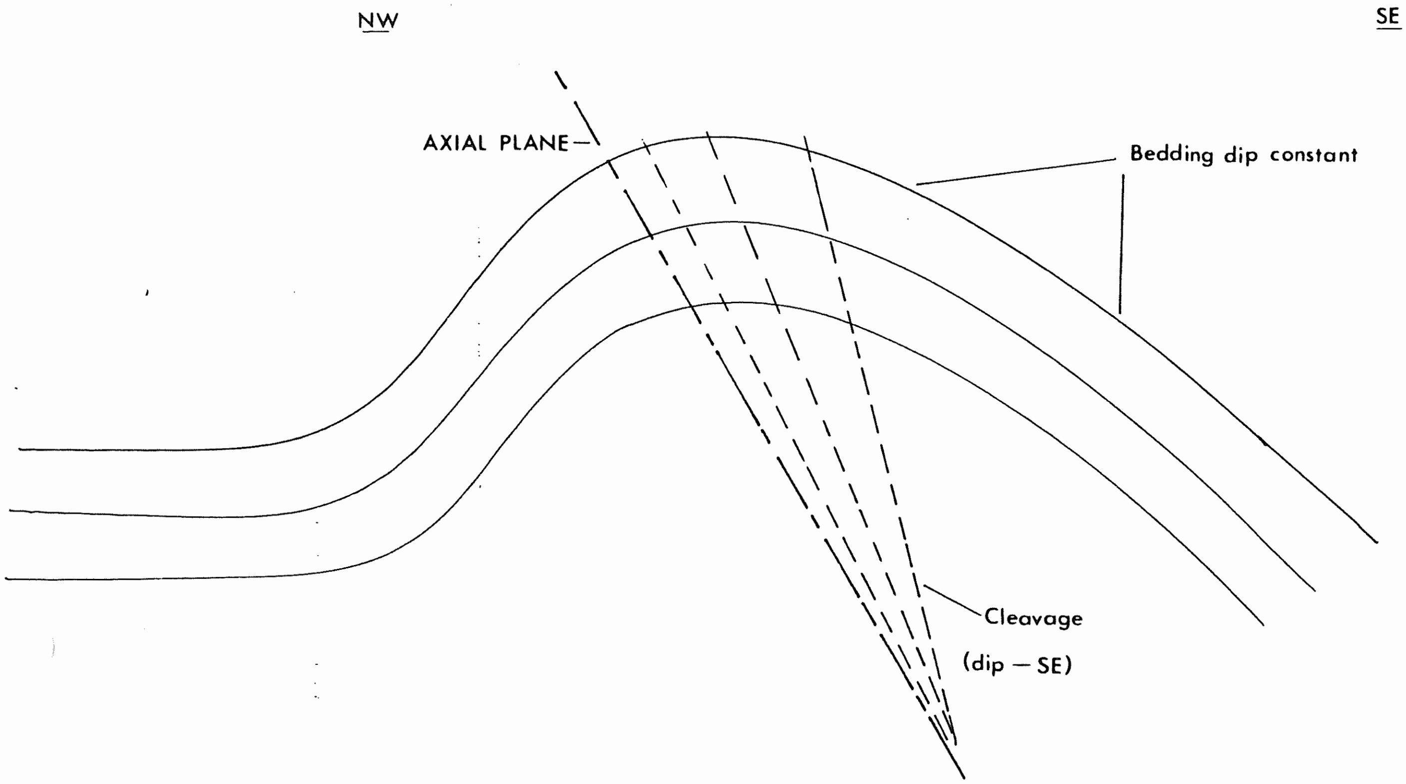
The cleavage planes, which strike 041° should not be steeply dipping to the southeast (40°SE) if the fold is a simple upright one. Fyson (1966) states that the cleavage in the argillaceous beds of the Meguma is subparallel to the axial plane and indicates in a block diagram that cleavage diverges upward. If either of these conditions are true and the fold underlying West Gore is upright, the cleavage should be dipping vertically or northwest (Figure 4A). One possible explanation of the steep southeast dip

Figure 4A. Upright fold with divergent cleavage. In this type of fold the cleavage on the SE limb should dip from vertical to steeply NW, and the bedding should dip steeply on the flanks and shallowly near the crest. These conditions are not present at West Gore.

Figure 4B. Asymmetrical fold with divergent cleavage. In this fold the dip of the bedding on the long SE limb will remain relatively constant. The axial plane cleavage will also dip to the SE. These features seem to match the bedding and cleavage measurements taken at West Gore.



UPRIGHT FOLD



ASSYMETRICAL FOLD

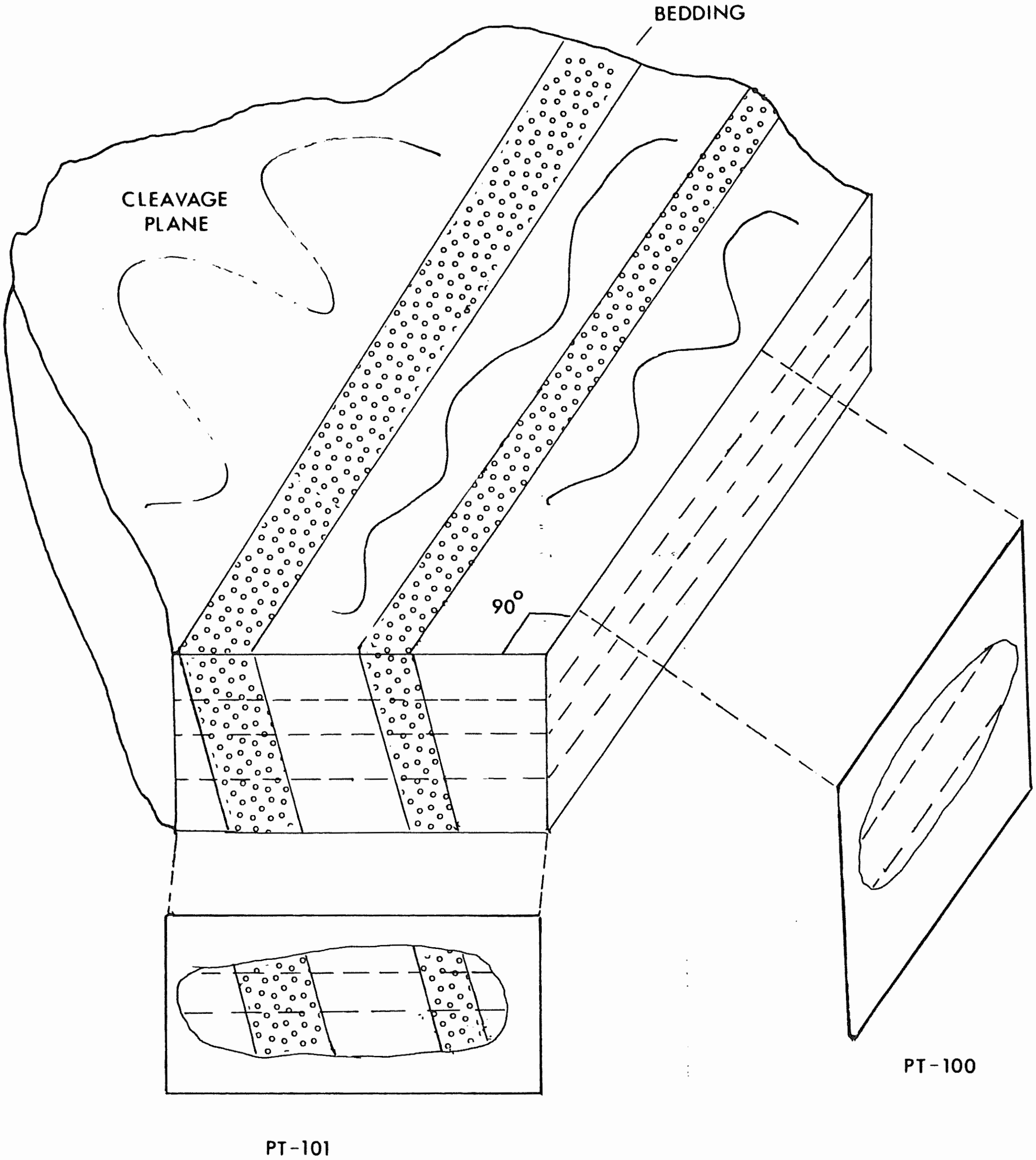
of the bedding and cleavage so close to the reported crest of the fold is for the fold to be strongly asymmetrical (Figure 4B).

Another indicator of an asymmetrical fold at West Gore is found in the slate which shows bedding. When bedding is visible it is due to the presence of silty layers alternating with the much finer material usually seen. The grains in these silty layers appear to be elongate in a direction perpendicular to the bedding cleavage trace. Since the bedding cleavage trace is parallel to the axial plane of the fold the elongate grains indicate that the direction of maximum stretching (the x axis of the appropriate strain ellipsoid) was perpendicular to the fold axis. This would suggest that the fold has been "pushed over" to form an asymmetrical fold.

In order to check the maximum extension direction of the rocks in this area two thin sections were cut from a sample of slate showing bedding, one was cut parallel to bedding and perpendicular to cleavage and the other perpendicular to both bedding and cleavage (see Figure 5).

Two criteria were used to try and judge the maximum strain direction; these were (1) the presence and degree of development of pressure shadows and (2) the degree of

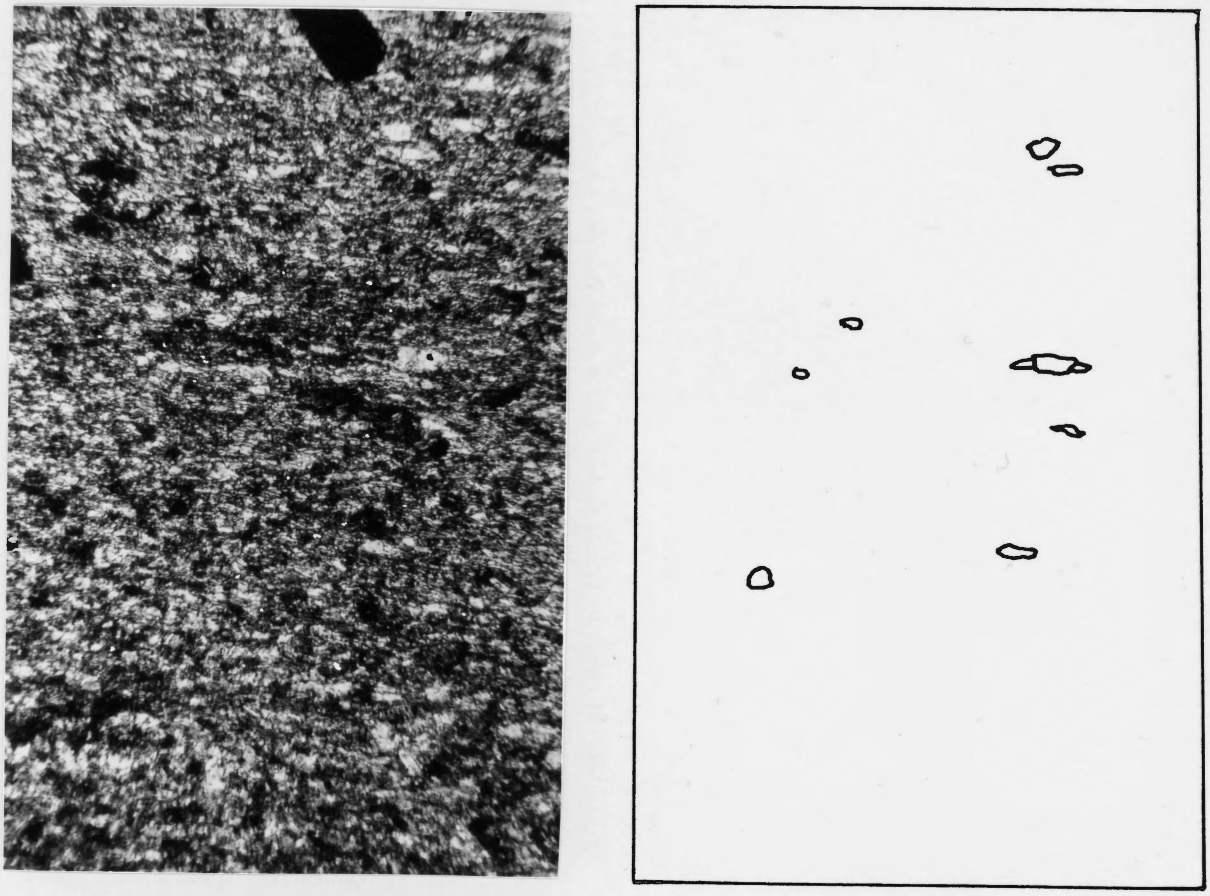
Figure 5. Sketch showing orientation of thin sections PT-101 and PT-100. PT-100 is cut parallel to bedding and perpendicular to cleavage. PT-101 is cut perpendicular to bedding and perpendicular to cleavage.


BEDDING
CLEAVAGE PLANE
90°
PT-100
PT-101

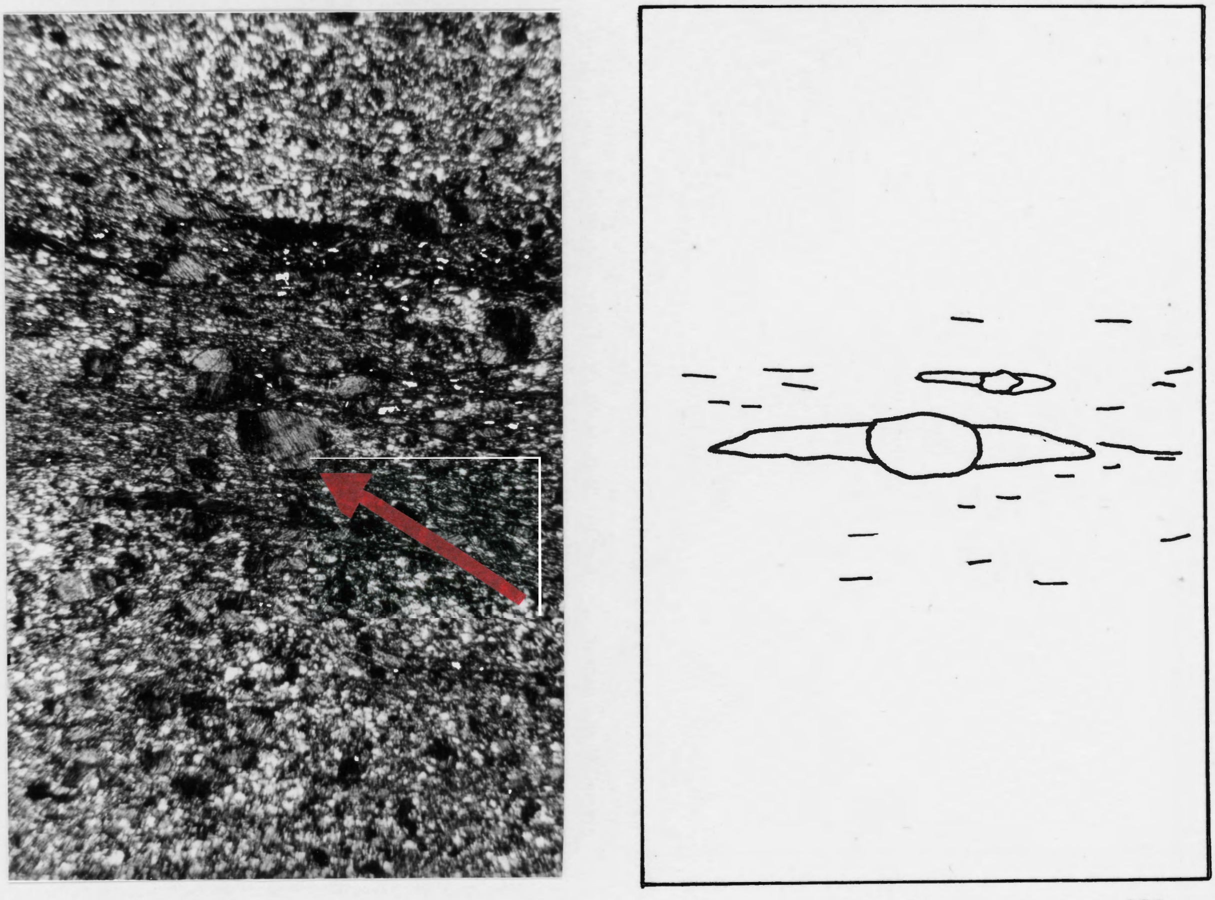
development of cleavage. The section that was cut perpendicular to cleavage and bedding (PT-101) had much more distinct cleavage planes visible than the section cut parallel to bedding (PT-100). This suggests that any elongate minerals in the cleavage plane have their long axes oriented perpendicular to the bedding because this would make the cleavage more distinct in that view (see Figure 6) Direction of the long axes of these elongate minerals should be parallel to the direction of maximum extension (Hills 1972, p. 467).

Pressure shadows are visible parallel to cleavage in both thin sections but they are longer and more plentiful in the section cut perpendicular to bedding (see Figure 6). The pressure shadows consist of long tapering tails of quartz on opposite sides of crystals of pyrite and chlorite. Pressure shadows form in areas of low potential in extension conditions. The length of the pressure shadow is proportional to the extension in the rock (Hills 1972, p. 134). Since pressure shadows were seen parallel to cleavage in both thin sections extension probably occurred within the cleavage planes perpendicular and parallel to bedding. However, the pressure shadows are definitely longer in the section cut perpendicular to bedding so the maximum extension direction or, the x axis of the corresponding strain ellipse, should be perpendicular to

Figure 6. Photographs of pressure shadows in slate. If these two photographs are compared it can be seen that Photograph PT-101 shows slate with a more distinct cleavage and longer pressure shadows.



PT-100 100x



PT-101 100x

to bedding. This result also supports the idea that an asymmetrical fold occurs at West Gore.

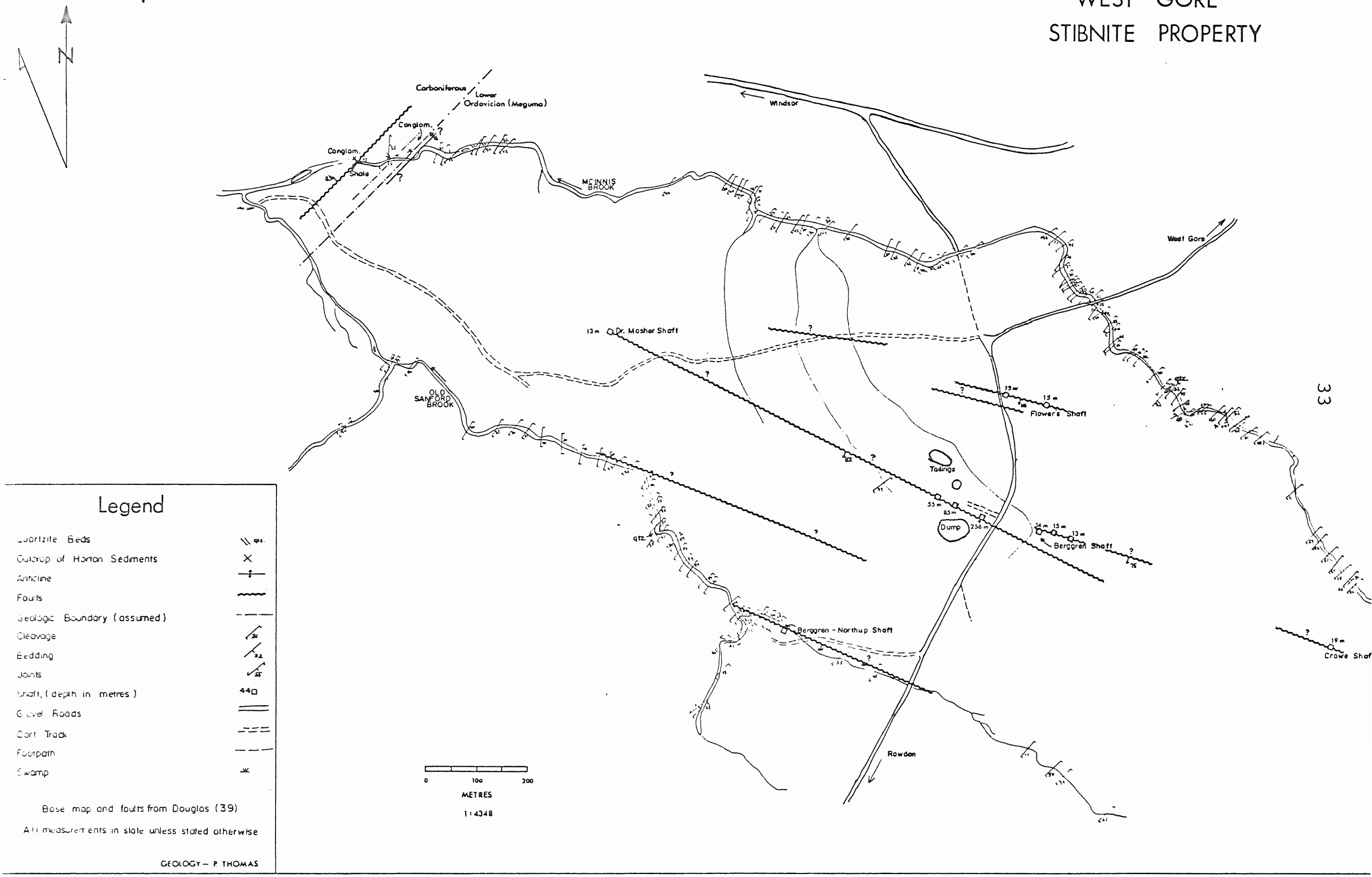
Several drag folds have been mapped in McInnis and Sandford Brooks by Douglas (1939). Another drag fold was mapped as being adjacent to the ore zone. While mapping this area the writer found these drag folds' presence difficult to confirm mainly due to the lack of visible bedding over most of the area. If these drag folds do occur they are likely very local in scale due to the tendency of folds to rapidly attenuate in weak rocks such as slate.

There are two major faulting directions which have been located in this area. The most important is the system striking approximately 120 degrees and dipping from 68 degrees SW to almost vertical. It is within these faults that the antimony minerals are found. There have been 10 separate breaks found, the largest extends 800 metres. All of the northwest trending faults are dextral but the amount of movement is not known (Douglas 1939).

The second direction of faulting is northeast. This direction of faulting can only be seen as the fault contact between the slates and the Horton sediments. Stevenson (1958) suggests that this fault is a low angle thrust fault but measurements by the author indicate that

Figure 7. Reduced version of Figure 18 (in pocket),
Geology Map of West Gore

WEST GORE
STIBNITE PROPERTY



Base map and faults from Douglas (39)

All measurements in slate unless stated otherwise

GEOLOGY — P. THOMAS

the fault plane is near vertical.

Mineralized Veins

The antimony mineralization at West Gore is found in the system of northwesterly trending faults. Mineralization has been found in all of the faults but only three have major amounts of ore. These three veins are made up of the 800 metre fault mentioned above and two smaller parallel faults, one 210 metres northeast and the other 300 metres southwest. The ore on the main vein extends horizontally for 150 metres and vertically for 256 metres with an average thickness of 15-60 cm. The other veins are not quite so large, their average thickness of ore is only 12 cm but it has been proven over a horizontal distance of 150 metres for the southwest vein.

Another vein system is reported to occur at depth in the mine. Askwith (1901) mentions the presence of cross veins of the gold bearing interbedded type occurring at depth in the mine. This generally ignored observation may mean that the auriferous nature of the West Gore deposit is in part due to intersection with auriferous structures (see below).

CHAPTER 5

MINERALOGICAL AND TEXTURAL OBSERVATIONS

The following section is a description of the mineralogy and texture of the country rocks and the vein filling material.

Country Rock

The country rock surrounding the deposit at West Gore consists almost completely of Halifax Slates. The major minerals which comprise the slate are chlorite, quartz, feldspar, muscovite (sericite), pyrite, arsenopyrite, and rutile.

Chlorite comprises as much as 35 percent of the slates giving the samples a decidedly green tint especially when thinly cut. The chlorite occurs as relatively large porphyroblasts approximately .2 millimetres in diameter and as much smaller grains comprising the matrix. The chlorite grains are easily identified by their light to mid-green pleochroism and high relief. The percentage of chlorite in the slates becomes lower as the fissure veins are approached.

Quartz and feldspar make up about 40 percent of the slates in this region. They are both very fine grained (.05 mm) and are found between the mica rich layers. Any elongate grains visible can be seen to lie parallel to cleavage.

Muscovite (sericite) is also present in the slate. In areas away from the quartz vein there is approximately 5 percent muscovite. Muscovite near the fissure veins increases to about 40 percent at the expense of the chlorite percentage. In areas where the slate is in intimate contact with the intruded quartz the sericitization is heavy. The mica can also be seen to have a wavy appearance and extinction.

Pyrite comprises up to 5 percent of the slates both near the veins and in the unaltered slates farther away. Pyrite appears as subhedral grains usually less than .1 millimetres in diameter. It may be recognized by its roughly cubic shape, opacity, and by the rusty weathering stain it produces.

Arsenopyrite is often found in the slates but only in those adjacent to the quartz veins. It usually has a distinctive diamond shape although it may appear in a variety of angular polygonal shapes (see Figure 8). The crystals do not show any preferred orientation and all exhibit sharp

Figure 8. Photographs of Arsenopyrite in Slate

A. Arsenopyrite forming diamond shaped crystals in association with rutile. Rutile appears here as elongate crystals approximately .1 mm long with a corroded appearance.

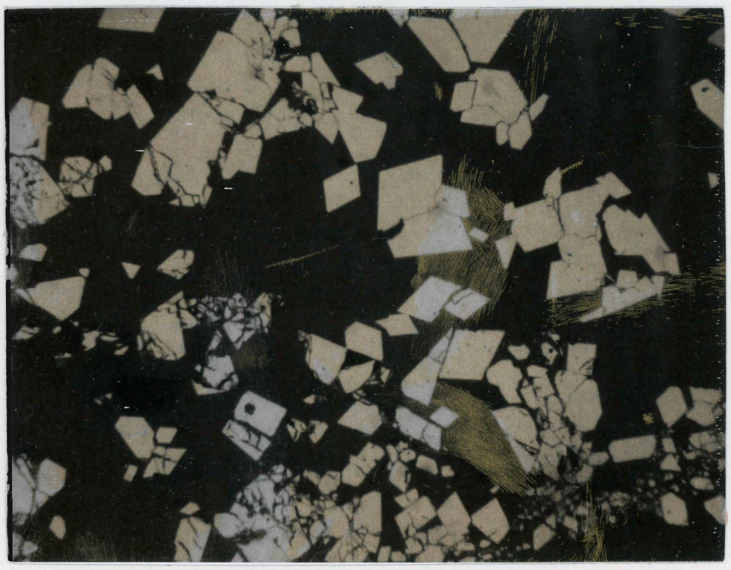
B. Polygonal crystals of arsenopyrite in slate.

A

128x

.1mm

B



128x

uncorroded crystal edges. Occasionally the crystals are faulted and the resulting offset and cataclasis is readily visible (Figure 9).

Rutile was observed in the slate, seemingly in association with arsenopyrite. Rutile has not been reported in the deposit at West Gore prior to this time. It appears to be somewhat corroded or poikiloblastic in texture (see Figure 8A).

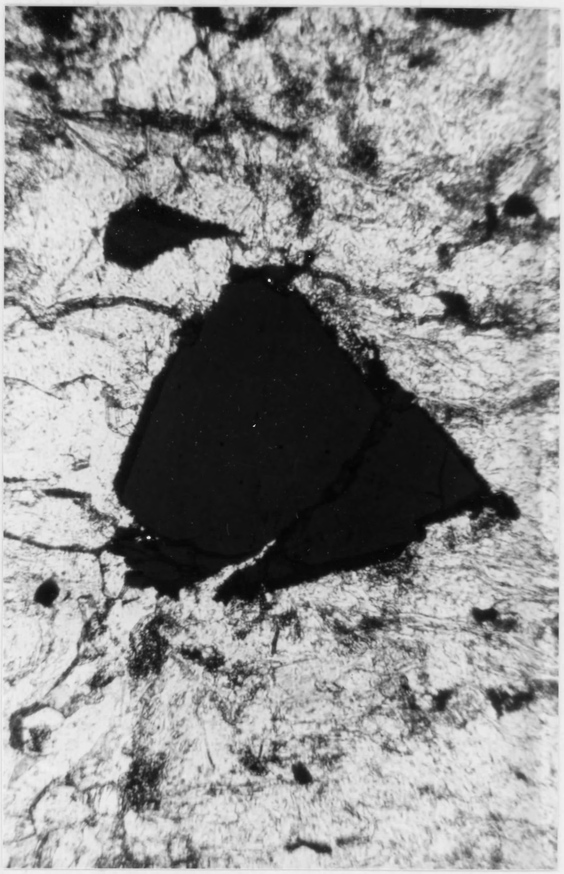
Vein Mineralogy

The following minerals were found in the ore from the mineralized veins at West Gore: quartz, stibnite, native antimony, pyrite, arsenopyrite, calcite and gold.

Quartz is very abundant in the ore bearing faults. It generally occurs as massive milky quartz which is heavily fractured and shows undulose extinction in thin section.

In one sample stibnite has intruded into a crack which split several large grains of quartz. The undulose extinction of the quartz followed from one side of the crack to the other side as if the stibnite was not there at all (Figure 11A). There are also many small cavities found in the massive quartz which are often filled by many minerals. In some samples, this milky quartz occurs as rounded grains in a matrix of massive stibnite. The

Figure 9. Faulted arsenopyrite crystal. This arsenopyrite crystal has been faulted and the resulting offset as well as the zone of cataclasis is visible.



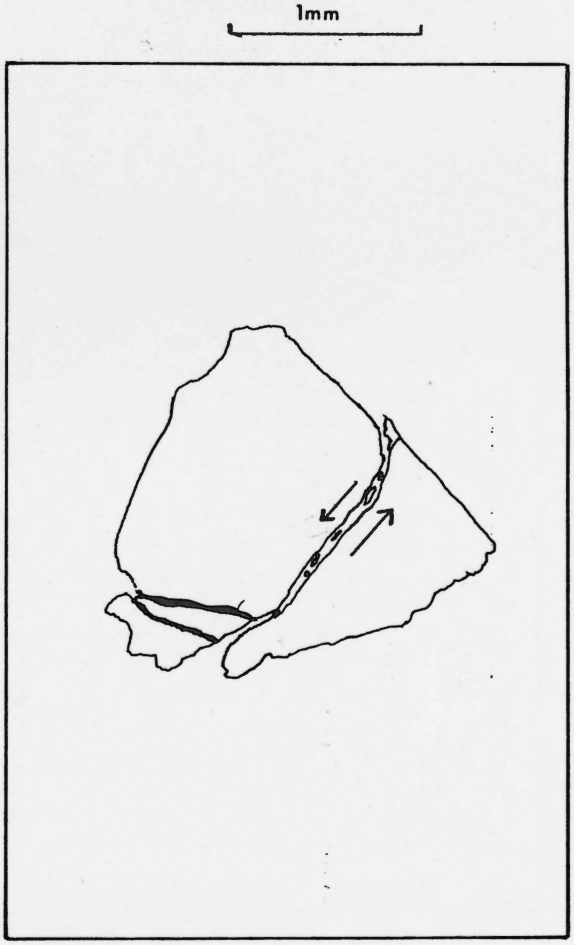

1mm

Figure 10. Drawings of Polished Slabs

The next 4 pages contain drawings of polished slabs. They are drawn full scale. A more complete description of each slab may be found in Appendix I.

LEGEND

Quartz	□
Stibnite	■
Arsenopyrite	⁙
Slate	▨
Mixture of Stib. + Qz.	▦
Pyrite	▒

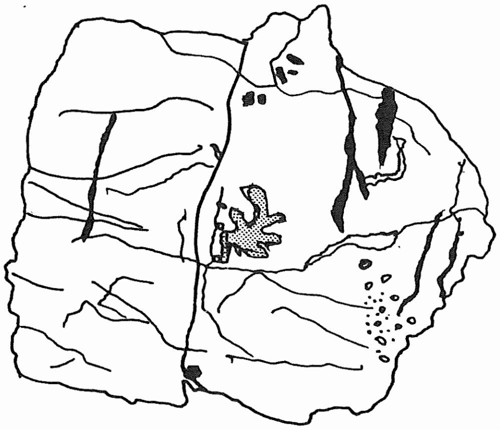
PT-6. Massive quartz with slate, appears to be intruded by quartz a second time.

WG-2. Massive quartz intruded by stibnite.

PT-9. Massive quartz with massive pyrite and stibnite.

PT-6

WG-2



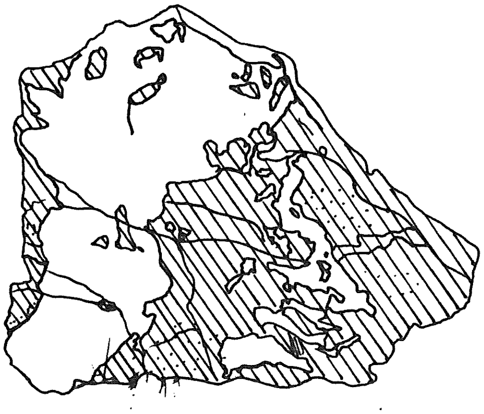
PT-9

PT-14. Massive quartz with broken slate and stibnite.

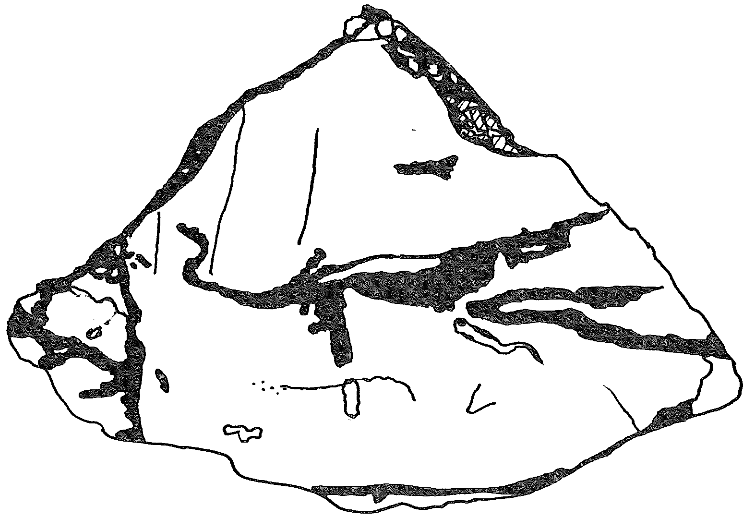
PT-4. Slate into which quartz has intruded, stoping off small pieces of slate.

PT-13. Massive quartz intruded by massive stibnite.

PT-14



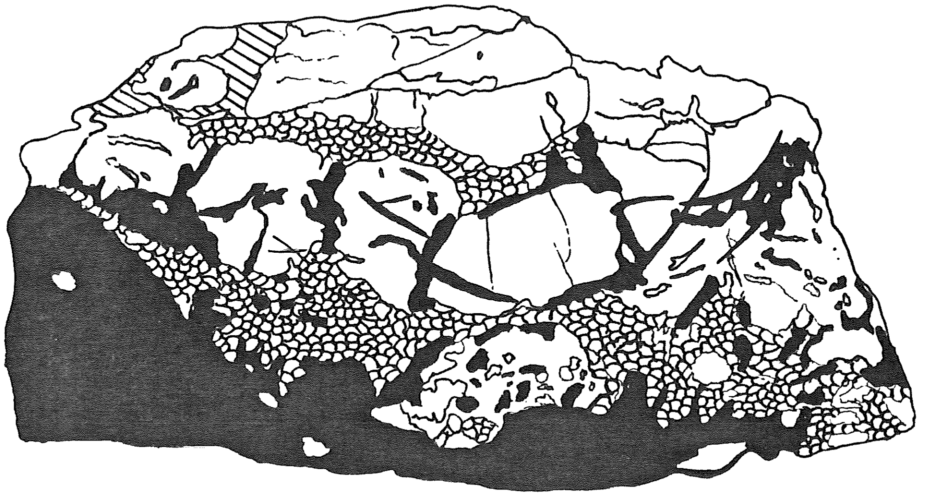
PT-4



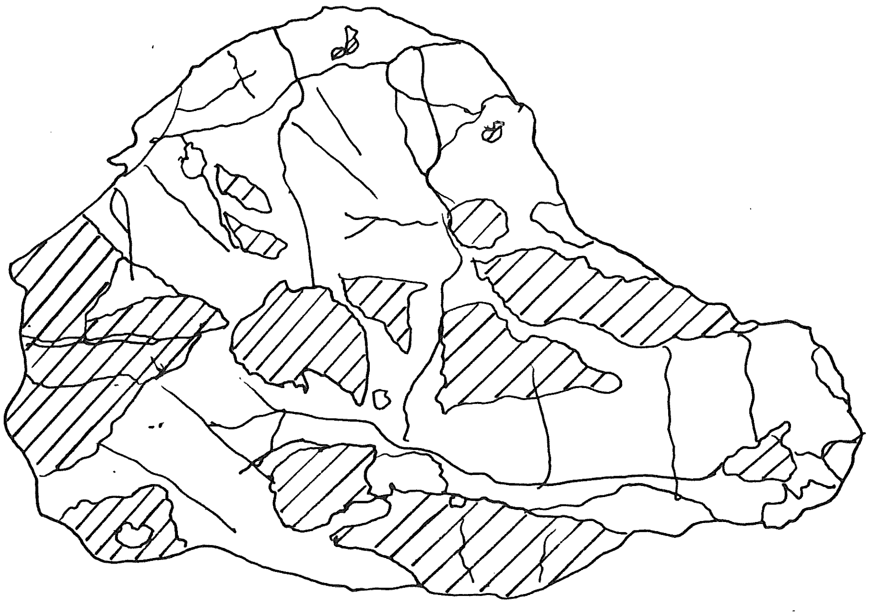
PT-13

PT-11. Massive quartz and stibnite. Stibnite appears to have assimilated or abraided the quartz fragments present causing them to be rounded.

PT-7. Massive quartz with brecciated slate.



PT-11



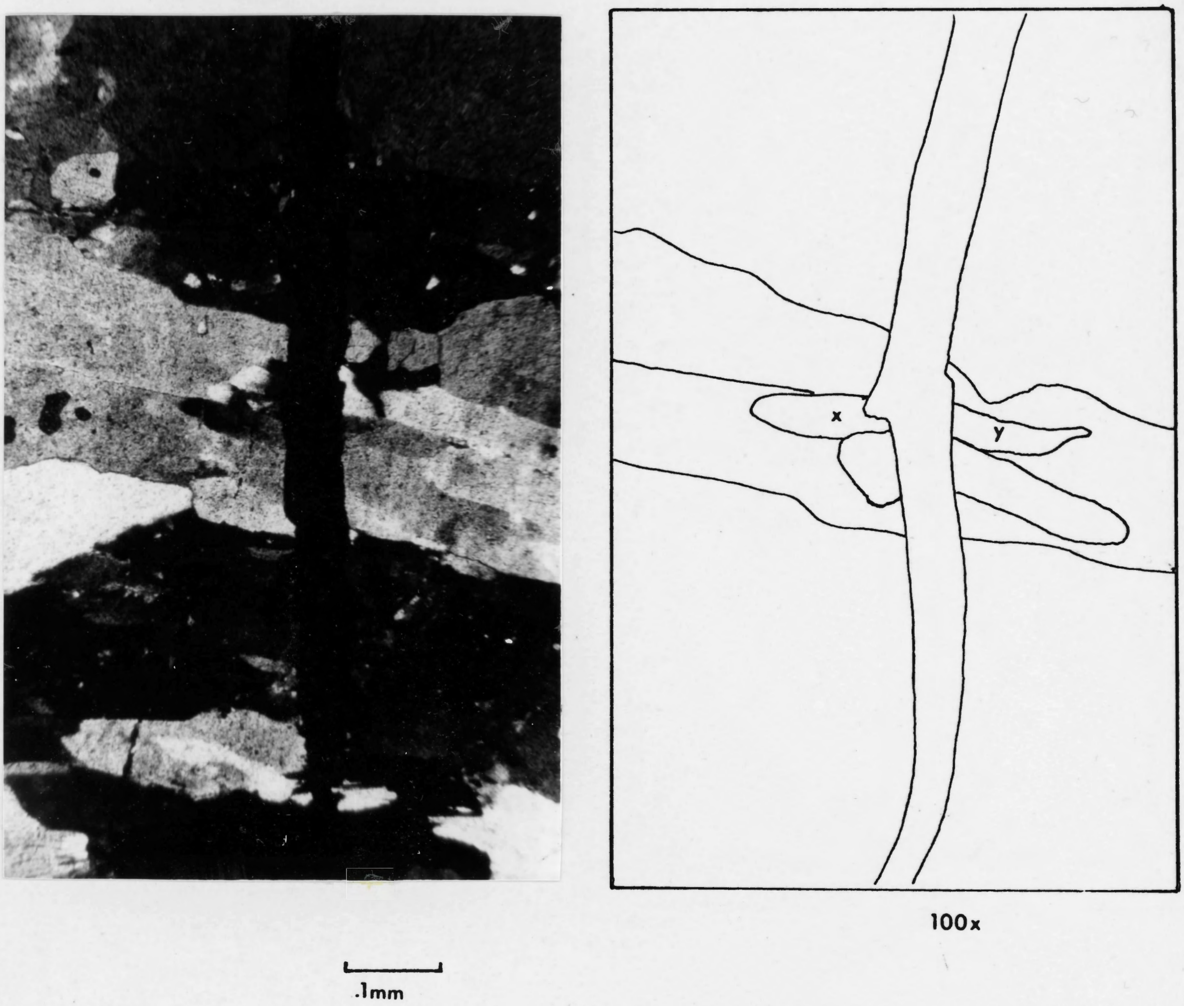
PT-7

Figure 11. Photographs of stibnite and quartz.

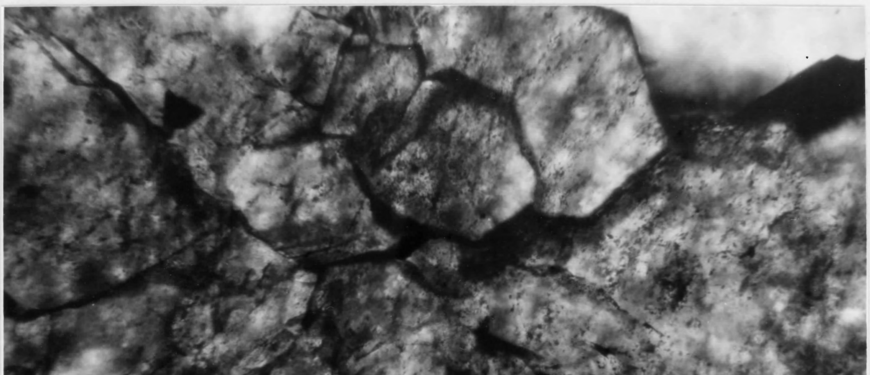
A. Veinlet of stibnite intruding through quartz grains. Undulose extinction can be seen to continue uninterrupted in the quartz from one side of the vein to the other. The area marked x on the diagram is a continuation of y. The differing extinction colour within this grain can easily be seen in the photos.

B. Poorly interlocking crystals of polygonal quartz with even extinction.

A



B



100x

quartz in these cases resembles pebbles being abraded in a stream (see Figure 10, sample PT 11). Quartz also occurs as poorly interlocking masses of well formed quartz crystals. The crystals are clear and do not show undulose extinction in thin section (see Figure 11B). These well formed crystals can occasionally be seen lining vugs in milky quartz.

Stibnite occurs in a massive form and in well formed needle like crystals of various sizes. Crystalline stibnite is found as radiating masses in vugs within massive quartz and stibnite (see Figure 12). The crystals vary in size from .5 millimetres to 3 centimetres, In some cases the crystals of stibnite are completely surrounded by clear quartz. All crystals of stibnite observed were totally undeformed.

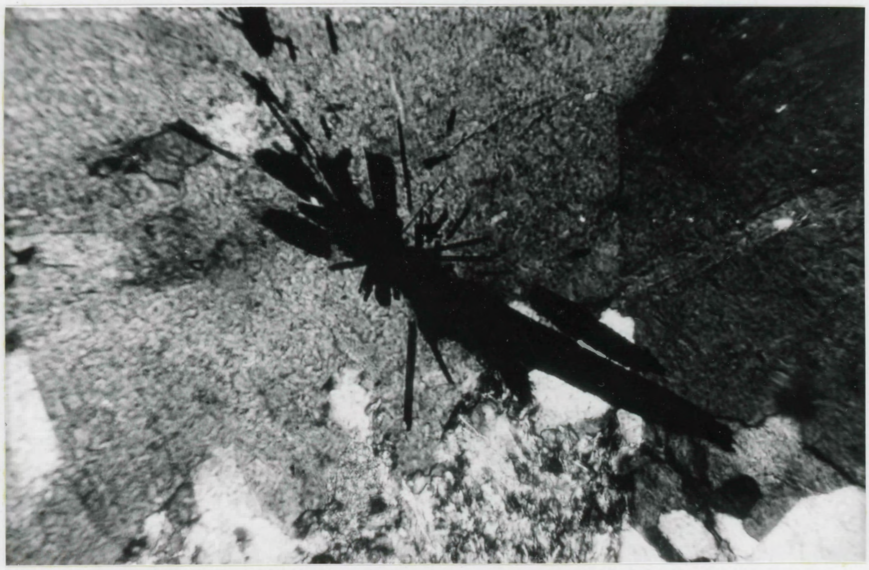
Most of the stibnite in the deposit is massive, having for the most part intruded into voids and fractures in the quartz. Under reflected light some areas of massive stibnite display an odd "zoning" where feather shaped areas have distinct colour zonations (see Figure 13A). However microprobe analysis did not reveal the presence of elements except sulphur and antimony.

Native antimony is in relatively low abundance when compared to stibnite. It is only found as dark grey,

Figure 12. Photographs of radiating stibnite crystals

A. Fine needles of radiating stibnite in quartz.

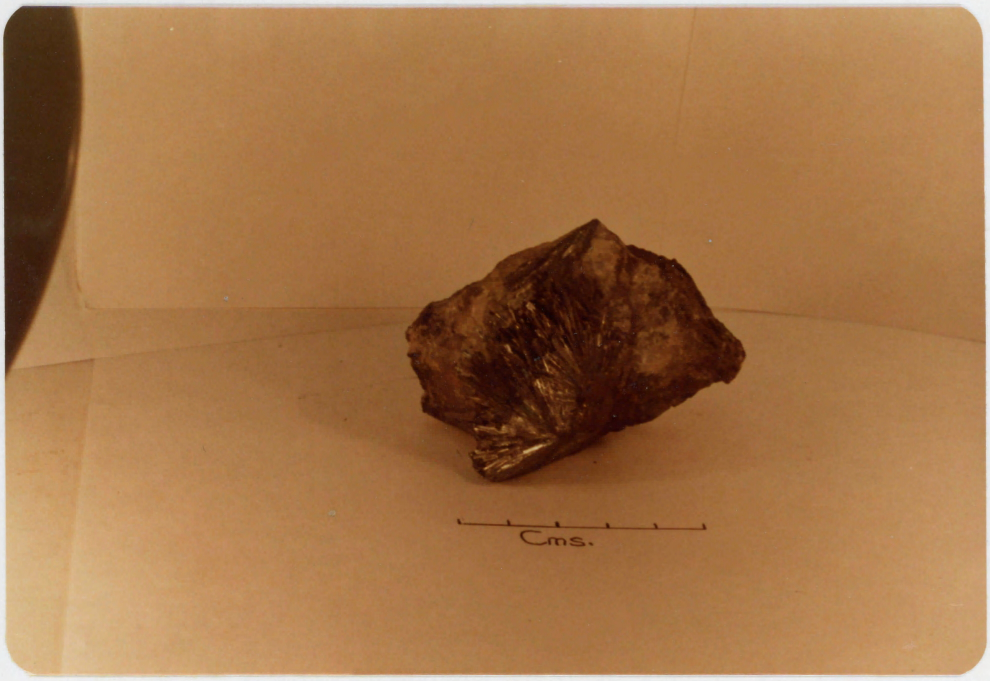
B. Hand sample of radiating needles of stibnite with quartz.



A

100x

.1mm



B

fine grained masses. It may be recognized under reflected light by a light grey colour with small isolated golden areas.

Pyrite occurs in both crystalline and massive forms. Pyrite crystals are found along fractures in quartz and, more rarely as isolated masses in quartz. These crystals are usually about .1 millimetre on a side although cubes with 2 mm long sides are present.

Massive pyrite may also be seen in fractures but more commonly it is found in intimate association with massive stibnite (see Figure 13B). Massive pyrite also occurs in rounded chunks of various sizes surrounded by massive quartz (see Figure 14A).

Arsenopyrite occurs in the massive quartz and stibnite found in the veins. It is in the same form as the previously described arsenopyrite in slate. Crystals of arsenopyrite isolated in stibnite may be seen in Figure 14B.

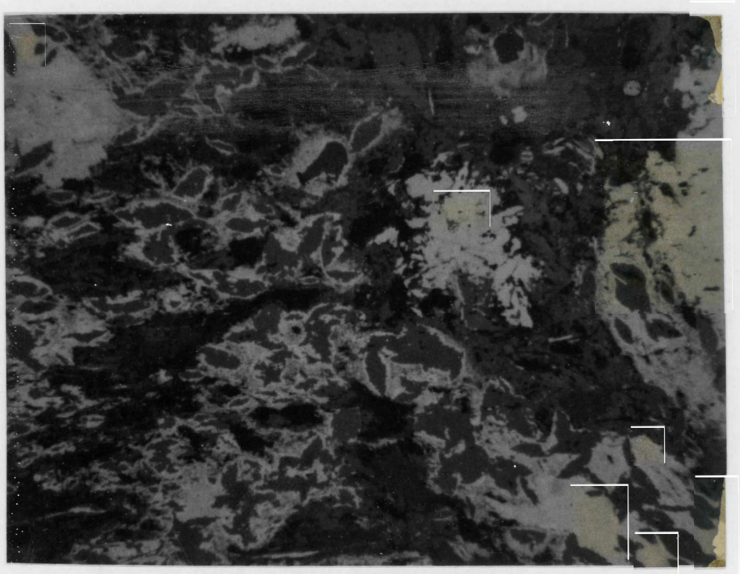
Calcite is a very minor constituent of these veins. It is found as good clear crystals in fractures in quartz and often is found encasing other minerals such as pyrite. It is also found in fractures filled with stibnite and in fact seems to be most abundant when in association with stibnite.

Gold is reported to have occurred in association with quartz, stibnite and slate (Haley 1909). As noted above, one must keep in mind that it has been reported to occur as free gold only where the interbedded veins at depth are intercepted by the fissure veins (Askwith 1901). Gold bearing samples examined by the author did not have any free gold, instead the gold was seen coating the ends of stibnite crystals.

Figure 13. Photographs of massive pyrite and stibnite.

A. Stibnite, massive, showing strange feather shaped zonations approximately .075 mm long. Colours zone from dark on inside to light grey on outside.

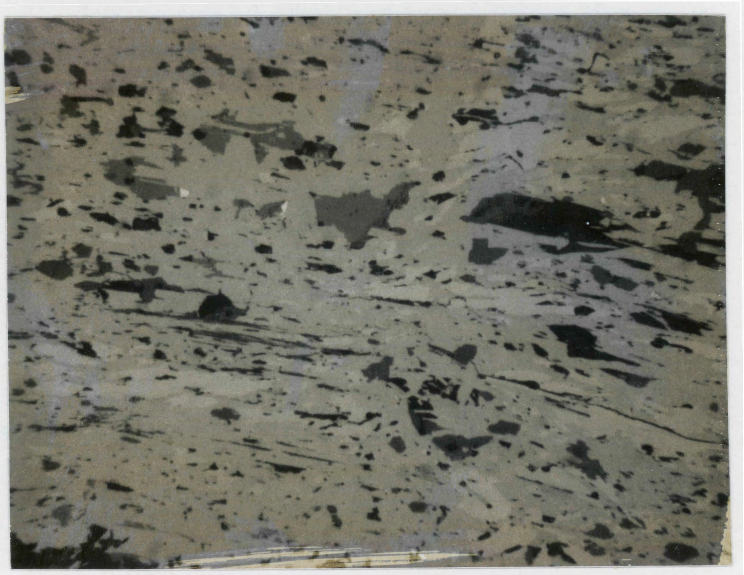
B. Massive intergrowths of stibnite and pyrite. Pyrite (medium grey) dominates this photo but there are irregularly shaped patches of stibnite (very light grey) mixed in randomly.



A

128x

.1 mm



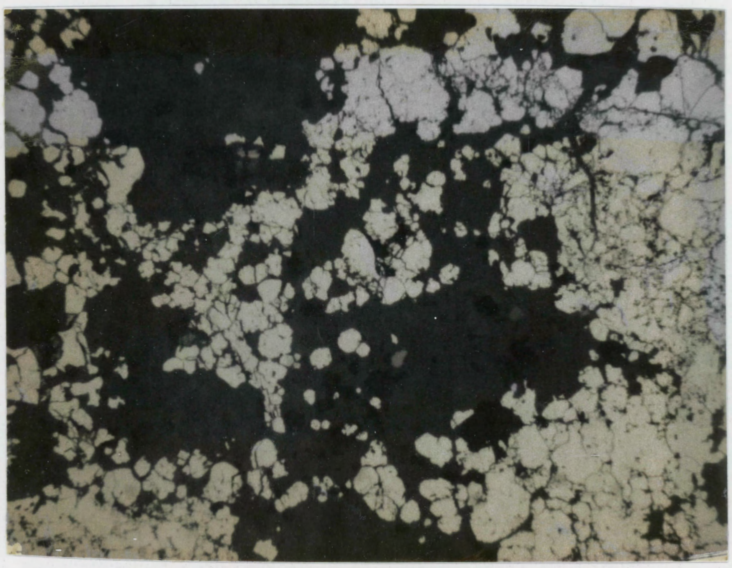
B

128x

Figure 14. Photographs showing the habit of pyrite and arsenopyrite.

A. Massive to rounded pyrite isolated in a quartz matrix.

B. Crystal of arsenopyrite showing a good triangular shape. Surrounded by massive stibnite (light grey) and massive pyrite (medium grey).



A

128x

.1 mm

B

128x

CHAPTER 6

FLUID INCLUSIONS

Studies of fluid inclusions in the massive quartz were attempted in order to try to assess a temperature of formation for the vein material.

The fluid inclusions in the quartz are very small and generally blocky. The average dimension is approximately .005 millimetres (5 microns).

Bubbles of either gas or liquid can be seen in most of the inclusions (Figure 15A) and in a few inclusions there are shadowy areas which may be solid phases (Figure 15B). The percentage of the inclusion occupied by bubbles varied considerably, ranging from approximately 15 to 35 percent of the total volume (Figure 16).

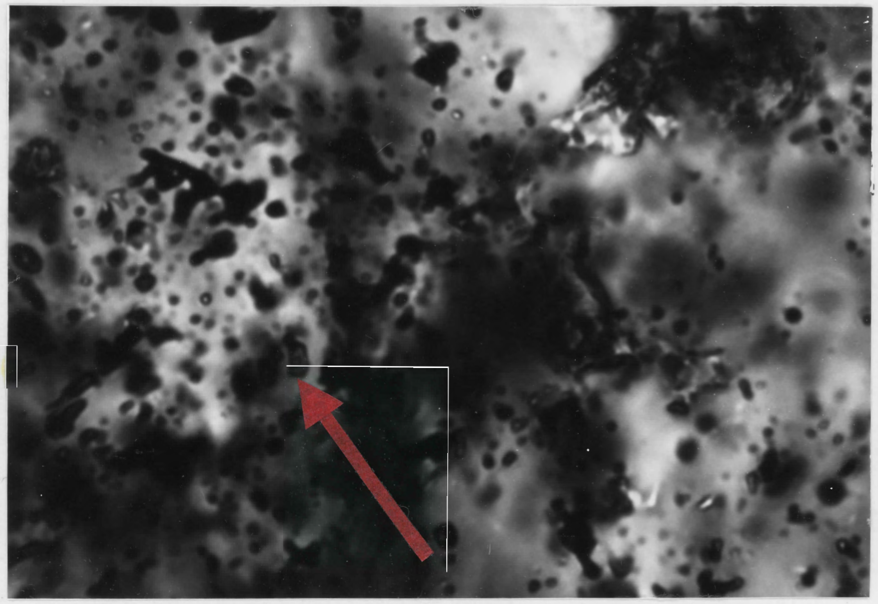
Heating experiments were carried out using the same apparatus as described by M. Graves (1976). The high magnification used (1000 x) lowered the resolution to a point where viewing was very difficult. This was improved by replacing the rather thick glass covering the heating chamber with a thinner slide cover slip. As a result of this slight modification a higher voltage was needed to maintain the temperatures in the heating chamber.

Figure 15. Photographs of Fluid Inclusions in Quartz.

A. Red arrow indicates a two phase fluid inclusion. The inclusion is fairly angular with approximately 20% of its area being occupied by a bubble of gas.

B. Red arrow indicates a relatively large angular fluid inclusion. The dark stripe down the centre of the inclusion may indicate the presence of a solid phase.

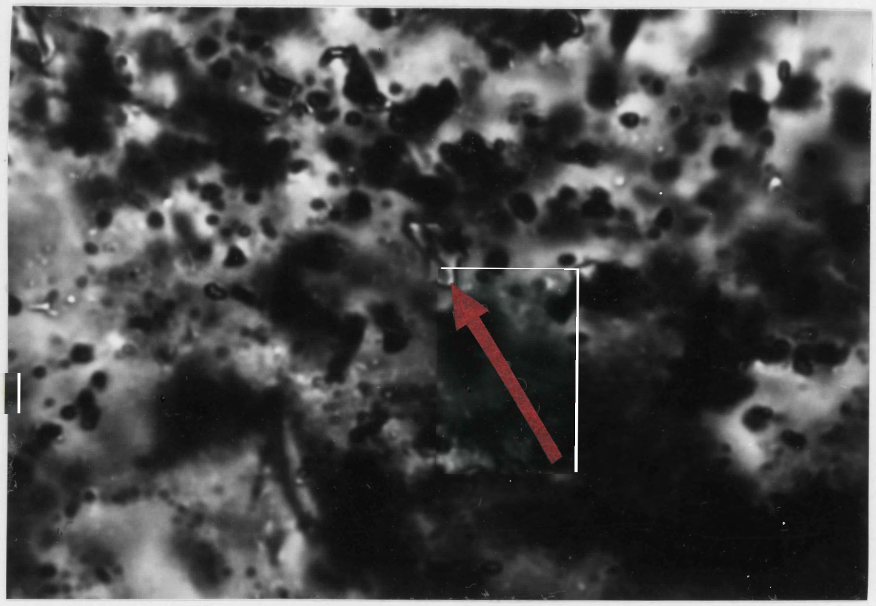
A



800 x

.01 mm

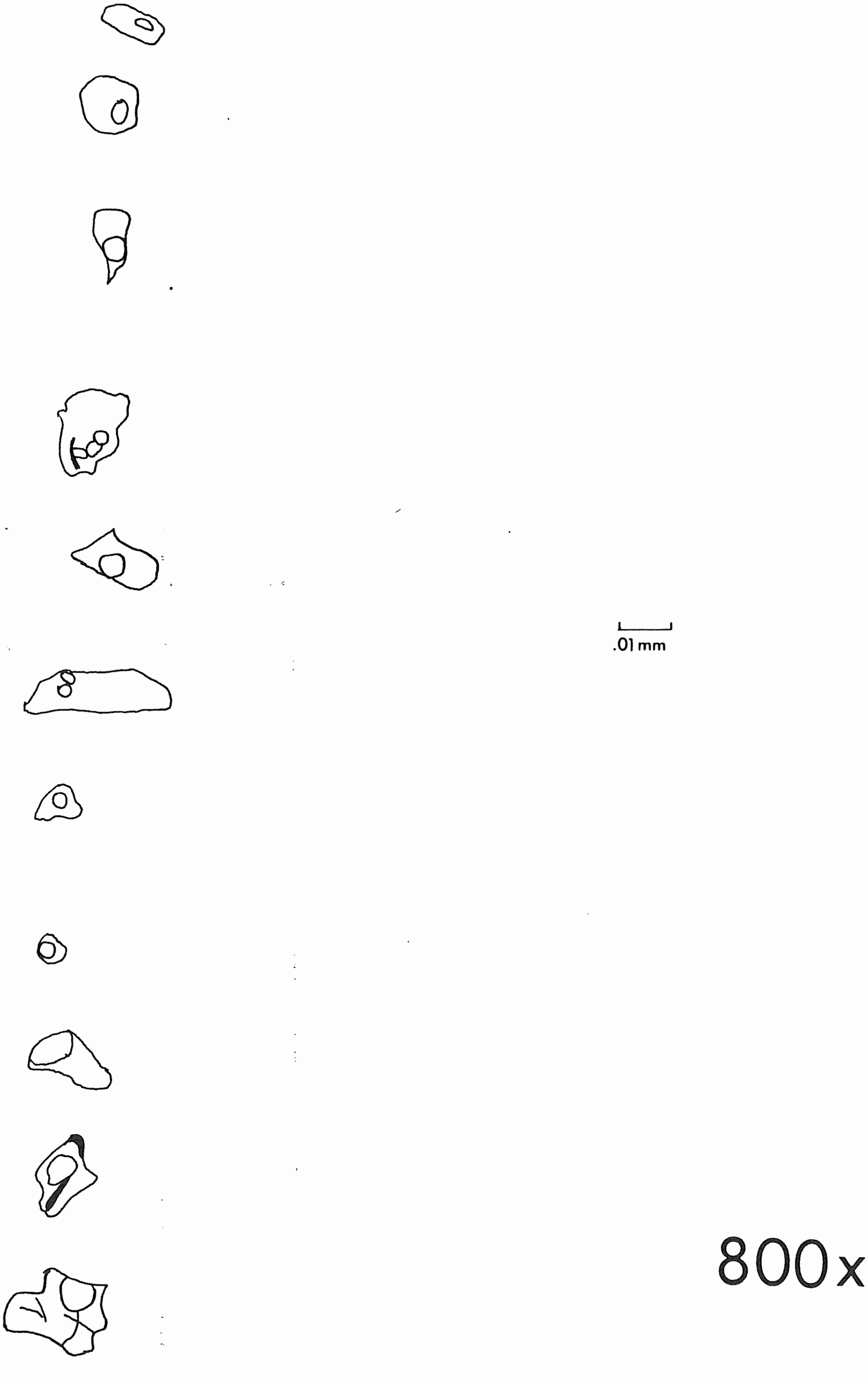
B



800 x

Figure 16. Sketches of Fluid Inclusions

These sketches show the variation in size, shape and number of phases present of the fluid inclusions found in quartz from West Gore. In some inclusions as many as 2 or 3 separate vapor or liquid phases may be seen as well as long filaments of solid material.


.01 mm
800x

Temperature gradients within the chamber (see Roedder 1976, p. 84) are probably increased by this, as are the possibilities of error in temperature measurement associated with them.

The results of the heating experiments were less than conclusive. All inclusions which were heated showed little change in bubble size with increasing temperature. In a few cases the bubbles became indistinct and possibly smaller but they never disappeared. The maximum temperature reached in this experiment was restricted to 510°C, primarily to prevent damaging the equipment and secondarily, a homogenization temperature of over 500°C from a quartz vein in a greenschist regionally metamorphosed rock seemed unlikely.

There are several possible explanations as to why the bubbles in the fluid inclusions did not disappear when heated. It may be that the original solution which was trapped as a fluid inclusion was boiling. This would lead to bubbles of gas trapped in many inclusions at the temperature and pressure of their formation. As a result these inclusions may be unable to homogenize except at unreasonably high temperatures. Secondary movement along the fault plane after the quartz's precipitation may break some or all of the inclusions. The resulting leakage would invalidate all fluid inclusion work.

Lack of time prevented the author from attempting further experiments with fluid inclusions. The possibility of boiling (above) should be investigated, because it may have had important effects on the precipitation of sulphides.

CHAPTER 7

FORMATION OF THE ORE

Paragenetic Sequence

In order to formulate a paragenetic sequence for this deposit the relationship between the minerals found in the vein must be made clear. The relative ages of the mineral phases present can be deduced by examining; cross cutting relationships, mineral coatings and the relationship between strained and unstrained crystals. The following is a list of pertinent relationships and their possible significance to the paragenetic sequence.

- the fissure veins truncate interbedded quartz veins at depth and cut the cleavage in the slates. This dates the fissure veins as younger than the episode of folding which formed the major structures in the Meguma and younger than the interbedded quartz veins. This is most important when coupled with the fact that free gold is only found where the interbedded veins intersect the fissure veins. One can suggest that the bulk of gold mineralization at West Gore is not genetically related to the stibnite mineralization but instead is present due to a chance intersection of the fissure vein with a gold bearing interbedded vein.

- the massive milky quartz has undulose extinction and arsenopyrite can be seen to be broken or faulted, (cataclastic texture). This indicates that the arsenopyrite crystals were subjected to deformational forces after they crystallized in the fissure. These may represent secondary movement on the fault.
- massive stibnite appears to have "stoped" the massive quartz and rounded the fragments off; also fractures in the massive quartz are filled by undeformed stibnite and pyrite cubes. The above two points suggest that the stibnite and pyrite are younger than the quartz, also the deformation affecting the quartz was before the introduction of the stibnite.
- stibnite crystals are sometimes encased in clear quartz, indicating a second deposition of quartz after the stibnite was deposited or possibly as a late stage precipitate from the stibnite bearing fluids.
- other than at the intersection of vein and interbedded quartz vein all gold seen was in complexes usually with stibnite. As mentioned above the gold may have been remobilized from the interbedded

vein, however it could have been mobilized by either the quartz or the antimony bearing fluids. Since it appears that the arsenopyrite was deposited with the massive quartz early in the veins' history and since it is known that gold is associated with milky quartz and arsenopyrite (Graves 1976), it could be that the gold was mobilized from the interbedded veins by the early fluids carrying quartz. If this is true the gold seen in association with stibnite could be due to a second mobilization of gold by the antimony rich solutions.

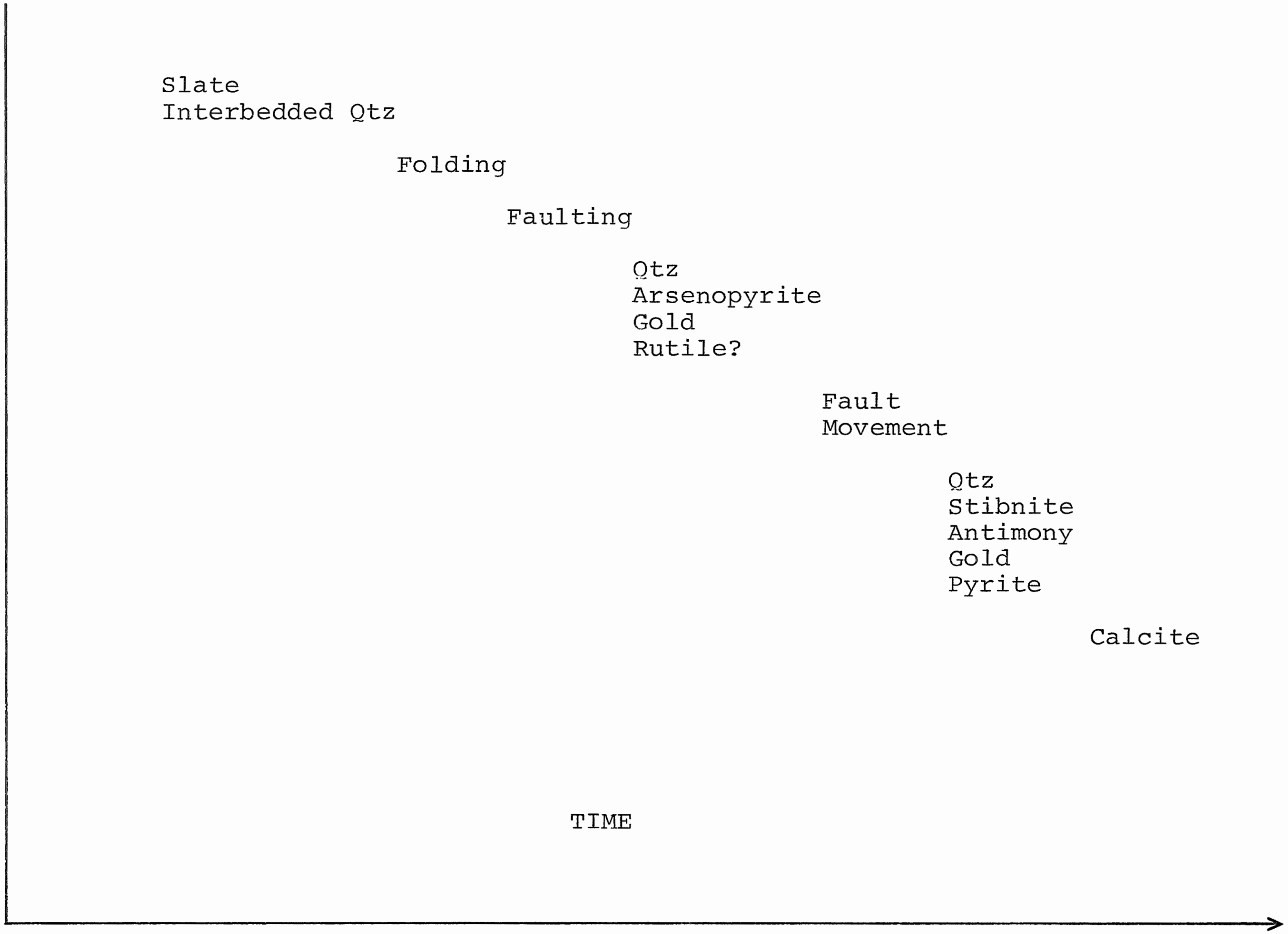
Figure 17 gives one possible paragenetic sequence for West Gore.

Genesis of the Ore

The West Gore deposit's mode of origin has never been discussed in detail. Douglas (1939) suggested that "the mineralization was a result of igneous activity" and cited the occurrence of orthoclase feldspar and quartz injected across cleavage planes as evidence. In his report of 1958 Stevenson agrees with Douglas's idea of igneous influence.

Graves (1976) has postulated that the interbedded quartz veins in the Meguma were formed originally as flat lying beds from minerals carried by water from the undeformed

Figure 17. Suggested paragenetic sequence for the West Gore antimony deposit.


Slate
Interbedded Qtz
Folding
Faulting
Qtz
Arsenopyrite
Gold
Rutile?
Fault
Movement
Qtz
Stibnite
Antimony
Gold
Pyrite
Calcite
TIME

Meguma sediments around them. Since this deposit is clearly post-folding the likelihood of the metamorphic de-watering of the Meguma Group being the supplier of ore forming solutions appears to be slight.

It is possible that the intrusion of the Devonian granites occurred during or after the time of faulting that produced the fissures at West Gore. If this is so the granite could have supplied the hydrothermal fluids which deposited the ore at West Gore. The geologic setting at West Gore, i.e. the granites being over 25 kilometres away does not readily support this but granites could be present at depth. The antimony occurrence at Lansdowne, Digby County, does have granites at a depth of 133 feet and it does have antimony minerals in quartz veins. West Gore could very well have a granite body present at a relatively shallow depth.

The question which now must be answered is what is the source of the antimony metal for this deposit? The amount of antimony on average in a granite has been measured to be approximately .2-.3 parts per million. In contrast to this the average content of antimony in shales is about 2 ppm, a value 10 times greater than that for granites (Kupick, 1978).

There are many areas in the world where there are large antimony, tungsten and mercury deposits occurring in Lower Paleozoic black graphitic slates and shales which are similar to the Halifax Formation.

Large deposits of this type occur in Sardinia, Turkey and the Eastern Alps (Maucher 1976). The large Bolivian tin deposits and the Keno Hill lead-zinc, silver deposits of the Yukon Territory also occur in similar rocks and contain minor antimony.

Unlike West Gore, the majority of large antimony-tungsten-mercury deposits in black shales are stratabound. However, a few of these deposits do have mineralized fault zones associated with them. The large deposits are often closely related to submarine volcanism and igneous hydrothermal activity. Also they have been related to processes occurring at convergent plate boundaries (Holl 1977).

Considering the number of deposits of antimony around the world occurring in black shales, it is tempting to suggest that the deposit at West Gore is also related to the host Lower Paleozoic graphitic slates. However, it must be noted that although black slates are present some other common features of many of the world's major deposits of antimony are not. The most notable of these is the lack of volcanic rocks.

There are many genetic models possible for the mineralization at West Gore. A simple model is deposition of antimony minerals in a fault zone which is syn- or pre-granitic intrusion. Hydrothermal waters from the granite mobilized antimony contained in the sediments and deposited them in the fault zone.

CHAPTER 8

FUTURE OF ANTIMONY MINING IN NOVA SCOTIA

Research

As a result of this study it is obvious that there are several facets of the West Gore antimony deposit which need further research. Experimentation with the fluid inclusions in quartz to find out whether other phases contain pure water, NaCl solutions, Methane, CO_2, etc. could be very enlightening with respect to the nature of the ore forming solutions.

If the vein is related to intrusion of the granites, dating the alteration minerals (sericite) along the fault may give valuable information on the age of the possible granite body at depth.

Exploration

Further exploration at West Gore should primarily be aimed at delineating the faults that occur in the area. The faults reported in this thesis were based on 40 year old reports and were not able to be confirmed by the author's surface mapping. Geophysical means such as a gravity or electromagnetic survey could be used to accurately outline the faults and more detailed exploration could continue from there.

On a more regional basis, exploration is certainly worthwhile in the Meguma. Argillaceous slates such as those of the Meguma contain many antimony deposits around the world and other deposits besides the West Gore could be present in the Meguma.

A first step for exploration on the scale of the whole Meguma would be to try and find similar fault zones to those present at West Gore. The use of satellite photos for this purpose would be a logical starting point. Once discovered, reconnaissance geochemical sampling for antimony and arsenic over suspected fault zones may be effective. Wide dispersion halos and a rise and fall in values were noted for antimony and arsenic by Boyle (1965) when he sampled across a vein containing minor antimony and arsenic in the area of the United Keno Hill deposit.

If antimony demands in the future are sufficient to warrant new exploration, the Meguma would seem to present an encouraging target.

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APPENDIX I

WG-2

- 75% quartz
- 25% stibnite
- >>1% calcite

- quartz present is white massive quartz except for areas surrounding intruding veins of stibnite where the quartz is clear
- needles of stibnite grow into the clear quartz surrounding the stibnite veins
- rusty coloured vugs in quartz are present but no pyrite is visible
- small grains of calcite occur along edges and in intimate contact with the massive stibnite
- some stibnite present is massive and is found in veins or cracks
- a few slightly rounded grains of quartz are isolated in the stibnite

PT-4

- 50% quartz
- 50% slate
- >1% calcite
- >1% arsenopyrite

- quartz present is massive and milky white
- contains many small fractures and cavities
- calcite occurs as spar in these fractures and voids
- calcite also appears as small (.2 mm)^2 crystals lining vugs in the slate.
- diamond shaped to polygonal arsenopyrite crystals are present, approximately .3 mm on a side
- quartz intrudes the slate and angular pieces of slate can be seen in the quartz
- quartz appears to be "stoping" the slate
- in areas close to the margins of the slate/quartz boundary there are a few tiny fractures in the quartz containing arsenopyrite

PT-6

- 60% quartz
- 25% slate
- 10% stibnite
- 4% calcite
- >1% arsenopyrite

- the quartz in this sample does not appear to be the usual massive, slightly vuggy type, instead it appears to be a well intergrown mass of perfect quartz crystals, good crystal faces and terminations are visible.
- any vugs present are due to voids created by the open spaces between crystals
- in one area there appears to have been a second intrusion of quartz, as seen by cross cutting relationships
- the second quartz intrudes through the first as well as through the angular fragments of slate present
- it also has some stibnite in fractures in it
- the slate appears as angular fragments
- the cleavage direction is not visible, the usual greenish colour seen in other samples is restricted to small central areas of a few of the fragments, the remainder is a dark brown
- the slate is intruded by quartz and is suspended by it

- the stibnite present is massive and occurs in fractures in the quartz. A rust coloured stain is also present in the same fracture as the stibnite
- an arsenopyrite crystal is present which seems to have been cracked by the intrusion of quartz, it is located close to the slate

PT-7

- 50% quartz
- 50% slate
- 1% pyrite, calcite, stibnite, arsenopyrite

- consists mainly of massive quartz with rounded slate inclusions
- slate contains angular crystals of arsenopyrite as well as cubes of pyrite (1 mm)
- the quartz is well fractured and along its fractures are stibnite crystals and pyrite, pyrite is also seen in the quartz mass a short distance from the fractures
- calcite has been deposited along the fractures with the stibnite

PT-9

- 93% quartz
- 5% pyrite
- 2% stibnite
- <<1% calcite

- massive quartz heavily fractured and mineralized with pyrite and stibnite
- both the pyrite and the stibnite occur as massive dendritic masses occupying old fractures in the quartz
- some of the fractures also contain calcite especially those with stibnite in them
- much of the quartz is stained orange, possibly from oxidation of the pyrite
- pyrite can be seen lining both sides of a fracture, leaving a small area in the middle

PT-11

- 50% quartz
- 50% stibnite
- <1% calcite

- this sample consists of basically 3 areas: (1) massive stibnite, (2) massive quartz (3) very fine aggregate of quartz pebbles and stibnite
- the stibnite in this sample is massive and intrudes along the fractures in the large quartz fragments; some vugs with needles of stibnite are visible
- the quartz present is massive and occurs as variably sized fragments. All the fragments are rounded.
- the fine grained aggregate of quartz and stibnite consists of fine (1 mm or less) rounded grains of quartz in a "Matrix" of massive stibnite. The quartz appears much darker in these areas but this is due to the surrounding of the grains of quartz by stibnite which gives it a darker tinge as it shines through from underneath
- this sample is graded with respect to the 3 above mentioned areas, one side is completely massive stibnite whereas the other is very quartz rich

PT-13

- 80% quartz
- 20% stibnite
- ∿1% calcite
- ∿1% slate

- this sample consists mainly of quartz which has been intruded by veins of stibnite
- the stibnite present is mostly massive but within the intruding veins there are small cavities which show a mass of very long needles of stibnite in radiating clusters
- there are also linings of calcite and/or quartz crystals in the vugs, as well as, calcite in the vugs of the massive quartz
- small chunks of calcite are present in the massive stibnite in the veins
- at one edge of the sample is an area of slate fragments and angular-subangular quartz fragments forming a breccia with massive stibnite as a possible cement

PT-14

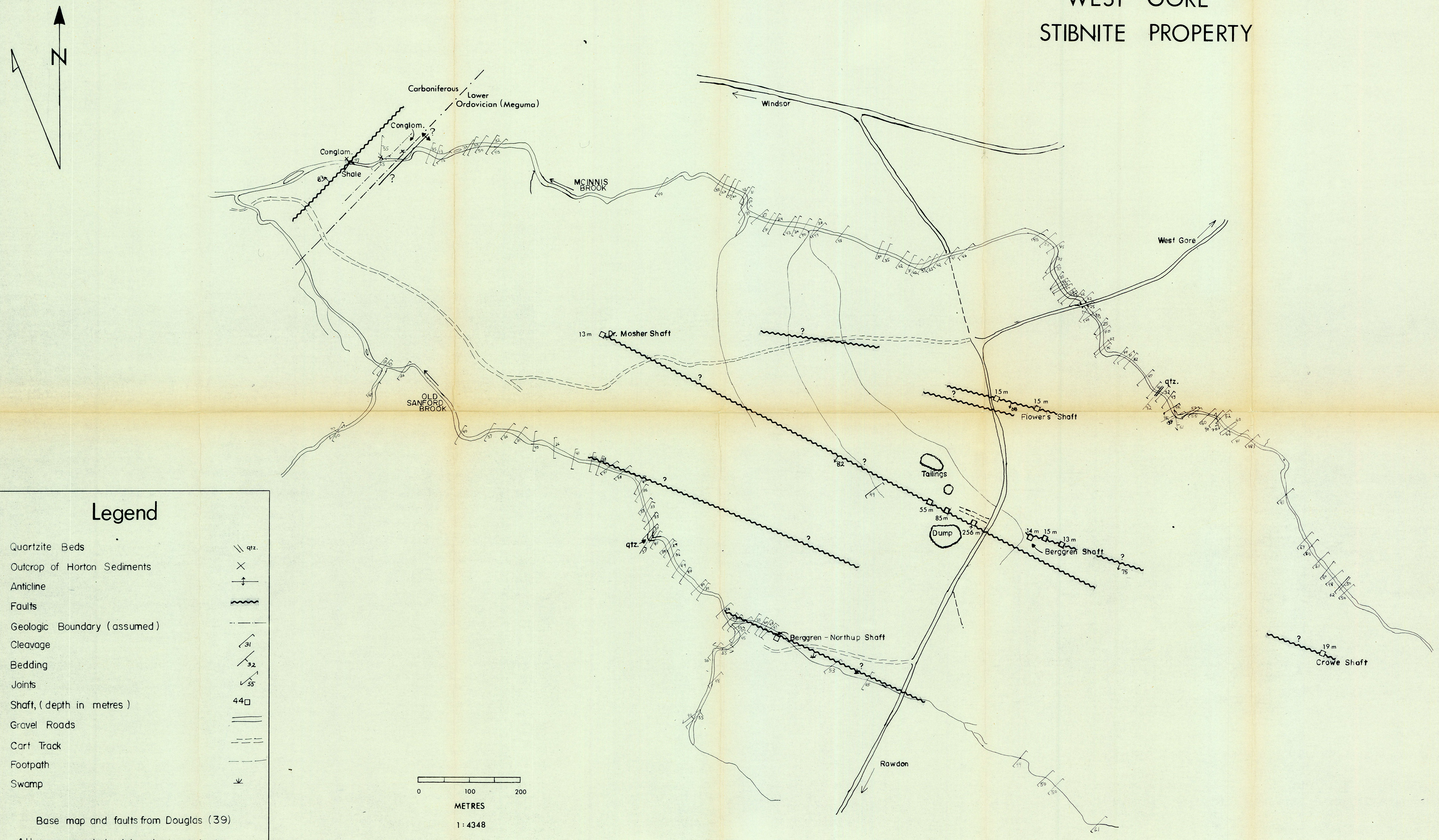
- 50% quartz
- 35% slate
- 11% stibnite
- 4% arsenopyrite
- <1% calcite
- <<1% pyrite

- quartz is massive, milky, crossed by many narrow fractures some of which contain calcite and stibnite
- pyrite also occurs in the fractured quartz, as a small (.1 mm) cube
- the slate occurs as rounded unoriented lumps in the quartz
- in the slate are many angular crystals of arsenopyrite
- the massive stibnite has intruded into the cracks in the quartz and in many cases occupies large volumes (i.e. a vein 4-5 mm across)
- stibnite also shows a needle like appearance along its borders with the quartz

TIME SPENT ON THESIS WORK

Field work	7 days (8 hrs/day)
Sample Processing (cutting, polishing)	40 hours
Outside research (Dept. of Mines, N.S. Museum)	35 hours
Sample descriptions (slabs, thin sections, polished thins)	80 hours
Microprobe	6 hours
Fluid inclusion work	40 hours
Drafting	25 hours
Writing/correcting	110 hours
TOTAL	392 hours

WEST GORE
STIBNITE PROPERTY



Legend

Quartzite Beds qtz.

Outcrop of Horton Sediments ×

Anticline

Faults

Geologic Boundary (assumed)

Cleavage 31

Bedding 32

Joints 55

Shaft, (depth in metres) 44□

Gravel Roads

Cart Track

Footpath

Swamp

Base map and faults from Douglas (39)

All measurements in slate unless stated otherwise

GEOLOGY — P. THOMAS