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REPORT

GEOLOGY OF HAVELOCK MINE

SWAZILAND.

deur/by

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A DESCRIPTION OF THE GEOLOGY AT HAVELOCK MINE

By

M.J. Mackenzie

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CONTENTS.

I. INTRODUCTION

A. Situation

Havelock Mine is situated in the northwest corner of Swaziland, latitude 25°57'10" and longitude 31°07'00" and occupies a position in the mountainous highveld. The railhead is Barberton in the Transvaal, to which it is connected by a 28 mile dirt road and by an aerial ropeway, 12.5 miles in length.

The climate is healthy with summer temperatures seldom exceeding 85°F. Rainfall is abundant, usually averaging 60" per annum with most of it falling during the summer months.

Deep erosion by the tributaries of the Komati River and the geological control exercised by the various Fig Tree sediments accounts for the spectacular rugged relief of the area.

B. History

The first known record of the origin of the deposit dates back to 1922 when a coloured man "Case" employed by a Mr Castle made a cutting into the bank of the Tutuzi River from which he collected some fibre samples.

Messrs Turner and Newall Limited purchased the property in January, 1930 and in 1939 the first processed fibre was despatched over the aerial ropeway.

C. Mining

Since 1938 the mine has been served by a three compartment 40° incline shaft, in which two compartments are equipped for hoisting while the third is a travelling way. This shaft has recently been replaced by a 20' diameter circular vertical shaft in the footwall.

Quarry operations ceased in 1948. Since then the mining method has been essentially a sub-level shrinkage method which has undergone various modifications over the years depending on the ground conditions encountered. West of the old incline shaft weak ground conditions are experienced due to intense faulting and shearing in the orebody. East of the old incline shaft there is far less shearing and faulting and ground conditions offered no great problem to the mining operations.

D. Milling

The milling process is basically one of repeated crushing, screening and air-lifting, with diminution of screen apertures until the economic limit is reached.

E. Geology

The chrysotile orebody is found in light green serpentine of the Jamestown Complex which intruded along the strike of the surrounding Fig Tree sediments. Prominent chert

E. Geology (cont'd)

horizons form the footwall and hangingwall of the serpentinite.

The serpentinite is not confined to one horizon but to several horizons and in addition, two main types can be distinguished, namely a fine grained dark green serpentine and a coarser grained light green serpentine.

Generally, the light green variety of serpentine forms the core of the ore bearing ultrabasic which averages six hundred feet in width.

Eastward along strike the serpentinite appears to intrude various basic schists whose position in the sequence is at present, difficult to ascertain.

Chrysotile fibre seams occur in both varieties of serpentine but are economically developed only in the light green serpentine. The orebody has a fairly continuous strike length of 4,000' and dips conformably with the surrounding sediments.

The conformable nature of the ultrabasic with the surrounding Fig Tree sediments has raised some doubt as to whether it is originally extrusive or intrusive. Recent work on the Havelock Mine serpentinite in the eastern section of the mine workings has shown a crosscutting relationship of the serpentinite with the Fig Tree rocks.

The earliest known geological description of the area was by Hall (1930) who states that the dark green serpentine and light green serpentine were probably originally derived from a pyroxenitic intrusion and olivine-bearing rock respectively.

Pretorius (1948) considered there were two periods of ultrabasic intrusion comprising an older Jamestown Complex and a younger Havelock Complex. The rocks of the Jamestown Complex represent the highly metamorphosed products of an original ultrabasic igneous intrusion and consist basically of four main types of schist:

(1) talc schist; (3) chlorite schists; and
(2) tremolite schists; (4) hornblende schists.

The Havelock Complex, according to Pretorius, is represented by a suite of differentiated igneous rocks of post-Jamestown and pre-granite age. Included in the Havelock Complex are serpentines, pyroxenites, epidiorites, and diorites.

The reasons for grouping the Havelock Complex as post-Jamestown in age and not as an integral part of the Jamestown Complex itself are as follows:

(1) The Jamestown rocks are highly schistose, whereas the schistose structure is only poorly developed in the Havelock Complex;

(2) The Jamestown Complex rocks are all products of metamorphism, whereas the diorites and some pyroxenites of the Havelock Complex represent original rock types;

(3) There is evidence that serpentinite cuts across Jamestown schists into the Fig Tree Series.

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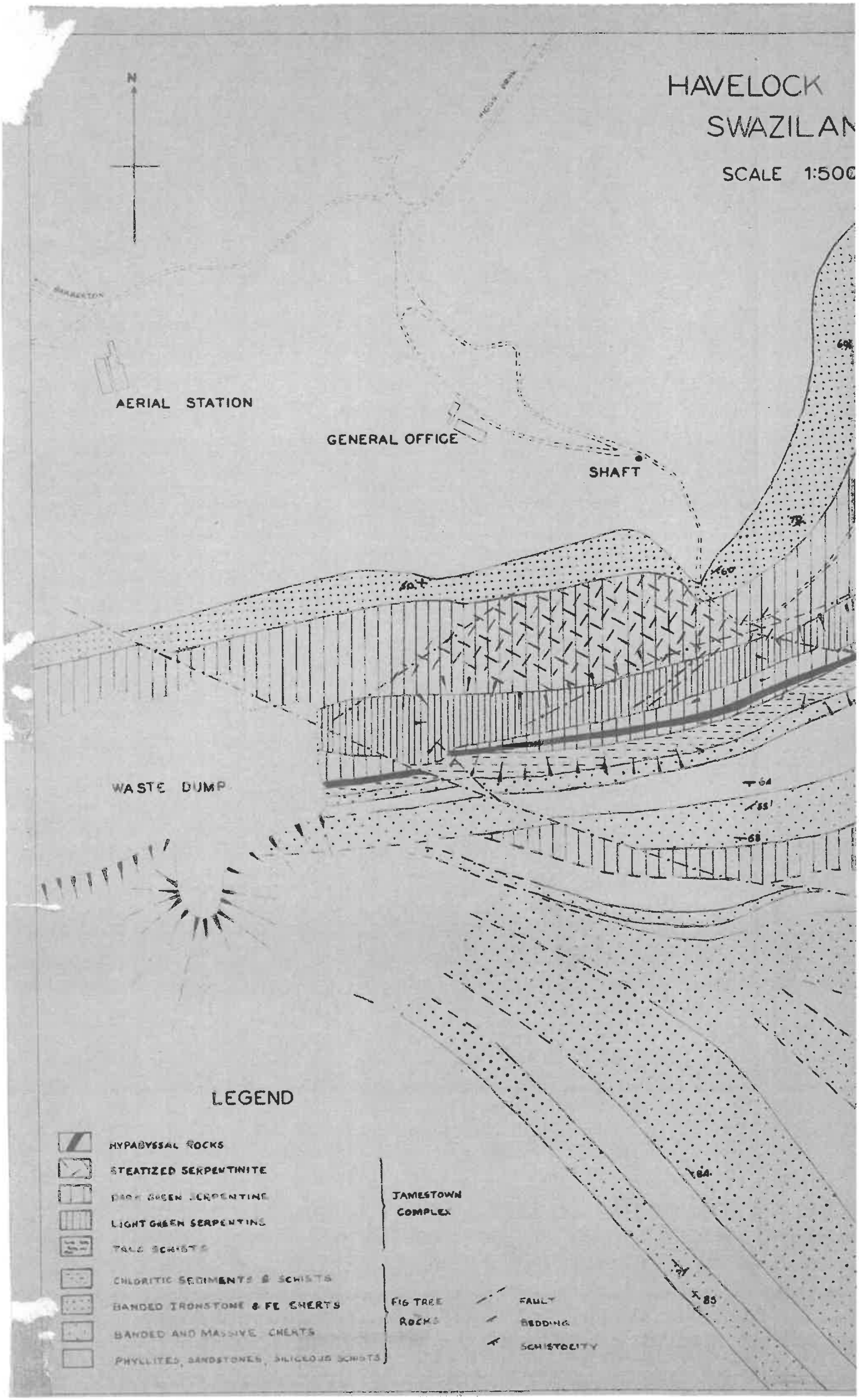
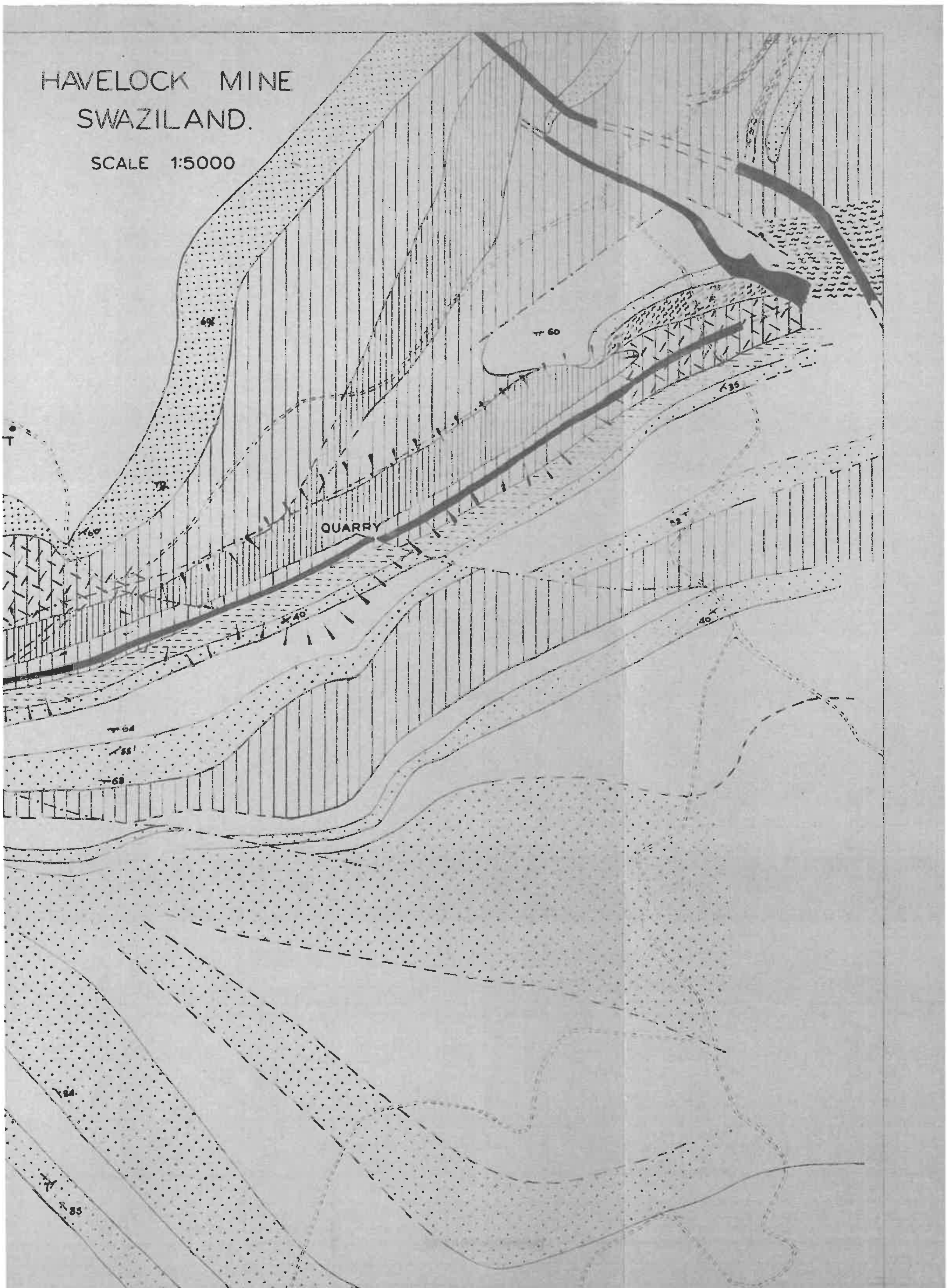
E. Geology (cont'd)

(4) The Havelock Complex represents a suite of differentiated rock types, whereas the original rocks of the Jamestown Complex appear to have been of comparitively uniform composition.

Van Biljon (1959) believes that the close association of schists and serpentinite, and because they grade into one another, indicates that the two-fold sub-division of the Jamestown Complex is not justified. Due to the serpentinites' association with cherts and strong folding, van Biljon believes it to be of the Alpine Type. A metasomatic origin for the ultrabasic is proposed which would explain the gradation of light green serpentine, originally dunite, to dark green serpentine (originally pyroxenite) and also the gradation of serpentinite along strike into argillaceous rock.

Urie (1957) considers the intrusion of the Jamestown Complex to have taken place by a process of selective assimilation rather than metasomatism. The sharp contact between schist and sediment is difficult to explain by a process of extensive metasomatism.


HAVELOCK
SCALE
N
AERIAL STATION
GENERAL OFFICE
SHAFT
WASTE DUMP
LEGEND
HYPABYSSAL ROCKS
STEATIZED SERPENTINITE
LIGHT GREEN SERPENTINE
JAMESTOWN COMPLEX
CHLORITIC SEDIMENTS & SCHISTS
BANDED IRONSTONE & FE CHERTS
BANDED AND MASSIVE CHERTS
PHYLLITES, SANDSTONES, SILICEOUS SCHISTS
FIG TREE ROCKS
FAULT
BEDDING
SCHISTOCITY


HAVELOCK MINE
SWAZILAND.
SCALE 1:5000
QUARRY

II. GENERAL GEOLOGY AND FIELD OCCURRENCE

A. General Succession

A cross section through the central part of the orebody would reveal the following rock types from footwall to hangingwall:

Rock Type	Approximate Width	Series
12. Massive and banded cherts with interbedded schists	over 1200'	Fig Tree (and Jamestown?)
11. Coarse grey talc rock	0' - 30'	Jamestown
10. Dark green serpentine	0' - 350'	"
9. Black and grey banded chert with interbedded shaley horizons	200' - 500'	Fig Tree
8. Siliceous chloritic schist	50' - 100'	" "
7. "Hangingwall sill"	20' - 50'	
6. Dark green serpentine	0' - 80'	Jamestown
5. Light green serpentine with orebody	110' - 240'	"
4. Talcose dark green serpentine	0' - 340'	"
3. Dark green serpentine	0' - 180'	"
2. Banded chert	50' - 230'	Fig Tree
1. Phyllite	over 400'	" "

B. Fig Tree Rocks

The general strike of the Fig Tree rocks in the area is northeast southwest and dips vary between 20° and 80° towards the southeast. See accompanying geological plan.

The main vertical shaft in the footwall is situated in a fine grained phyllite consisting of quartz, chlorite, sericite, and carbonate. Elongated carbonate inclusions occur in the plane of the schistocity.

Overlying the phyllite is the most conspicuous banded chert horizon which underlies the ore bearing serpentinite in the western section of the mine. Eastwards the chert horizon swings away northward, still underlying the serpentinite, the latter now no longer ore bearing. The banded chert is sporadically ferrugenised, haematite, specularite, and goethite being present.

In the eastern section of the mine there occurs an inlier of sedimentary rocks in the footwall of the orebody which strikes and dips conformably with the serpentinite. This group of rocks consists of three prominent horizons:

(1) Fine grained talc schist which underlies and pinches out against the ore bearing serpentinite. On surface it is a dirty brown colour and weathers easily. Fresh samples are highly schistose, soft, and grey in colour. This talc schist might belong to the Jamestown Complex.

(2) Underlying the talc schist is a thinly bedded ferrugenous shale horizon in the middle of which is an irregular massive chert band.

B. Fig Tree Rocks (Cont'd)

(3) A brownish schistose rock forms the lower horizon of the inlier. This rock does not give rise to prominent outcrops but is intersected by the Tutuzi deviation adit. Fresh samples are talcose, dark grey and have a fine grained texture. Quartz veins are common.

The contact between this rock and the underlying serpentinite is a fault contact striking at N5OE and dipping at approximately 60^{o} to the southeast.

Further towards the eastern extremity of the mine there occur two banded ironstone horizons which terminate against transverse dykes. These two banded ironstone horizons dip uniformally towards the southeast but where they are cut by the dykes there is evidence of intense folding manifested by minor folds and contortions in the banded ironstone.

Overlying the serpentinite there occur a succession of massive and banded cherts with interbedded schists and shaley material including a serpentinite horizon. The individual bands of the banded chert are usually alternatively black and grey and vary considerably in width, rarely exceeding two inches. The cherts are resistant to weathering and form the prominent topographic features in the footwall. The major schist horizon is a carbonate schist containing some chlorite. The rock is dark grey in colour and fine grained.

C. Jamestown Complex

Serpentinites in the immediate vicinity of the mine are confined to three major horizons and in addition two varieties may be distinguished, namely a light green and a dark green serpentine. The light green serpentine is granular and shows colourless cores of crosshatched chrysotile fibre surrounded by veinlets of light yellow green serpentine. Some specimens of light green serpentine contain partly altered remnants of a mineral which looks like olivine. Brucite and small flakes of talc may be present. Ore minerals are sparingly present usually as stringers of magnetite and grains of the spinnel-chromite series. Magnetite may be present within the fibre seams or paralleling the fibre seam walls as thin irregular seams.

The light green serpentine in most cases forms the core of the ultrabasic and is the host rock to the orebody. Texturally the light green serpentine varies considerably: from a hard coarse grained serpentine with carbonate to a light yellow green serpentine, distinctively granular in character. The latter type is characteristic of the western section of the mine where there is a greater amount of shearing and faulting than in the eastern section.

The dark green serpentine is hard, fine grained, and consists of chrysotile, antigorite, tremolite and commonly some talc and chlorite. Magnetite, carbonate and picrolite may also be present.

The contact between the dark green and light green serpentine is gradational over a few feet. In some areas there is no surrounding dark green serpentine and the light green serpentine is in direct contact with the rocks of the Fig Tree Series.

C. Jamestown Complex (Cont'd)

Serpentinization of the intrusion has been complete and the two varieties of serpentine are probably due to the separate intrusion of two magmas whose original composition differences on serpentinization gave rise to light green and dark green serpentine.

The olivine remnants found in the light green serpentine indicate the original rock as being dunitic in composition, while the darker green variety may have been derived from the pyroxenitic end of the ultrabasic suite.

In the eastern section of the mine the serpentinite splits into two bodies, enclosing the inlier of Fig Tree rocks. The orebody maintains its strike and is found in the southern limb of the bifurcation. The northern serpentinite body has an inner core of light green serpentine which is not economically fibre bearing.

Further eastward the serpentinite terminates in steatised schists which are considered as part of the Jamestown Complex. These rocks are generally highly schistose, contorted, and contain hydrothermal quartz veins. No gradational contact has yet been found between the serpentinite and the schists.

D. Hypabyssal Rocks

The prominent dykes in the east traverse the area striking E50S and dipping at 55° N40W. They contain euhedral to subhedral crystals of augite and interstitial plagioclase plus secondary quartz. The texture is hypidiomorphic.

Further westward two smaller diabase dykes occur, striking N39W and dipping at 66° to the east. These dykes traverse the orebody, post dating the fibre formation and have the same general strike as all the pre-Transvaal dykes present in the area. The thickness of these two dykes is generally less than twenty feet.

In the upper portion of the serpentinite a sill occurs known as the "Hangingwall Sill". It is irregular in nature, 20 feet to 40 feet wide and splits up into as many as three different bodies. It is generally coarse grained but some off-shoots are fine grained. Under the microscope it is made up of extremely fine-grained needles of colourless amphibole set in a matrix of fibrous amphibole and plagioclase. In places there is an increase in the plagioclase content near the margins of the dyke. The "Sill" resembles the rock found in the reaction zone between an acid intrusion and serpentine in the Mashaba area. Laubscher (1963).

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III. CHRYSOTILE OREBODY

The orebody has a strike length of approximately 4,000 feet and strikes N67E with an average dip of 57° towards the southeast. The shape of the orebody is irregular and generally lenticular as shown in the accompanying section.

Fibre seams are economically developed in the light green serpentine and rarely in the dark green serpentine. The length of the cross fibre varies from microscopic size to a maximum of $2\frac{1}{2}$ inches. The first impression of a section of the orebody is the apparent haphazard arrangement of the fibre seams as a stockwork. A closer examination will reveal the bulk of the fibre seams to favour three major strike directions: N to N22E, N22W, and E10N.

The dip of the fibre seams averages 50° and the dip direction is predominantly towards the east and south.

The fracture density and fibre quantity diminishes towards the dark green serpentine and very often the economic cut-off is sharp. The width of the cross fibre seams also decreases towards the dark green serpentine.

Irregularities in the shape of the orebody are due to one or more of the following processes:

(1) Faulting

In the eastern section a dextral wrench fault striking east/west displaces the orebody an estimated one hundred feet in the horizontal plane.

(2) Steatization

Steatization of the serpentinite post dates the fibre formation and is most evident in the extreme eastern section of the mine. The probable reaction is as follows:

$$2H_4Mg_3Si_2O_9 + 3CO_2 \longrightarrow H_2Mg_3Si_4O_{12} + 3MgCO_3 + 3H_2O$$

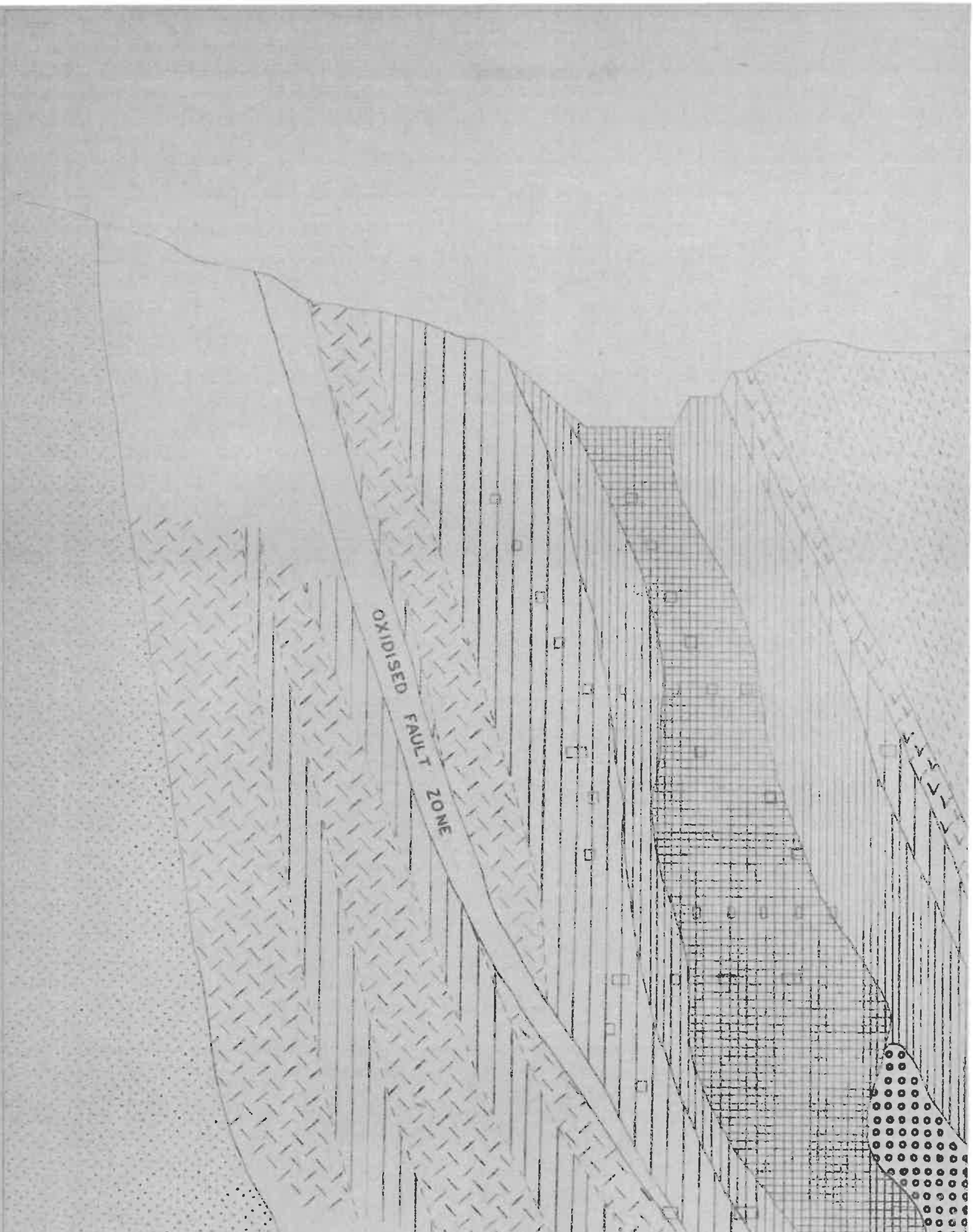
Serpentine — Talc — Magnesite

The result of the talcification is an increase in the amount of silica and a harshness imparted to the fibre seams. The serpentine becomes darker in colour and more siliceous in character. A further increase in talcification results in the serpentine becoming soft and grey in colour with the fibre seams being completely replaced and occurring as pseudomorphs in the surrounding talcose serpentine.

In the eastern section there is also an appreciable increase in the amount of magnesite seams. Van Biljon (1959) noticed the complete replacement of chrysotile fibre by magnesite.

(3) Silicification

Silification has affected the original shape of the fibre body giving rise to pronounced irregularities in the shape of the present day orebody.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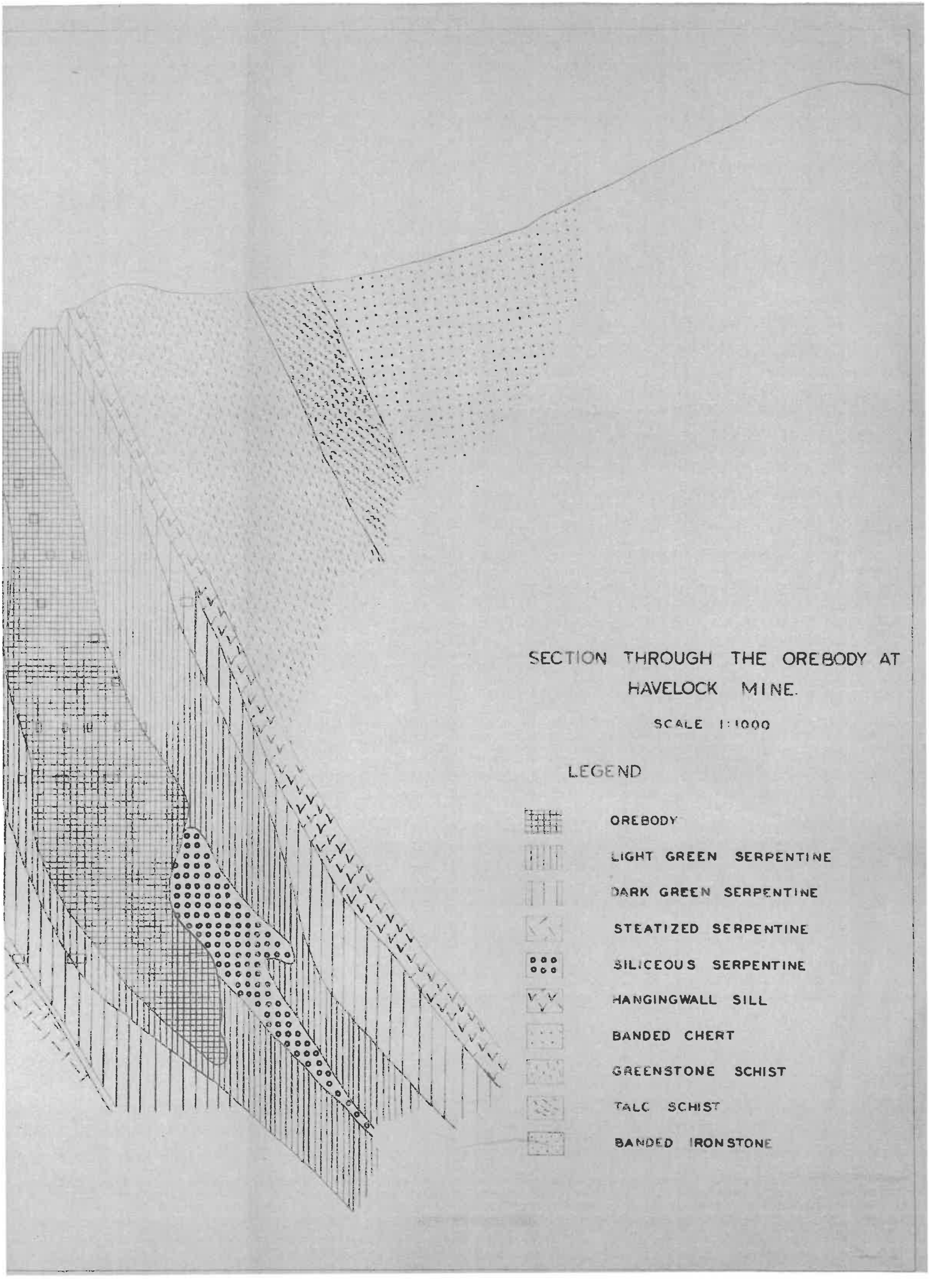
SECTION THROUGH THE OREBODY AT HAVELOCK MINE.
SCALE 1:1000
LEGEND
OREBODY
LIGHT GREEN SERPENTINE
DARK GREEN SERPENTINE
STEATIZED SERPENTINE
SILICEOUS SERPENTINE
HANGINGWALL SILL
BANDED CHERT
GREENSTONE SCHIST
TALC SCHIST
BANDED IRONSTONE

(3) Silicification (cont'd)

Silification effects are confined mainly to the hangingwall portion of the serpentinite and in some cases are closely associated with faulting. The serpentinite becomes hard and glassy and fibre seams may be completely replaced.

(4) Intrusion of Younger Dykes

The intrusion of younger diabase dykes has caused a deterioration of the fibre in the immediate vicinity of the dykes. Harsh fibre in "chocolate" serpentine next to a dyke was found to have been recrystallized to a fine aggregate and radiating bundles, van Biljon (1959).

IV. FIBRE FORMATION

Van Biljon (1959) considered three possible modes of fibre growth:

(1) Chrysotile fibres could have grown in open cavities.

(2) Replacement at the expense of the wall rock. This is untenable for the bulk of the fibre development because a characteristic of replacement veins is the irregularity of their walls.

(3) Fibre grew in fractures either by pushing the walls apart, or during the gradual separation of the walls under the influence of other forces. Van Biljon (1959) considered that the chrysotile fibres actually grew during the separation of the walls of the fracture and not as a recrystallization of picrolite.

Van Biljon suggested that chrysotile crystallized directly from serpentinous solutions under tension, while picrolite represents material which remained after the tension was released or crystallized at places where no tension existed.

Van Biljon noticed that most of the chrysotile deposits in dolomite and massive serpentinite are intimately associated with faulting.

The association of chrysotile deposits with faulting can be explained in two ways:

(1) Fractures caused by faulting could have provided channelways for watery solutions which brought about the formation of chrysotile.

(2) In a rock fractured under shearing stress, tension and compression points will develop. Van Biljon (1959) suggested that stresses will be relieved by:

(a) Compression - solution of serpentine

(b) Tension - crystallization of chrysotile asbestos.

Laubscher (1963) in the light of his interpretation of the major Rhodesian deposits considered that fibre may form in four different ways:

(1) Replacement fibre

Fibre grows outward from cracks or crystal boundaries and is an extremely common form of fibre growth resulting from the serpentinization of olivine. Fibre seams are always of a short length with the growth direction and length bearing a relationship to the spacing and arrangement of the initiating surfaces. Replacement fibre seams do not give rise to economic fibre development.

IV. FIBRE FORMATION (cont'd)

(2) Recrystallization of Serpentine - Slip Fibre

The recrystallization of serpentine to chrysotile fibre in fracture cleavage planes gives rise to what is known as slip fibre. The fibres are usually orientated in the direction of release. As an example, in the so called "partly formed seams", fracture cleavage planes are developed at a large angle to the side wall. Movement takes place along these planes and the serpentine recrystallizes to slip fibre, giving the overall impression of a cross fibre seam with the fibres separated by slivers of serpentine.

(3) Recrystallization of Picrolite

Picrolite is the name given to seams of green compact, banded and often coarsely fibrous serpentine. After x-ray diffraction analysis and electron microscope examination it was concluded by Laubscher (1963) that picrolite consists of antigorite with varying amounts of chrysotile. The proportion of chrysotile to antigorite bears a relationship to the degree of stress that the picrolite has experienced. Structural analysis indicates that the picrolite formed in an opening tension fracture. The picrolites are often cleaved and sheared, with fibre growth taking place in the plane of cleavage. The fibre orientation in the plane of cleavage varies from the P. intermediate to the P. minimum direction, with maximum length obtained when the fibres approach the P. minimum direction.

(4) Structurally Controlled Dilation Veins

It is considered that the bulk of fibre growth takes place in original fractures, the walls of which have moved apart with the material being derived from the sidewall. The following observations bear out this hypothesis -

(a) Seam walls can be matched and fragments caught up in the fibre growth can be fitted to the sidewall.

(b) The seam walls are composed of minute randomly orientated replacement fibres.

(c) The quantity of magnetite in the seam bears a relationship to the iron content of the sidewall.

(d) The fibres do not adhere to the sidewall unless cemented by later magnesite or magnetite. The lack of cohesion between the fibres and the seam wall establishes that the fibres have not formed as a replacement of the sidewall.

During serpentinization, excess magnesium and silica go into solution and crystallize as chrysotile fibre in the adjacent fractures. The iron is precipitated as magnetite which by preference will replace the serpentine before the fibre.

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(4) Structurally Controlled Dilation Veins (cont'd)

The actual mechanism of fibre growth is considered to be one of forcing the walls of the fracture apart by the force of crystallization provided that the growing force of the fibre is greater than the structurally lessened load on the walls.

For evidence of this method of fibre growth Laubscher (1963) gives the following reasons:

(a) It is doubtful whether the growing force of the crystallization of fibre could overcome a load of thousands of feet of overlying rock.

(b) Picrolite forms if the fractures are opening under tension.

(c) Fibre seams with picrolite and/or magnesite partings are common - an indication of the chrysotile forming process being disrupted and the opening filled with foreign material.

(d) In curved fibre seams the fibres are not parallel but bear an angular relationship to the sidewall. In curved fibre seams maximum seam width is attained in those positions at a large angle to the release direction, whereas, in the curved portion, the fibres grow along the bisectrix of an angle made up of a right angle to the seam wall and the line of least resistance.

(e) The fibre fractures pre-date all the major and minor features which have a bearing on fibre formation. Structural analysis of these features show the fibre growth to have taken place in the P. minimum/P. intermediate plane and nowhere does the fibre growth direction correspond exactly with the tension direction.

(f) Small kinks are fairly common in the fibre seams, the kinks representing variations in fibre growth direction caused by changes in the stress field. The changes in the stress field are shown by changes in the striation direction in slips. This is a further example of growth in an original fracture.

Laubscher concludes that, "though the crystallizing force exerted by the fibres is necessary, no growth will take place unless the load on the fracture has been lessened. Therefore, structural control plays a very important part in the formation of ore deposits. Fibre growth will continue provided material is made available and a state of tension exists in the block of ground."

V. STRUCTURE

A. Folding

The general folding of the sediments in the area is northeast, southwest and is considered to have formed as a result of the first recognised phase of deformation in the Barberton Mountain Land. The direction of dip of the folded sediments and serpentinite is always towards the southeast. A later period of deformation in the area caused the development of folding almost at right angles to the first folds. This later folding is apparent in the footwall chert with the hinge region in the vicinity of the Main Shaft. The trace of the fold axis can be followed southward trending E70S, the fold becoming a steeply dipping anticlinal structure.

Minor fold structures are present in all formations except the serpentinite and are best developed in the schists in contact with the serpentinite and in the talc schist horizons of the Jamestown Complex.

The inlier of sedimentary rocks in the eastern section of the mine is tightly folded in contact with the main ore bearing serpentinite. Light green serpentinite in contact with the schist is unaffected by the folding in the schist and fibre seams were noticed within a few feet of the contact. The schist showed no signs of any metamorphism which could be attributed to the serpentinite.

An analysis of the schistosity and fold axes revealed the schist to be folded into an anticlinal structure, the fold axis of which varies between E74S and S2W, and plunges southward at 58^{o}. The northern limb of the anticline appears to have been pinched out against the serpentinite. The structure is further complicated by the intrusive nature of the massive black quartz or chert horizon.

Surface exposures leave no doubt that the serpentinite displays an intrusive relationship with the inlier of sedimentary rocks.

B. Faulting

The area has been extensively faulted, the major faults being longitudinal or strike faults. Many smaller oblique faults cross the Fig Tree rocks and serpentinite at moderate angles. A major strike fault occurs in the footwall of the orebody, which often obscures the true relationship with the footwall sedimentary rocks. The fault dips steeply to the south with the banded cherts pulled down against it, indicating that it is a normal fault.

This fault is considered to have formed during the formation of the major folds in the area and later reactivated after the serpentinite intrusion. The fault zone may be up to thirty feet wide and the fault gouge consists of one or more of the following: highly sheared serpentine, platy talcose serpentine, magnesite or oxidised material.

Steeply dipping oblique faults which cross the serpentinite at low angles conform to two main directions: in the western section the oblique faulting trends N55E, while in the eastern section the oblique faults strike east, west. Movement along these faults appears to be contemporaneous with the fibre formation.

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B. Faulting (cont'd)

An oblique fault in the western section of the mine is surrounded by a zone of grey talcose serpentine and is thus probably associated with the process of steatization. The fault may have acted as a channelway for aqueous hydrothermal solutions.

The oblique faults can be traced to the hinge zone of the E70S striking fold described above. Nowhere else along the strike of the footwall banded chert (within the mine limits) is there any significant development of faulting.

It is of interest to note that the mineralization of the ultrabasic is broadly confined to the area in the vicinity of the oblique faults.

VI. SUMMARY AND CONCLUSIONS

(1) The crosscutting relationships of the ultrabasic with the inlier of Fig Tree sediments indicates that the ultrabasic is intrusive into the upper portion of the Fig Tree Series. The ultrabasic is then post Fig Tree and probably post Moodies in age and therefore by definition a member of the Jamestown Complex.

(2) The strike fault is considered to represent a major zone of weakness, along which the ultrabasic rocks were initially intruded. Intrusion of the ultrabasic must then post date the first recognised deformational phase of the Barberton Mountain Land and the initial downwarp of the Fig Tree sediments.

(3) Intrusion of the ultrabasic followed the argillaceous horizons associated with the more resistant banded chert horizons. From the attitude of the displaced banded chert horizons in the eastern section of the mine the intrusion was one of thrusting aside of the overlying rocks.

The apparent pinching out of the talc schist against the serpentinite and the occurrence of remnants of schist in the serpentinite supports Uries' view that a process of assimilation was operative during the intrusion of the magma. The contacts between the serpentinite and schist are too sharp to consider any metasomatic reaction having taken place during the intrusion.

(4) Low grade metamorphism in the area included serpentinization followed by steatization. The absence of high grade contact metamorphism indicates a low temperature intrusion of the magma.

There is no known granite occurrence in the near vicinity from where the hydrothermal solutions, which caused the serpentinization and steatization, could have originated. It is believed by Laubscher (1963) that in the case of the major Rhodesian deposits these solutions were derived from connate water driven off from the surrounding sediments during downfolding.

(5) Some of the talc schists are clearly intruded by the serpentinite and are therefore either members of an earlier intrusive magma into the Fig Tree series or are steatized equivalents of certain argillaceous horizons in the Fig Tree Series.

(6) It has been shown by van Biljon (1959) and Laubscher (1963) that structural control in fibre formation is of paramount importance but any conclusions at Havelock must necessarily be tentative at this stage.

Generally, the light green serpentine is well fractured, and it is those fracture directions which make a large angle to the strike fault and oblique faults that contain the bulk of the fibre development.

The influence of the faulting on fibre formation is demonstrated by the confinement of the economic fibre development in the ultrabasic to the vicinity of the oblique faults.

VII. ACKNOWLEDGEMENTS.

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Asbes.

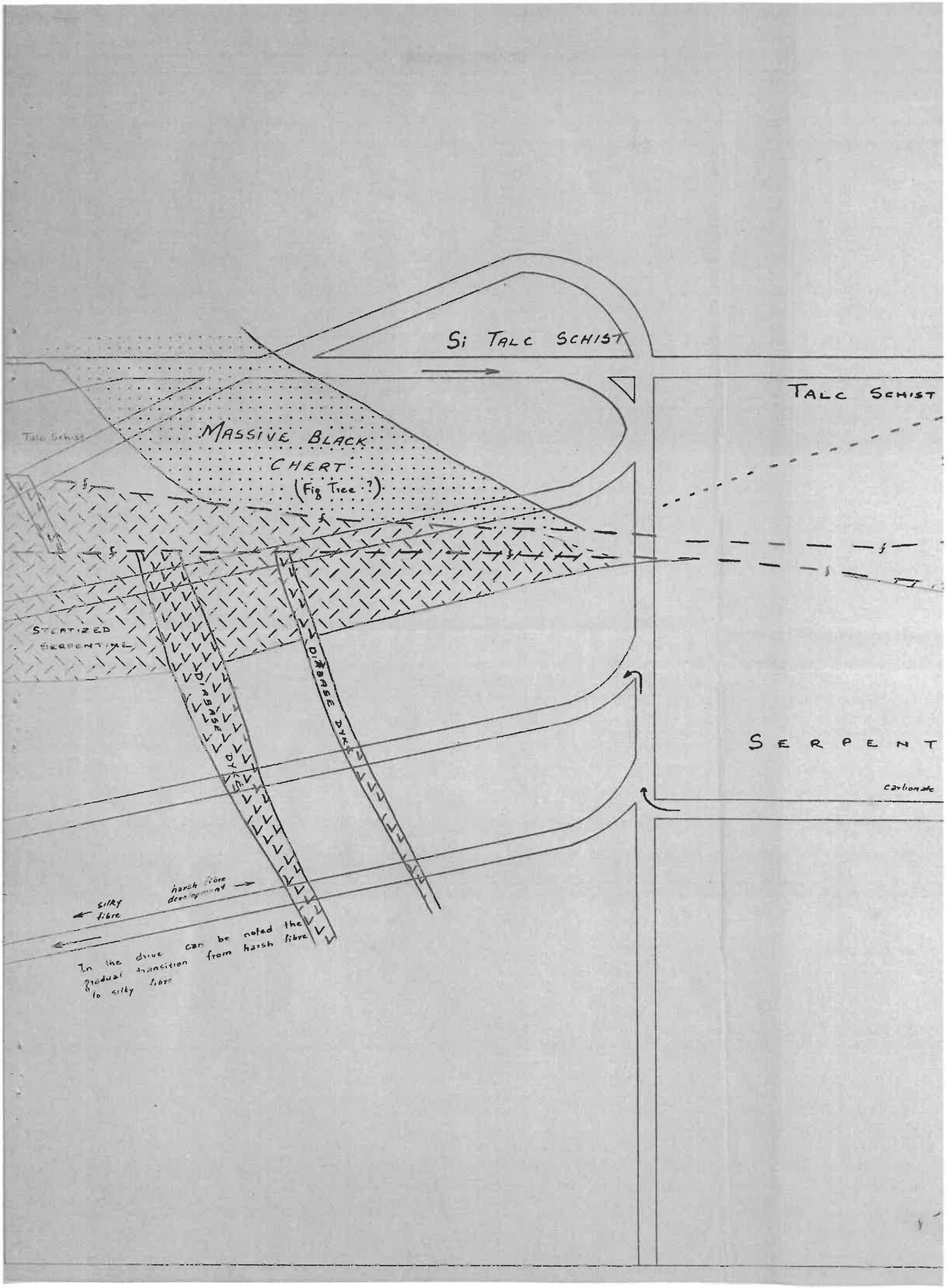
→ GEOLOGY OF

HAVELOCK MINE

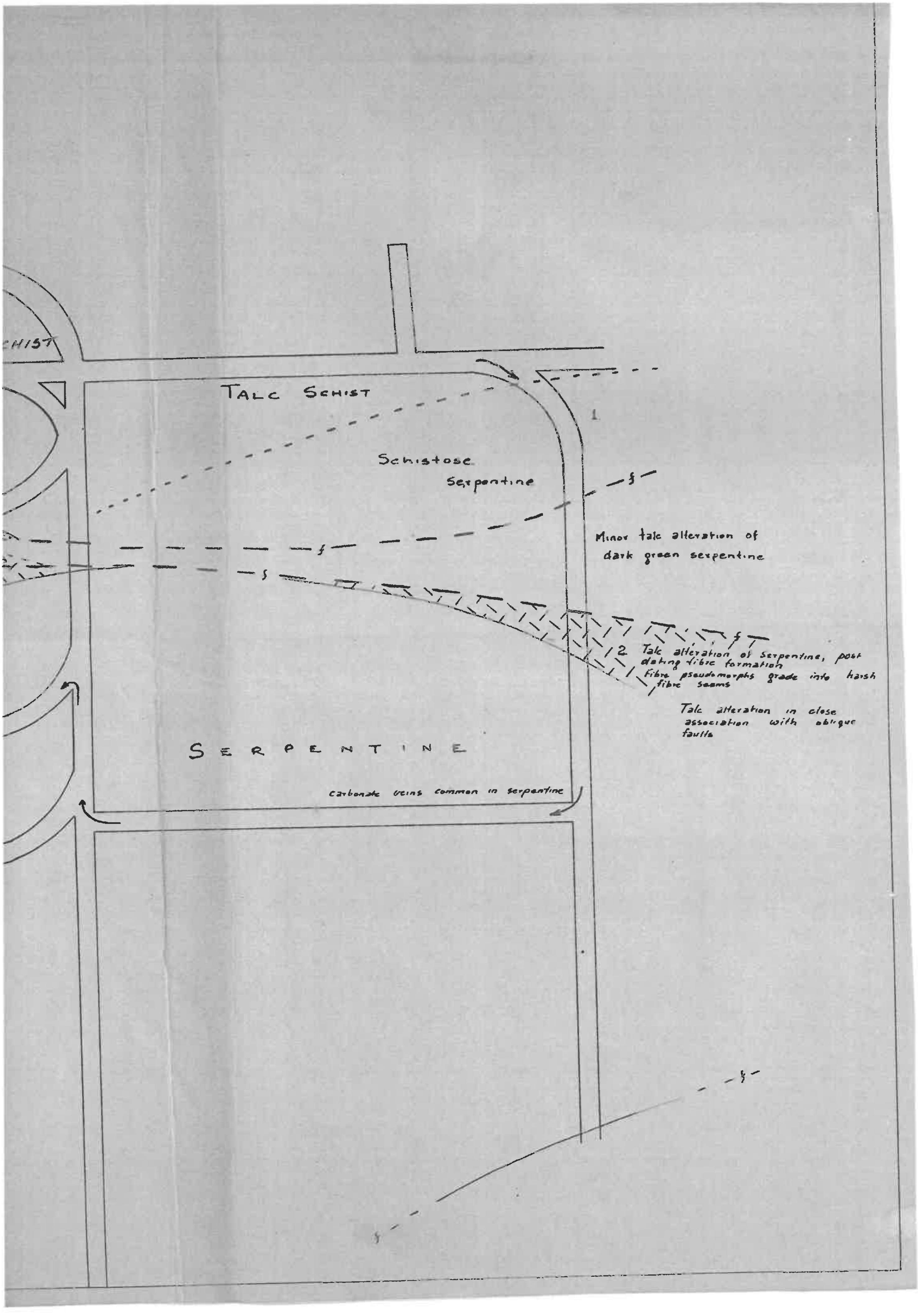
(SWAZILAND)

by

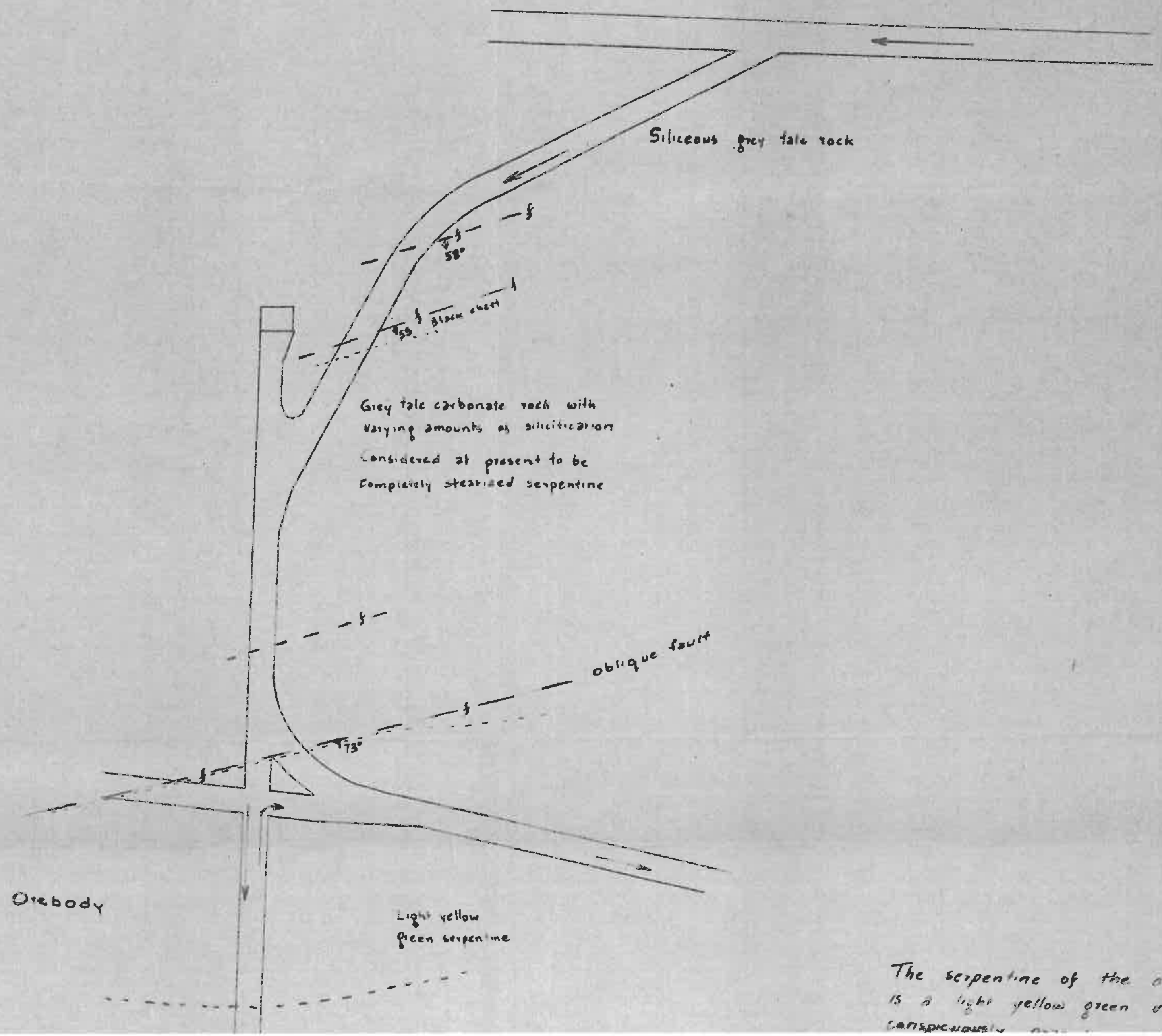
M.J. Mackenzie



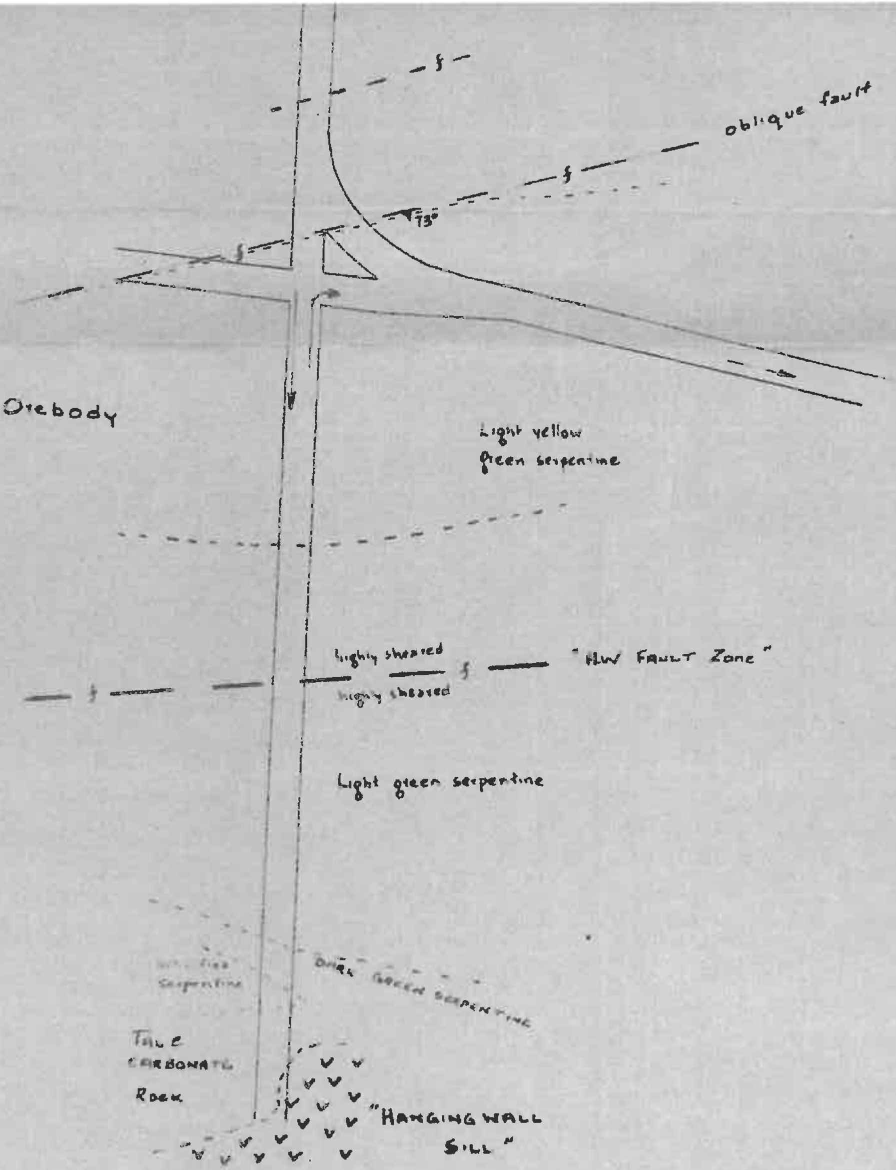
Si Talc Schist
Talc Schist
Massive Black Chert (Fig Tree ?)
Stertized Serpentine
Diabase Dyke
Diabase Dyke
Serpent
carbonate
harsh fibre development
silky fibre
In the drive can be noted the gradual transition from harsh fibre to silky fibre



CHIST
TALC SCHIST
Schistose Serpentine
1
Minor talc alteration of dark green serpentine
2 Talc alteration of serpentine, post dating fibre formation
Fibre pseudomorphs grade into harsh fibre seams
Talc alteration in close association with oblique faults
SERPENTINE
Carbonate veins common in serpentine



The serpentine of the orebody
is a light yellow green variety,
conspicuously



The serpentine of the orebody is a light yellow green variety, conspicuously granular in texture. The fibre seams of the orebody appear almost as a stockwork. As will be seen further eastward, the orebody in the eastern section is of a quite different character. The fibre seams are more systematic in attitude and the ground is less sheared and a darker green in colour.