

**GOVERNMENT OF PAKISTAN
GEOLOGICAL SURVEY OF PAKISTAN**

INFORMATION RELEASE NO 114



**LEAD INVESTIGATIONS IN THE LICHI AREA
GILGIT DISTRICT**

By
Sajid Hussain Shah

*Issued by the Director General Geological Survey of Pakistan, Quetta
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CONTENTS

ABSTRACT	1
INTRODUCTION	2
Purpose and scope	2
Location and accessibility	2
Physiography	...	...	...	3
Acknowledgement	...	...	...	3
Method of investigation	...	...	...	4
GEOLOGY	...	...	...	5
Regional Geology	...	...	...	5
Description of Rock Types	...	...	...	5
Garnetiferous amphibolite	...	...	...	5
Metasedimentary rocks	...	...	...	7
Argillaceous quartzite & quartz- sericite-muscovite schist	...	...	...	7
Limonitic calcareous-silicate/ hornfels	...	...	...	9
Limonitic siliceous limestone/ calc. quartzite	...	...	...	10
Diorite and micro granite	...	...	...	10
ECONOMIC GEOLOGY	...	...	...	13
Nala Mine	...	...	...	13
<u>Mineralogy and association</u>	...	...	...	14
Divide Mine	...	...	...	15
<u>Mineralogy and association</u>	...	...	...	16
Shukisoh Mine	...	...	...	17
Origin	...	...	...	18
CONCLUSION & RECOMMENDATIONS	...	...	...	19
REFERENCES	...	...	...	20

ILLUSTRATIONS

Figures:

1. Location map of Thelichi Gab (Gilgit District).
2. Geological map of the mine area of Thelichi.
3. Planimetric map of Nala Mine.
4. Planimetric map of Divide Mine.
5. Planimetric map of Shukisoh Mine.
6. Cross-section along line A-B (in Figure 2)
7. Growth of quartz crystals in the form of comb structure with vugs in the centre.

ABSTRACT

Two principal mineralized zones exist along the Thalichi Gah, where small scale mining has been done, as small adits. The mine located in the Thalichi Gah named "Nala mine" consists of small and thin veins of lead-zinc ore; while the other mine located at the top of a hill between Thalichi Gah and its northern tributary named "Divide mine", consist of small and thin veins of lead-copper ore. In general, the veins in both mines, measure less than 5 cms. in thickness and not more than 9.5 meters exposed length; with steep dip. In Shukisoh area lead-copper has been mined from the phyllitic gneiss zone, where mineralization occurs as very small veinlets and disseminated grains.

In the Nala and Divide mines the host rock is in the form of highly fractured and pulverized thin bands of argillaceous quartzite and siliceous limestone localized by the diorite mass.

The mining is uneconomical, because of small extent of the mineralized zones and steep dip of the metallic veins. The mining work was abandoned by the Mineral Cell, Gilgit because it proved uneconomical due to lack in the increase of thickness of the veins with depth.

INTRODUCTION

Purpose and Scope

The purpose of the present work was to investigate the extent, mineralogy and economics of the lead mineralization, reported in the Thelichi area.

The field work was carried out during November, 1974 at 1:250,000 scale, on the toposheet No.43-I, which was then enlarged to 1:50,000 in order to transfer the field data properly. Further work was carried out in Shukisoh Mine area in May, 1978. A total area of about 8 sq. kms. around the galena occurrences, was mapped in order to investigate the lead mineralization.

Location and accessibility

The mineralization occurs in Thelichi area which is located on right bank of the Indus River, at a distance of about 65 kms. downstream from Gilgit (Figure-1). Thelichi Rest House is approachable by the Karakoram Highway.

The Nala mine is located in the Thelichi Gah, at a distance of about five kms, while the Divide mine is located at the top of the ridge at a distance of about four kms, from Thelichi Rest House. The divide mine is much difficult to approach, because of high elevation and steep slope. The skukisoh area mine is located at an altitude of about 2100 meters along the mountain slope, at a distance of about six kms. from the Thelichi Rest House towards Gilgit.

Physiography

The region lies in the Great Himalayan Range. The topography is virgin and rugged, with the mountains representing steep gradient. The valleys and their tributaries are young with occasional cascades. The mines are located at an elevation of 1950-2400 meters above the sea level. The Thelichi Gah elevation ranges between 1350 to 3900 meters from its confluence with Indus valley upto the watershed area.

Acknowledgements

The valuable guidance provided by Mr. Asrarullah, the then Deputy Director General, GSP, both in the field as well as in preparation of the maps is gratefully acknowledged. The author deeply acknowledges the equal participation of Mr. Moharmad Shafique and Mr. Mohammad Mehdi Zaidi during the initial stage of field work conducted in 1974. The later also studied some thin sections of the rocks.

The local people and civil authorities Gilgit are thanked for extending cooperation during execution of duties.

Method of Investigation :

The present study aimed to investigate the nature of lead mineralization in the Thalichi area, Gilgit Agency, which had been reported some time before. Almost all the known occurrences were examined systematically, which were reported by the local people.

The geological mapping of the surrounding area and the detailed study of mineralization within mine was accomplished with the aid of Brunton compass and tape. Few selected samples were examined under microscope.

Within the Nala mine the detailed measurements were made at six different points marked as ABC DEF (Figure-3) at an interval of 1.80 meters each; while within the Divide mine the measurements were made at six different points, at different suitable intervals (Figure 4). Within the Shukisoh mine measurements were made at five different points at an interval of about 1.5 meters each (Figure-5).

Following measurements were taken at each point:-

1. Height of the tunnel from centre of roof.
2. Height of each wall.
3. Width of the tunnel.
4. Attitude of veins and host rock.
5. Metallic content of lead bearing veins—thickness, percentage content, association and behaviour with depth.
6. Detailed measurements of various lithologic alterations within the host rock in roof of tunnel.

GEOLOGY

Regional Geology

The area mapped along the Thelichi Gah, consists of metamorphic and metasedimentary rocks of possible Pre-Cambrian age, which have been intruded by metamorphosed diorite of probable early Tertiary age (Geological Map of Pakistan, 1964). D.N. Wadia showed this area to be Salkhala series of Pre-Cambrian age intruded by epidiorite and basic rocks (Rec. Vol. L XVI, pl. 7). The metamorphic rock comprises garnetiferous amphibolite while the metasedimentary rocks comprise of the following units:-

Argillaceous quartzite, quartz-sericite-muscovite schist, limonitic calcareous silicate hornfels and limonitic siliceous limestone/calcareous quartzite.

The following sequence of the rock types is established in the area:

1. Garnetiferous amphibolite.
2. Metasedimentary rocks.
3. Diorite and micro-granite.

Description of Rock Types

Garnetiferous amphibolite:-

It is confined mostly along the northern side of the Thelichi Gah and mostly covered by alluvium and hill scree. The amphibolite is fine to medium grained, dark grey to black and weathers to reddish brown colour. It is tough, thickly bedded, well-banded and well-foliated. The foliation is due to the

combination of preferred orientation of elongated hornblende grains and the lithologic layering. The regional attitude of the rock type is generally N. 90° E/72°N.

The field examination reveals the presence of hornblende and quartz with subordinate plagioclase, biotite and porphyroblasts of garnet.

The amphibolite is well-banded and the banding is due to alternate light and dark bands of quartz, feldspar and hornblende, biotite respectively. The bands are distinguished as fine and medium grained bands. Some of the bands exhibit asymmetrical folding of microscopic scale.

Thin section study of the banded amphibolite has shown the following mineralogy based on the average mineral composition of light and dark bands:

Hornblende	42%
Quartz	40%
23% plagioclase	12%
Biotite	5%
Garnet	1%

All minerals are fresh and unstrained.

Small xenoliths of sugary carbonate rock have been noticed in the amphibolite. The amphibolite is bordered on its northern side by pink coloured metasedimentary rocks.

Because of the presence of biotite, xenoliths of carbonate rock and fine banding, the rock is expected to be para-amphibolite.

Metasedimentary rocks:

The metasedimentary rocks are distributed on the northern side of the amphibolite body. However, a small screen of these rocks is present within the gneissic diorite mass in Thalichi Gah. They are well-foliated, thickly bedded and run along NW-SE direction.

The metasedimentary rocks are usually pink coloured, weather to reddish-brown, fine to medium grained and well-banded. Quartz veins are commonly present.

They occasionally enclose thin bands of the neighbouring rocks viz; amphibolite and thin sills of diorite. The bands are parallel to each other and represent original sedimentary bedding. Ptygmatic folding and boundinage structures are present.

These metasedimentary rocks are generally the host for lead-zinc and lead-copper mineralization. According to the thin section studies these metasedimentary rocks are differentiated as the following rock units:

Argillaceous quartzite; quartz-sericite-muscovite schist; limonitic calcareous silicate hornfels, limonitic siliceous limestone/calcareous quartzite, and calcareous phyllite.

Argillaceous quartzite and quartz-sericite-muscovite schist: These rock units are intermixed with each other and serve as the host rocks for the lead-zinc mineralization, in the Nala mine. The rocks are highly brecciated and gouged because of the intrusion of diorite.

The argillaceous quartzite show alternate fine and medium grained bands. The fine grained bands which are thicker than the

medium grained bands, consist of equigranular quartz grains, which are evenly distributed throughout the rock, and associated with kaolinite-partly changing to muscovite. Their mineralogy show:

Muscovite-kaolinite	- 32%
Quartz	- 65%
Opagues	- 3%

The medium grained bands consist of kaolinite-alternating with small well defined, discontinuous bands of quartz, which show micro-folding; so it may be called as a schistose rock, which develops banding in its medium grained part. Their mineralogy show:

Kaolinite	65%
Quartz	30%
Opagues	5%

The quartz-sericite-muscovite schist is well-foliated and banded. Alternate bands, lenses and streaks of sericite/kaolinite, quartz and muscovite are present. Sericite bands are highly folded and broken in eye shapes, with folded muscovite trains going around them. Muscovite developed at the expense of white mica (sericite), because streaks of sericite are bordered by fresh muscovite.

The mineralogy shows:-

Quartz	45%
Sericite	30%
Muscovite	20%
Opagues	5%

Although banding developed in initial stage but not fully developed, so cannot be called a gneiss.

Limonitic calcareous silicate hornfels: This rock unit is present as a host rock in the Divide mine and as a small screen within diorite, in the Thelichi Gah.

The part of rock unit which is exposed as a host rock in Divide mine reflect the following properties under microscope—fine grained equigranular, anhedral except garnet which is subhedral to euhedral, and contact metamorphic texture. Garnet (grossularite), diopside, quartz and calcite are evenly distributed throughout the rock. Diopside and grossularite tend to be coarser in grain size. Calcite and diopside are surrounded by grossularite, showing later development of grossularite. The rock is slightly limonitic:

The mineralogy shows:

Diopside	10%
Grossularite	35%
Calcite	40%
Quartz	20%

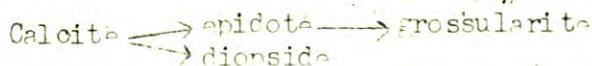
The contact metamorphism of shale with high amount of marl result the formation of grossularite, diopside and wollastonite etc. and absence of cordierite andalusite etc. (Tyrell, p.295). This suggests the origin of the calcareous silicate hornfels as "shale with high amount of marl".

The part of rock unit exposed as a small screen in diorite in the Thelichi Gah reflect the following properties under microscope. There are five, fine grained, alternate bands varying in proportion of different mineral constituents.

Their average mineralogy reveals:

Quartz	5-70%
Calcite	5-60%
Diopside	10-15%
and	
Grossularite	45%

Grossularite and diopside are formed at the expense of calcite:



The banding in the banded metasedimentary rocks is perhaps the result of metamorphism done through the heat and the structural upheavals at the time of intrusion of diorite.

Limonitic siliceous limestone/calcareous quartzite:

This rock unit is the most widespread rock in the Divide mine and predominantly it serves as the host rock for the lead-copper mineralization.

It is fine to medium grained, light pink coloured rock, well-coated with limonite. It gives bright sheen, because of pulverization.

Being intruded by diorite, the rock is highly deformed resulting sheared, gouged and brecciated properties. At the contact, the angular fragments of diorite are also present. Longitudinal faults and cracks were also produced. Such zones of weakness resulted mineralization.

Diorite and Micro-granite

The diorite occurs as intrusive body along the amphibolite and metasedimentary rocks.

It is grey, coarse grained, equigranular and generally well-foliated thus exhibiting gneissic fabric. The foliation generally strikes NW-SE and dips 73° - 83° N; but in the Divide mine the foliation exhibits - N 70° W/ 84° S.

The foliation is defined by rough, discontinuous lens like bands alternatively rich in hornblende and plagioclase; in which c-axis of hornblende being parallel to the foliation.

The main mineral constituents are 20° - 28° feldspar (50%), hornblende (45%) with subordinate amount of biotite-epidote, chlorite and mineral quartz. Hornblende and plagioclase is anhedral to subhedral and highly strained and granulated; thus suggesting that the rock has been subjected to quite strong dynamic metamorphism, perhaps due to intrusive stress during structural upheaval.

The diorite at the contact with the screen of the meta-sedimentary rock in Thelichi Gah is a very well-foliated garnet bearing biotite-feldspar-quartz gneiss. This is actually diorite which reacted with the metasedimentary rocks to form a contact metamorphic garnet-biotite-feldspar-quartz bearing diorite gneiss. Hence the diorite is of magmatic origin. Also the texture of diorite is equigranular everywhere and the grain size remains constant.

Another feature in support of its magmatic origin is the crosscutting relationship between the foliation of the diorite and the banding of metasedimentary rock which contains small, irregular, discontinuous, banded amphibolite xenoliths. The diorite is perhaps the syntectonic intrusion in the Thelichi Gah area.

The diorite has enclosed thick beds of metasedimentary rocks which serve as the host rock for lead mineralization in the area.

In the Thelichi Gah, two kilometers upstream of Thelichi village, the foliated diorite has been intersected, along joint plane, by a thin vein showing trending $N 23^{\circ}W/37^{\circ}NE$ but has no economic significance. The foliation of host diorite is $N 70^{\circ}W/86^{\circ}N$. The vein measures 2.5 meters exposed length and 25 cms. maximum

thickness with the following general composition:

Sphalerite	50%
Quartz	30%
Muscovite/Chlorite	20%
Lead	0.2%

A small elongated patch of light grey, medium to fine grained, unfoliated microgranite dyke is exposed under the foliated diorite, along the eastern wall of the Divide mine. Also a thin dyke of microgranite cuts across the metasedimentary rocks, as seen in the roof of the Divide mine.

ECONOMIC GEOLOGY

Nala Mine

The mine is located in the upper reaches of Thelichi Gah, at a distance of about five kms. from Thelichi Rest House. The trend of mineralization is generally NW-SE and the adit mouth lies towards south. Measurements were made from six different points named A, B, C, D, E, F, at the interval of 1.80 meters each (Figure 3). The observations made are as under:

Exposed length of vein (along the strike)	9.50 m
General width of adit	one m.
General height of adit	1.65 m.
The mined dip depth of vein	1.65 m.
General trend of vein	N 50°W/53°NE (Fig. 2)
Trend of host rock	N 39°W/65°E

The lead-zinc veins disappear towards the floor of the mine.

There are two major sets of mineralization, which remain discontinuous for many feet. The one which runs approx. N-S is smaller, richer in sphalerite content and contain numerous small and thin offshoots running N 30°E. The second set which runs N 25°W is longer, almost devoid of sphalerite except at points E & F, and without offshoots. A stockwork measuring 48 cms in thickness and about 1.80 m in length is encountered at point E within the mine i.e., at a distance of about 6.60 m. from the adit mouth. This stockwork contain very thin veinlets of lead and zinc criss-crossing each other. In general the work consists of Pb (10%) + Zn(90%).

The mineralization occupies the bedding surface of the host rock. The host rock is banded argillaceous quartzite, which

gives a gneissic appearance. Recrystallized quartz and small stringers of late carbonate are associated with the lead veins. The lead veins run near the contact zone of the host rock and very occasionally intruded diorite. Total output of galena is very small.

Mineralogy and association:

Lead veins contain galena (lead-grey) sphalerite (yellow coloured with reddish brown tinge) and are associated with calcite, quartz, chlorite, chalcopryite and epidote. The central part of the vein consists mainly of galena and minor golden chalcopryite.

Quartz crystallized in comb form in the outer margins of the cracks. The absence of brownish black coloured Wurtzite (Hexagonal, fibrous form of Sphalerite) in the mineralized zone, show that probably the mineralization took place below 1020°C (Danas' Mineralogy, p.422).

Divide Mine

The mine is located at top of a ridge in Thelichi Gah at a distance of about four kms. from Thelichi Rest House. The trend of mineralization is generally N-S and the adit mouth lies towards south. The measurements were made from six different suitable points, named A, B, C, D, E, F., at irregular intervals (Figure 4).

The observations made are as under:

Length of adit	10.50 meters
Exposed length of vein (along the strike)	9.50 "
Height of adit mouth	7.80 meters
General height of adit	Reduces from 7.80 meters at point A to 1.30 meters at point F.
General width of adit	1.20 meters.
General trend of vein	NS/72 (Figure 2).
The mined dip depth of lead vein at point "A"	4.50 meter

In this mine, the mineralization consist of lead and copper, intermixed in different proportions. Two principal lead-copper veins run continuously and measure 1.25 cms thickness each at tunnel mouth. They gradually coalesce and attain a thickness upto 5 cms at a distance of 6.60 meters from the adit mouth, where the proportion of the metals being Pb (80%)+Cu (20%); while at a distance of 8.40 meter the thickness reduces again to 0.75 cms and then pinches out (Figure 4). There lie three small offshoots of pure lead, measuring in thickness from 1.25 cms to 3 cms. In the principal lead-copper vein, copper lies in the centre, while lead lies on the margins.

The veins are tabular and folded. The mineralized lead bearing zone consist of a greyish-white gouge and rusty yellow/brown limonite. The veins have generally sharp contact with the host rock.

The host rock is fine grained, limonitic siliceous limestone and calcareous silicate hornfels; which is fractured, brecciated and pulverized due to the intrusion of diorite mass. These secondary forces produced cracks, fissures and faults along which the mineralized solutions emerged, thus resulting mineralization. Diorite, the country rock, is also sheared because of its intrusive force.

Mineralogy and association

In general the mineralogy of the lead-copper veins reveal galena (80%) and copper in form of azurite and malachite (5-30%). Greenish yellow/yellowish-green stains of nickel are also present. Quartz and carbonate veins accompany mineralization. Quartz along the outer margins of metallic vein usually forms comb structure.

The vein is commonly zoned and some open vugs remain in the centre (Figure 7).

Shukisoh Mine

This mine is situated in Shukisoh area, in a small ravine on northern side of Sagachal Nala and at a distance of about one km. west of Karakoram Highway. The mine is at an altitude of about 2100 meters. The general trend of mineralization is almost N-S, and the adit mouth lies towards North. One vertical shaft on its southern end was sunk but now has collapsed.

Measurements were made at five points at an interval of about 1.5 meters (Figure 5).

The observations made are as under:-

Length of adit and vein	--	6 meters
General height of adit	--	1 meter to 2 meters (one meter in the central area and about 2 meters on both ends).
Height of adit mouth	--	2 meters approx.
Trend of vein	--	N 10°W/65°E
Trend of the country rock	--	(Phyllite)- N10°W/70°E.
Width of adit	--	1.20 meters

The mineralization consists of lead and copper, associated with quartz vein and recrystallized small vugs and druses of quartz. The content of copper (as malachite and azurite) is about 25-30 percent, and is almost constant throughout the gouge zone. The thickness of vein reduces from North towards south.

The host rock for mineralization is reddish-brown

limonitized gouge. The country rock on western side is diorite, while on eastern side is calcareous phyllite, which is the continuation of the metasedimentary rocks exposed in the Thalichi Gah.

Mineralization took place in the pulverized zone of phyllite at its contact with diorite.

Mineralization is not in the form of solid veins, but as small veinlets, druses and disseminate grain only.

Origin

The lead-zinc and lead-copper mineralization is the result of high temperature hydrothermal activity. The metallic veins occur as irregular and occasionally regular veins, veinlets, pockets, vugs and stringers within the cavities, cracks and fractures of the metasedimentary host rocks.

The intrusion of huge diorite mass, caused great stress and strain within the pre-existing metasedimentary rocks. These diastrophic forces resulted cracks, fractures, faults and other zones of weakness along which the hydrothermal solutions emerged and the mineralization commenced.

The mineralized cracks are almost parallel to each other or otherwise deflect at a low angle and dip at a high angle towards east. The contact of veins with the host rock is sharp, without any wall-rock alteration or metasomatic replacement.

CONCLUSION AND RECOMMENDATIONS

The metallic veins are irregular and small ranging in thickness from 0.5 cms to 5 cms with a maximum length of 9 meters. In each mine, they dip at high angle, and are confined in the thin band of host rock and enclosed on both sides by hard, tough country rock-diorite. The diorite does not or otherwise very occasionally show any fracture along which mineralization could take place. The thickness of veins does not vary with depth.

The area is mountaneous with steep slope and it is quite tough for approaching to the mines.

In view of small thickness of veinlets and the host rock, steep gradient, massiveness of the dioritic country rock, the metallic veins are not recommended for commercial exploitation. Even if there is a small increase in thickness with the depth, the mining will not become economical because of extremely difficult terrain and small reserves.

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(Rec. Vol.IXVI, Pl. 7)

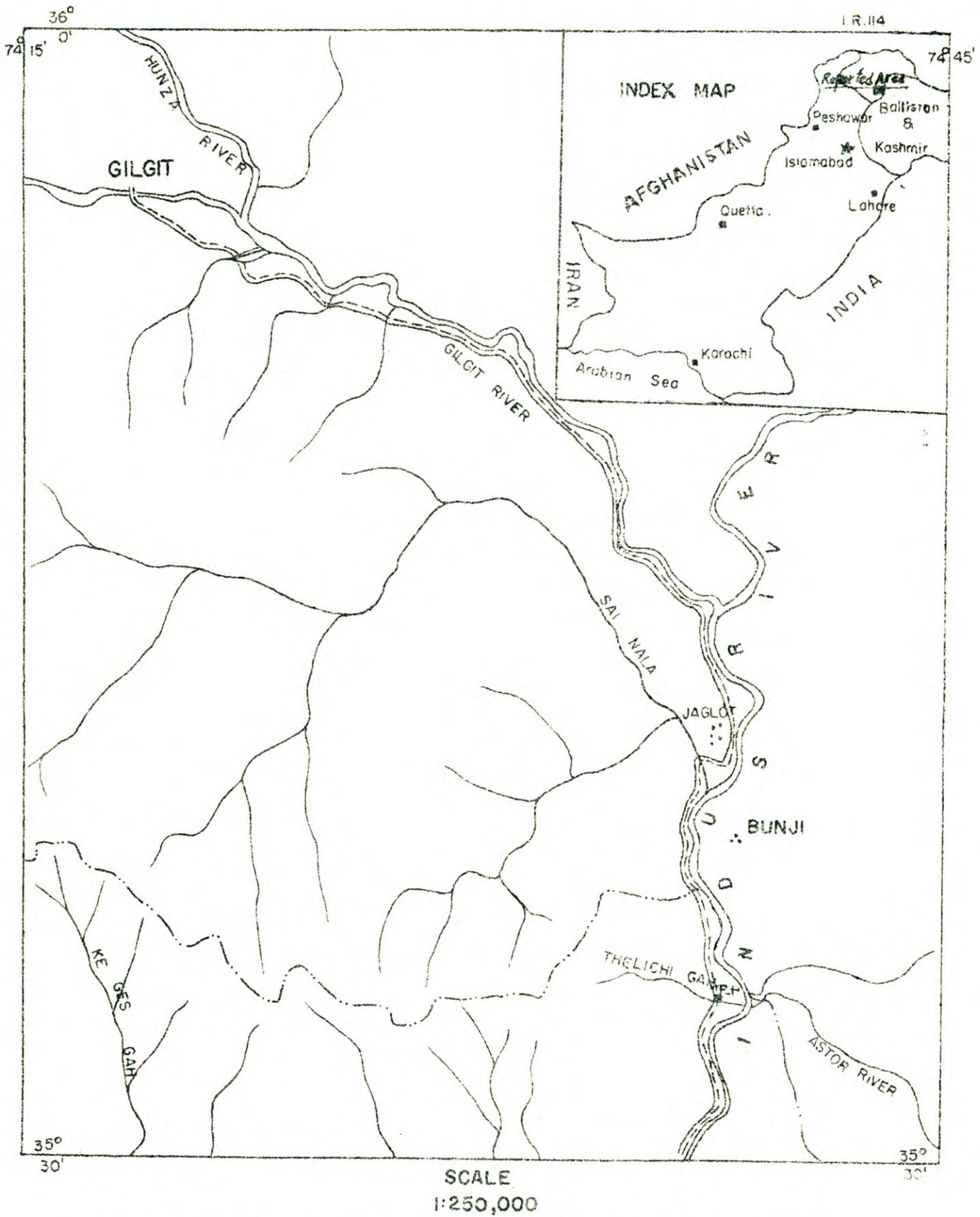
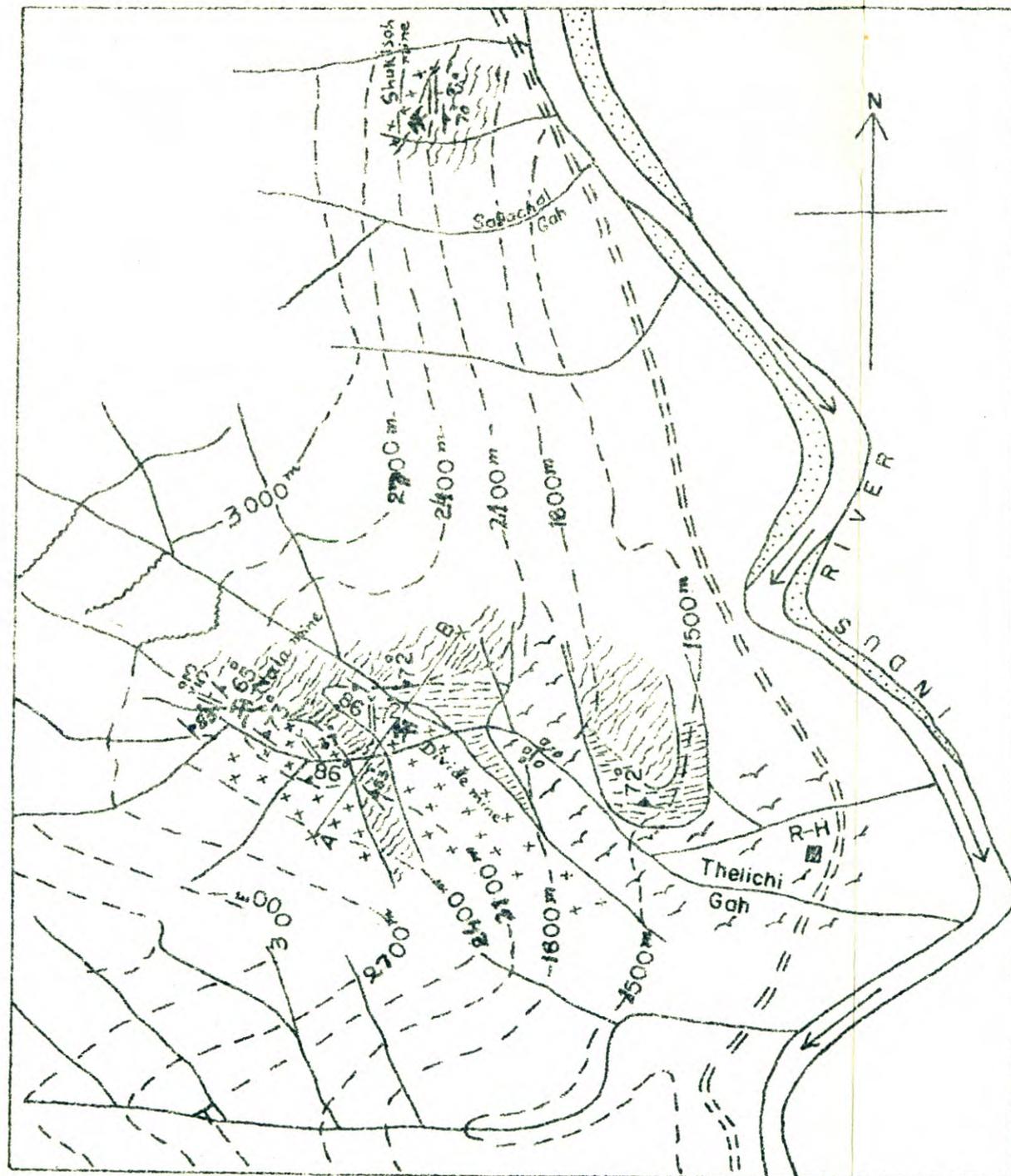
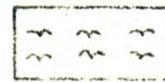


FIG. 1. LOCATION MAP OF THELICI GAH (GILGIT DISTRICT).



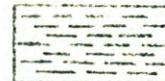
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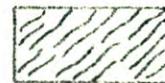
Alluvium



Diorite



Amphibolite



Meta sediments



Mine



Foliation of rock



Trend of vein

Contact, dotted where uncertain

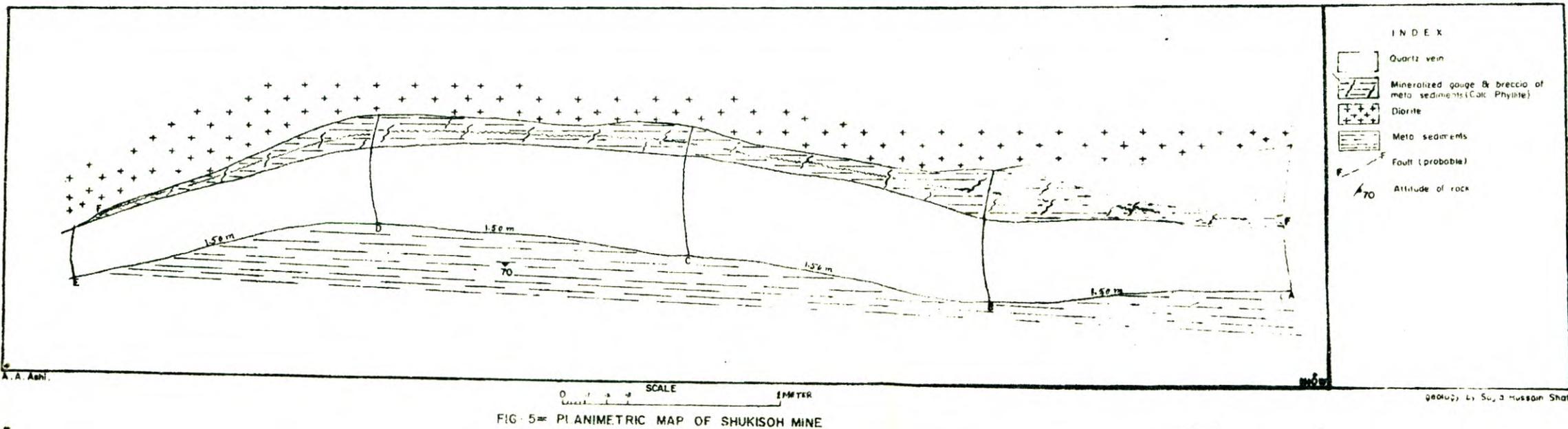
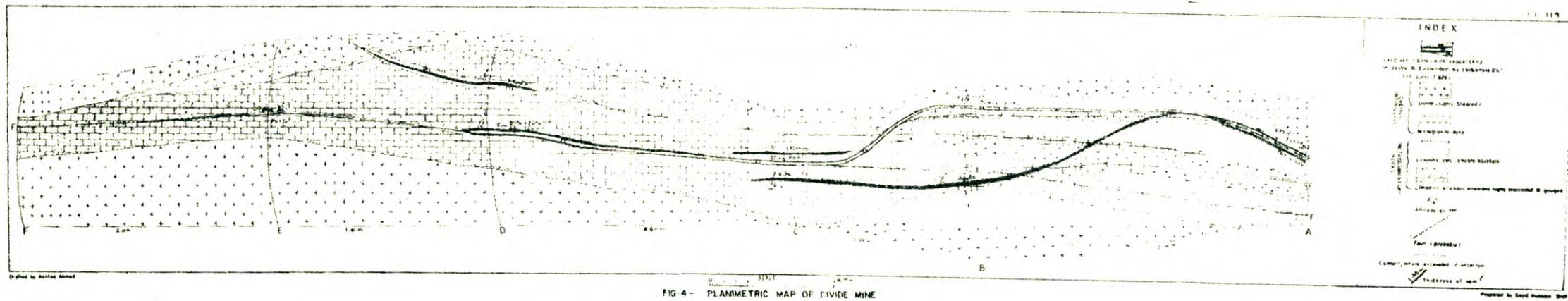
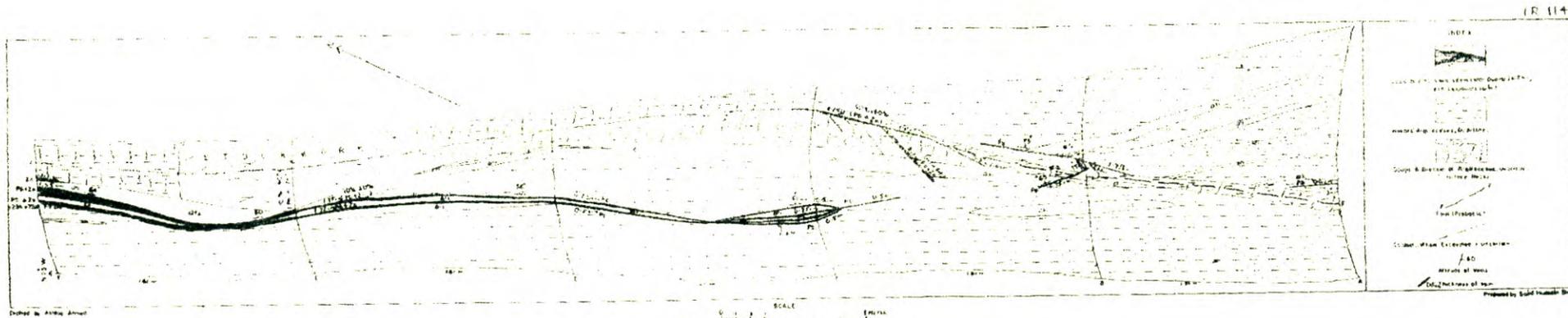
Contact, Gradational

Cross-section
A ← B

SCALE : 1 : 50,000

Prep. by Sajid Hussain Shah

FIG 2= GEOLOGICAL MAP OF THE MINES AREA OF THELICH (GILGIT DISTRICT)



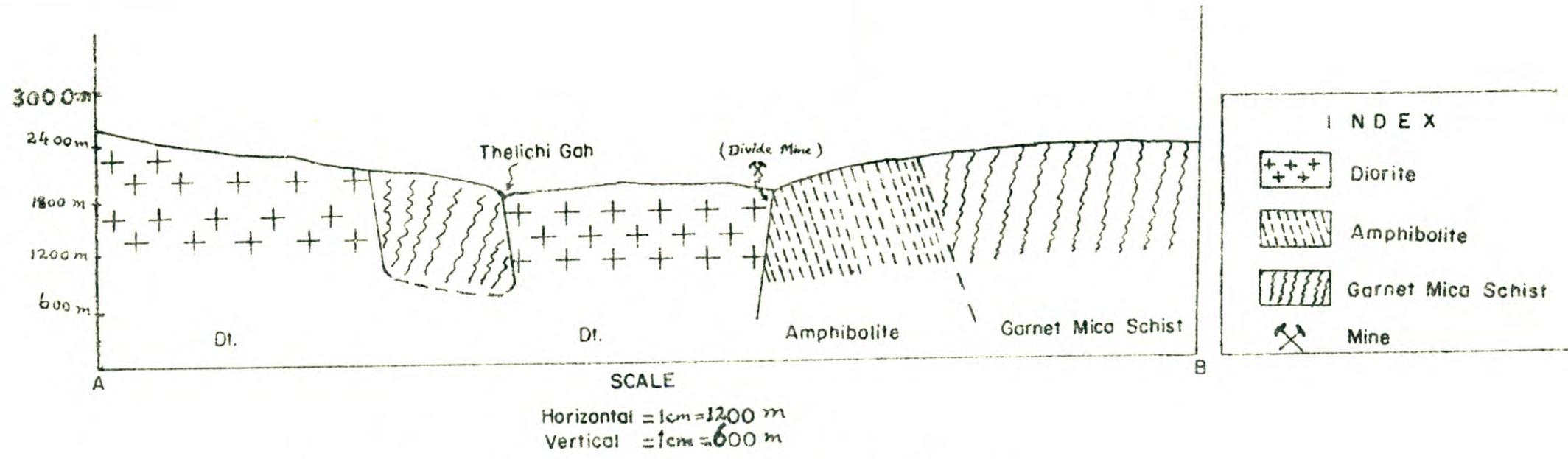


FIG:6 = CROSS-SECTION ALONG LINE A_B (in Fig.2)

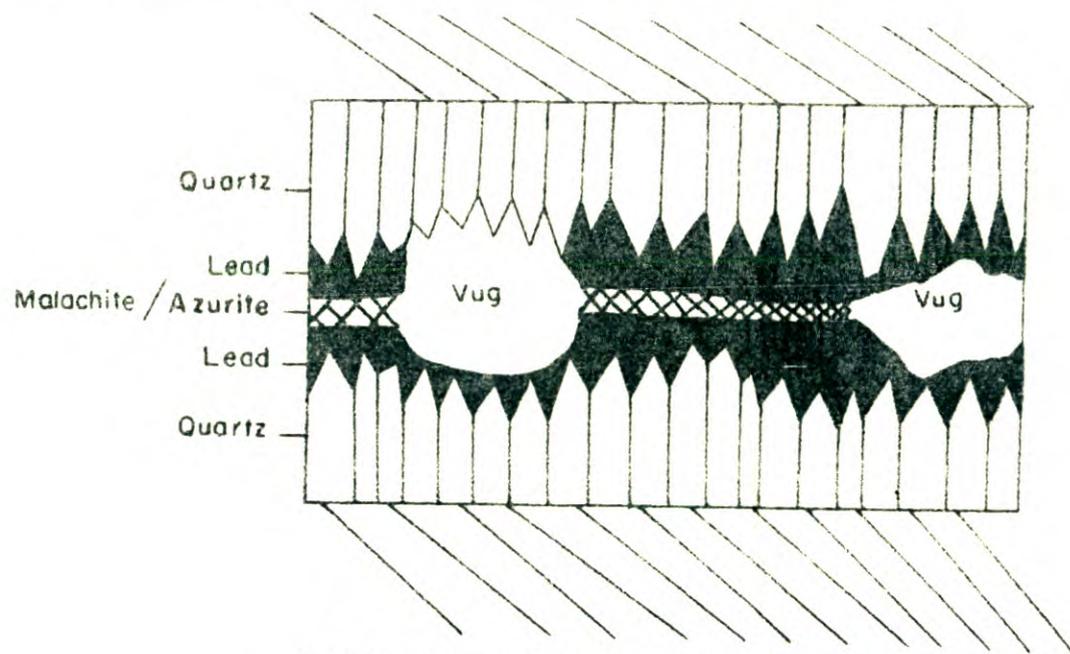


FIG:7 = GROWTH OF QUARTZ CRYSTALS IN THE FORM OF COMB STRUCTURE WITH VUGS IN THE CENTRE