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GEOLOGY AND MINERAL INVESTIGATIONS OF NALTAR - PUNIAL AREA, GILGIT (N.A.) PAKISTAN

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ABSTRACT

The geological mapping of Naltar-Punial area toposheet 42 L/4 is carried out on 1:50,000 scale. The geological sequence is represented by Greenstone complex Ladakh intrusives and Quaternary deposits. The Greenstone complex consists of meta-volcanic and meta-sedimentary rocks. The volcanics are basalts, andesites, decites, diabases, pillow-lavas and agglomerate-tuffs. The metasedimentaries are schists, quartzites and marble lenses. The Ladakh intrusives include multiphase plutonic rocks, from basic to acidic in composition and comprise granodiorites, tonalites, diorites granites, gabbros, Qz-monzonites, aplites, hornblende and granitic pegmatites, with diabasic dykes.

The sulphide mineral occurrences at Sher-Qila, Nomal, and Naltar are found. The dissemination of chalcopyrite-pyrite is found 2 km NW of Nomal along Naltar gah.

The marble lenses at Bichgari, across Bichhar gah and SW of Nomal are exposed. The Quartz crystals are developed in the pagmatites exposed along Jaglot gah, west of Naltar peak and SE of Shirot. The red garnet crystals are found along Bichgari nullah within schists and quartzite.

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INTRODUCTION

Purpose and Scope

The Northern Areas of Pakistan are marked by a very high relief and rugged topography which has been a handicap for those engaged in geological investigations of this area. These areas assume importance for their particular tectonic set-up and probable development of metallogenic regimes. With this view, the project area (toposheet No. 42 L/4 has been mapped on 1:50,000 scale as part of a systematic geological mapping and mineral investigations programme being conducted in areas hitherto unexplored.

The present report is based on the field investigations carried out during 1982-84 followed by laboratory studies including petrography and chemical analysis of rock samples.

Location and Accessibility

The project area lies between latitudes, 36°00 N and 36°15' N, and longitudes 74°00'E and 74°15'E (Fig. 1). The area can be approached from the Gilgit-Gupis road along Gilgit River and from Gilgit-Naltar road. Gilgit is a major town located 15 km south of the area and is linked with Rawalpindi by the all-weather Karakoram Highway. The PAF Skiing Base of Naltar lies almost in the centre of the area.

Previous Work

Ivanac' King,and Traves, (1956), and Abu Bakr (1965), Matsushita and Huzita (1965) gave a general account of the geology of Gilgit area. Desio, A. (1964) prepared a tentative geologic map of Karakorams. Stauffer (1968) geologically mapped the eastern part of this quadrangle on 1:250,000 scale. Tahirkheli and Jan (1979) and Tahirkheli (1982) established the tectonic set-up of northern Pakistan on the basis of Plate tectonics.

KEYS TO SHEETS

1:250,000 Sheets

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

43

1:50,000 Sheets

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

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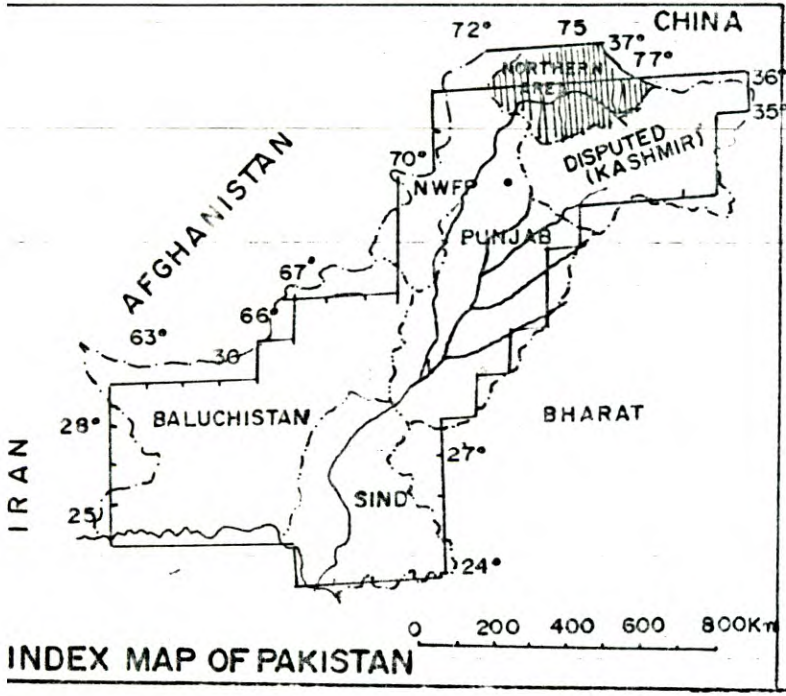

INDEX MAP OF PAKISTAN

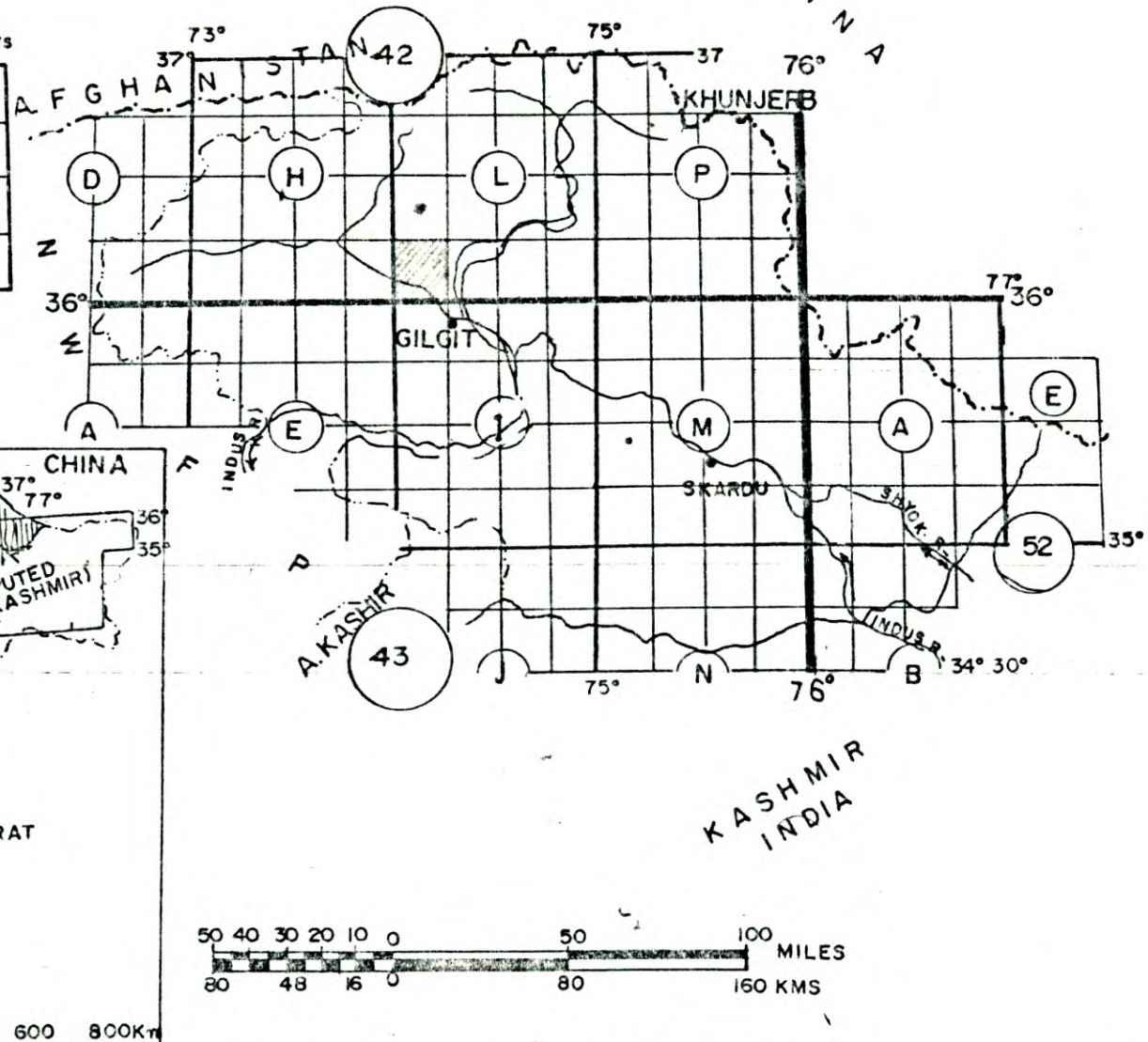

FIG. 1· LOCATION MAP OF THE AREA.

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PHYSIOGRAPHY

The project area covers a part of the Kailas Ranges which lie in the south of Karakorams. The high peaks are covered by permanent snow. Perennial snow melt-fed streams, rugged topography and high relief are salient features of physiography. The climate is characterised by dry and severe cold winters and pleasant summers. The rainfall is low and precipitation is in the form of snow above 4500 meter ASL. The population is sparse and mostly confined to the major valleys in the low altitude areas. The area is under early mature stage of geomorphic cycle of erosion.

Topography and Relief

The highest peak is charikhand 5888 Meter ASL whereas the lowest point along Gilgit river is 1524 M, ASL, yielding an absolute relief of 4364 meters. The abundant steep and cliffy slopes often hinder access to a large part of the area. However, the traverses along the established tracks and major valleys provided some access during field work. The Naltar valley is flanked by ridges as high as 5000 meters ASL.

Hydrology, Drainage, Glaciation

The hydrologic features are perennial streams fed by snow-melt waters. The major streams are tributaries of Gilgit river and Hunza river. The Shergah, Bargu Gah, Gulapur gah and Shirot gah are tributaries of the Gilgit river while Naltar gah is a tributary of Hunza River. The water discharge reaches its maximum during summers. The drainage pattern is sub-parallel to sub-dendritic because of local structural and lithologic variation.

The glacial caps and valley glaciers are recognized at Charikh and Sassai Khand and Khaltar areas. Jagot, Bichgari and Bichhar glaciers sometime break and advance at high speeds. There are examples of glacial surge along these in the near past, causing damage to the property and loss of life. The

snow line changes seasonally from 3000 m ASL to 5000 m ASL.

Climate, Vegetation, Habitation

The climate is semi-arid to arid. The area is lying between high monsoon barriers of Karakorams and Himalayas. Rainfall is low, and the precipitation is mainly in the form of snow at high altitudes. The rainfall is slightly higher in upper Naltar area as compared with other areas of this toposheet.

The vegetation is mainly of two types (i) Pine trees and (ii) fruit trees. The pine trees are grown over north facing shadowy slopes at Khyot, Bichari Dugah, Upper Shirot and Gulapur gah areas. The fruit trees and crops are cultivated over the terraces where adequate water supply is ensured from the perennial streams. The pear, apple, appricot, grapes walnut, almond peach trees are grown in the fruit orchards. The crops cultivated are wheat, maize, barley, potato, tomato and some fodders.

The population is sparse and mainly along the major valleys. The habitations are scattered over the gravel fans and alluvial terraces near the perennial steams mostly below 3000 meter ASL.

GEOLOGY

Regional Set-up

The geological set-up of Northern Pakistan is characterised by the presence of an island-arc bounded by the two continental plates. The Kohistan island-arc is a well developed geotectonic element sutured with the Eurasian plate in the north along Main Karakoram Thrust (MKT) and Indo-Pakistan plate in the south along Main Mantle Thrust (MMT) (Tahirkheli 1979) Bard (1980). Both of these suture are marked by the presence of ophiolitic melanges. The exposures of arc sequence are stretched between Chalt in the north and Jijhal in the south where MKT and MMT are marked respectively

(Bard, 1982). The arc sequence is comprising, Jijhal complex, Kamila amphibolites, Behrain Pyroxene granulites, Ladakh intrusives, Rakaposhi volcanic complex (described as Greenstone complex) and chalt ophiolitic melange (Tahirkheli 1982, pp. 23-28).

The occurrence of Greenstone complex and Ladakh intrusives in the project area marks it as a part of northern Kohistan arc west of Nanga Parbat - Haramosh massif. The Greenstone complex was originated as a thick oceanic crust in the Tethyan sea between the converging Indo-Pak and Eurasian plates. This complex is developed on the northern periphery of the arc and its extension has been traced uninterrupted through Hindu Kush and Baltistan across Afghan and Indian borders on the west and east respectively (Tahirkheli 1982, p. 26). The Ladakh intrusives are multi-stage batholithic plutons, accurring south of the main outcrops of Greenstone complex.

Stratigraphy

A brief resume' of stratigraphic sequence is detailed below: (Fig 2)

AGE	UNIT	DESCRIPTION
Pleistocene-Recent	Quaternary deposits	Alluvium, terraces unconsolidated sediments moraines, and fluvioglacial deposits.
Late Cretaceous to pliocene	Ladakh intrusives	Multi-phase granitic plutons mainly granodiorites, tonalites, diorites, granites, gabbroes, Quartz-monzonites, aplite and pegmatite veins,and diabasic dykes
Lower Cretaceous	Greenstone complex	Tholeiitic and andesitic lavas, tuffs-agglomerates with schists, quartzites and marble lenses

Greenstone Complex

It is an assemblage of heterogeneous, multi-lithological rocks with greenish hue, so intermixed with each other that renders it to be inseparable on small scale maps (Ivanac' et al 1956, p.9). It consists of meta-volcanics

and meta sedimentaries. The volcanics are at least of two types, (a) Tholeiites and (b) andesites-rhyolites. The small dioritic bodies are also associated wih the volcanics. The tholeiitic volcanics are composed of olivine-poor basalts, diabases, andesites, pillow-lavas, volcanic breccia and agglomerate-tuffs. These are highly epidotized and occasionally amphibolitized. These may have been originated during the early stages of arc-development by the intra-oceanic basic volcanism. Tholeiitic volcanics are exposed in Naltar paeen, Khaltar peak, Sher Qila-Bargu area (Fig. 2)

The andesitic volcanics are massive to poorly foliated, and composed mainly of andesites, dacites, andesite and dacite porphyries, rhyolites, and tuffs. The andesitic volcanics are exposed west of Gulapur gah, Naltar peak, SW of Nomal and Sassaia Khand areas.

The meta sedimentaries include phyllites, slates, calcareous schist, quartz mica schist graphitic schist, garnet mica schist, albite-actinolite schist epidote- amphbolites with biotite, garnet and sturolite bearing quartzites and marble lenses. The meta -sedimentaries are exposed in Bichhar, Shirot, Bichgari and Jagot areas. The rock exposure of Bargu, Khaltar and Sher Qila are mainly volcanics with intermixed metasedimentaries. The volcanics are basalts andesites, diabases, and tuffaceous layerings whereas metasediments are schists phyllites quartzites and amphibolites. The azurite/chalcopyrite mineralization within the volcanics, near the intrusive contact, is developed in near Sher Qila. These volcanics are highly epidotized and well foliated.

The section near Naltar village is composed of basalts, andesites pillow-lavas and tuffs. The pillows are 3-30 cm long and 1-15 cm wide. The material of pillows is mainly basic and of pyroclastic nature. The biotite and garnetiferous quartzite are interlayered.

The rock exposures at Shirot, SW of Nomal, around Naltar and Sassai Khand peaks are mainly the result of andesitic volcanism with some intercala-

intercalation of schist and para genisses. These are mostly massive to weakly foliated. Near the Naltar peak, alkaline trend in volcanics is noted as the biotite and barvekitic hornblende are occasionally present. The cataclastic gneisses/cataclasites are encountered near Naltar Rest house and Shingobar.

The outcrops along Shergah, Jagot, and Bichgari nulla consist mainly of metasedimentary rocks with some andesitic lavas and tuffs. Along Shergah phyllites, calcareous, schists, albite-actinolite schist, amphibolites, biotite schist, garnet-staurolite schist are present. The outpourings of andesite, dacite and rhyolite also took place in the area.

The biotite and garnetiferous quartzites, gray-wackes are mainly exposed near the village Jagot in Naltar gah.

Small boss-like gabbro and diorite bodies, are also present near Sher Qila and west of Naltar gah. These bodies are medium to coarse grained and granular in texture. The bodies may have been formed in the original magma chambers during the process of volcanism. The contacts of these bodies are sheared at places. The epidotization is commonly present.

Tahirkheli (1982) assigned a lower cretaceous age on the basis of fossil occurrences in the associated rocks. The fossils repor'ed are Globotruncana and Thaminasteria matsushitai (Matsushita, et al 1965).

Ladakh Intrusives

Ladakh-Kohistan granitic belt of Jan et. al, (1981) is described as Ladakh intrusives by Tahirkheli (1982). It consists of a linear belt of isolated batholithic plutons on both side of Greenstone complex. Each of these plutons ranges in composition from basic to acidic with the presence of some ultrabasic bodies. Five phases of magmatic activity have been recognized. Petterson and Windley (1986, p. 46) described, two major stages of intrusions. The first older, comprising a bi-modal suite of basic to intermediate gabbros diorites and quartz-rich tonalites, deformed to give gneisses and occasionally

recrystallized, whereas the second stage comprising tonalites, granodiorites and granites least deformed and younger.

Jan et. al, (1981, p. 172) recorded a five-phase calc alkaline to peralkaline magmatic activity. The general trend of these bodies is from south east to north west. The major intrusive bodies, separated by the meta-volcano-sedimentaries are described below:

(i) Gulapur

(ii)Gilgit-Bargu and

(iii) West Charikhand plutons

Gulapur pluton . The Gulapur pluton is a batholithic body mainly composed of diorites, gabbros, tonalites and granodiorites with basic and granitic pegmatites. It is greenish brown to greyish brown in colour and granular to sub porphyritic in texture. The deformation and recrystallization in gabbros and diorites is well marked. At least four-phases of magmatic intrusions are noticed. The hornblende - pegmatites with mainly hornblende and plagioclase are associated with the earlier basic to intermediate phases. The hornblendite / amphibolites bodies are frequent in the Gulapur gah section. The granitic pegmatites are of late-stage activity and compose of microcline, schorl, quartz with some mica, and copper ores. A prominent pegmatite composed of microcline and black tourmaline crystals embedded in the amorphous quartz is 1-1.5 metre thick and E-W trending. The biotite, pyroxene, hornblende lamprophyre with some bluish quartz granules is noted along Shirot gah. The contacts of this pluton along Shirot and Gulapur gah are sharp and discordant while occasional concordant relationship is present.

Gilgit Bargu pluton: The Gilgit-Bargu pluton is again a composite batholith with at-least five-phases of intrusions. It comprises diorites, tonalites, granodiorites, quartz manzonites, hornblendites, granites, gabbros and aplite-pegmatites. These rocks are medium to coarse grained and equigranular to

porphyritic in texture. The porphyritic granodiorites and quartz-rich tonalites are exposed north of Bargu whereas gabbro, diorites, and quartz rich tonalites are present in the Hirali ridge. The exposures south of Bargu are mainly granodiorites, granites and aplites. The migmatized gneisses are developed near Shirot. The pegmatites are sparse in the west of Bargu and composed of feldspar, flourite and quartz (GR 923, 261).

The contacts are mostly sharp but gradational contacts at Hachina, L. Naltar gah and Shirot are also present where migmitized gneisses are developed. The contact studies have revealed that complete record of metamorphic facies near the contacts within country rocks is missing which indicates the shearing along these contacts.

West Charikhand pluton: The West Charikhand pluton is a stock like body of granodiorites, tonalites and diorites. All of these rocks are redish brown to brownish grey in colour, medium to coarse grained and equigranular in texture. The hornblendite body in Jagot gah is coarse crystalline. The pegmatites are quartz and aquamarine bearing. Some of the dolerite dykes are showings disseminated chalcopyrite and azurite mineralization. This pluton is extending in a sheet-like manner towards Naltar lake in the N-NW direction. The southern contact of this body with greenstone complex is faulted and sheared at Jagot and Bichgari area.

The ages determined by radiometric dating for the plutonic rocks of this unit by Petterson and Windley (1986) are 102 to 19 m.y. whereas Jan et al (1981) have advocated 63-19 m.y. ages. The age assigned is L. Cretaceous to Miocene.

Quarternary deposits

The glacial moraines are exposed near Gulapur, Shardi gali and Bichgari. These deposits consist of boulders and cobbles of Greenstone complex and blocks of Ladakh intrusives embedded in sandy/gritty matrix. The light brown

to rusty brown colourations are exhibited. The sub-angular to angular shape and faceting/striations of material are recorded. The recent glaciation from Charikhand, Sassai Khand and Khaltar peaks has deposited huge quantum of material which is present as high level terraces in the area.

The fluvial terraces are mostly formed along Gilgit river and Shergah, where clay, sand and gravel alternations are stratified in the natural levees. A vast area underlain by unconsolidated sediments is present near Henzal and Hachina.

GEOTECTONIC HISTORY

The geological sequence represents the occurrence of arc-type volcanics with contemporaneous metasedimentary rocks of Lower Cretaceous age, known as Greenstone complex, intruded subsequently by Creto-Tertiary, S-type calc-alkaline to subv-alkaline granitic plutons. The project area is a part of northern Kohistan Island-arc falling immediately south of Main Karakoram Thrust. The lithology and rock types of Greenstone complex be speak of its origin as a part of thick oceanic crust formed in the trapped Tethys between the converging Indo-Pakistan and Eurasian plates (Tahirkheli, 1982).

The geological history is in fact the description of arc-development with its characteristic volcanism and plutonism. The geotectonic history is explained here with a discussion on sea-floor spreading in the Indian ocean, arc building on the subduction margin and continental collision.

The Indian subcontinent was a part of the Gondwanaland in Pre-Jurassic Era and its position fitted near Madagascar between Africa, Antarctica and Australia (Hallam, 1975). A new ocean was born with its rifted margins and fragmentation of Gondwana was initiated. A vast stretch of Tethyan ocean lay betwen the Gondwana and Eurasia whereas the two geosynclines of Northern and Southern Tethys were the pre-existing geotectonic features on its respective margins (Seyfert, 1973). India splitted apart from the rest of the

Gondwana by Mid-Jurassic and its historic northward drift started by the end of Jurassic (Powel, 1979). The Indian ocean began opening up by sea floor spreading due to convection currents, with Indian plate over-riding towards north. The history of sea floor spreading has been unraveled by paleomagnetic studies in the Indian ocean, during which marine magnetic anomalies pattern with the respective dating was discovered, under deep-earth sampling programme. The polar wandering curvers were drawn and the results of these analyses supported the hypotheses of continental drift and sea-floor spreading away from the mid-oceanic ridge during the period about 130 m.y. ago till recent times. The sea floor spreading took plae at the expense of Paleo Tethys, which was being consumed by active subduction along the sutures. Two major sutures of Main Karakoram Thrust (MKT) and Main Mantle Thrust (MMT) on the margins of the arc are marked in Pakistan by the presence of ophiolites near Chalt in the north and Jijal-Pattan in the south.

The occurrence of deep focus earthquakes along both of the sutures indicate the presence of Benioff zones below these sutures. The subduction along the southern suture of MMT is commonly agreed whereas southern paleo-tethys was consumed whilst the back-arc basin is believed to have been closed in along the northern suture of MKT.

During the subduction process along the southern suture, the tholeiitic lavas were poured out, followed by some hybridized calc-alkaline anestitic to rhyolitic lavas with concurrent depositions mainly of sedimentary material. The subduction beneath the arc continued during Cretaceous to Eocene times evolving the Greenstone complex, during Lower Cretaceous epoch. The subduction phase ended probably with the outset of collision process, popping-up the crustal material.

Petterson and Windley (1985) describe the magmatism in Kohistan domain in two major stages. In the first stage from 102 m.y. to 80 m.y., one third

of plutons, a bi-modal suite of basic to intermediate composition like gabbro-dioritites, qz-rich tonalites was emplaced and deformed while during the second stage the magma became progressively acidic with time, and intrusives like diorite tonalites, granodiorites, granities were emplaced with a late stage of aplites-pegmatites veins. The intrusive phases also occurred during the collisional activity because a vast stretch of time (cretaceous to miocene) is shown by the dating of the rocks. The India is colliding against Eurasia for the last 50 m.y. (Molnar and Tapponier, 1975). During the later stages of orogeny the arc areas were uplifted to their present position with the simultaneous development of foredeeps and the concurrent metamorphism of jumbled crustal mass. The subsequent geomorphic cycle of erosion has resulted in the formation of Quaternary deposits.

ECONOMIC GEOLOGY

The mineral investigations of this area have shown the occurrence of sulphide mineral zones marble lenses and pegmatites. These showings are briefly described below:-

Sulphide Zones

Four different zones of metallic minerals are recognized in the area.

Sher Qila area:

Near the abutments of Sher Qila suspension bridge, the hydrothermal alteration of medium grained, diorite bodies have produced malachite staining in the form of 1-1-5 meter thick veins. More than fifteen such veins are studied in the road cuts along Gilgit river. The mineralogy has revealed, malachite with azurite, bornite, sphalerite, and galena whereas the chemical analyses of six samples have yielded contents of copper (1.5%,) manganese (1%), lead (500 ppm) molybdenum (100 ppm) and zinc (50 ppm). These samples

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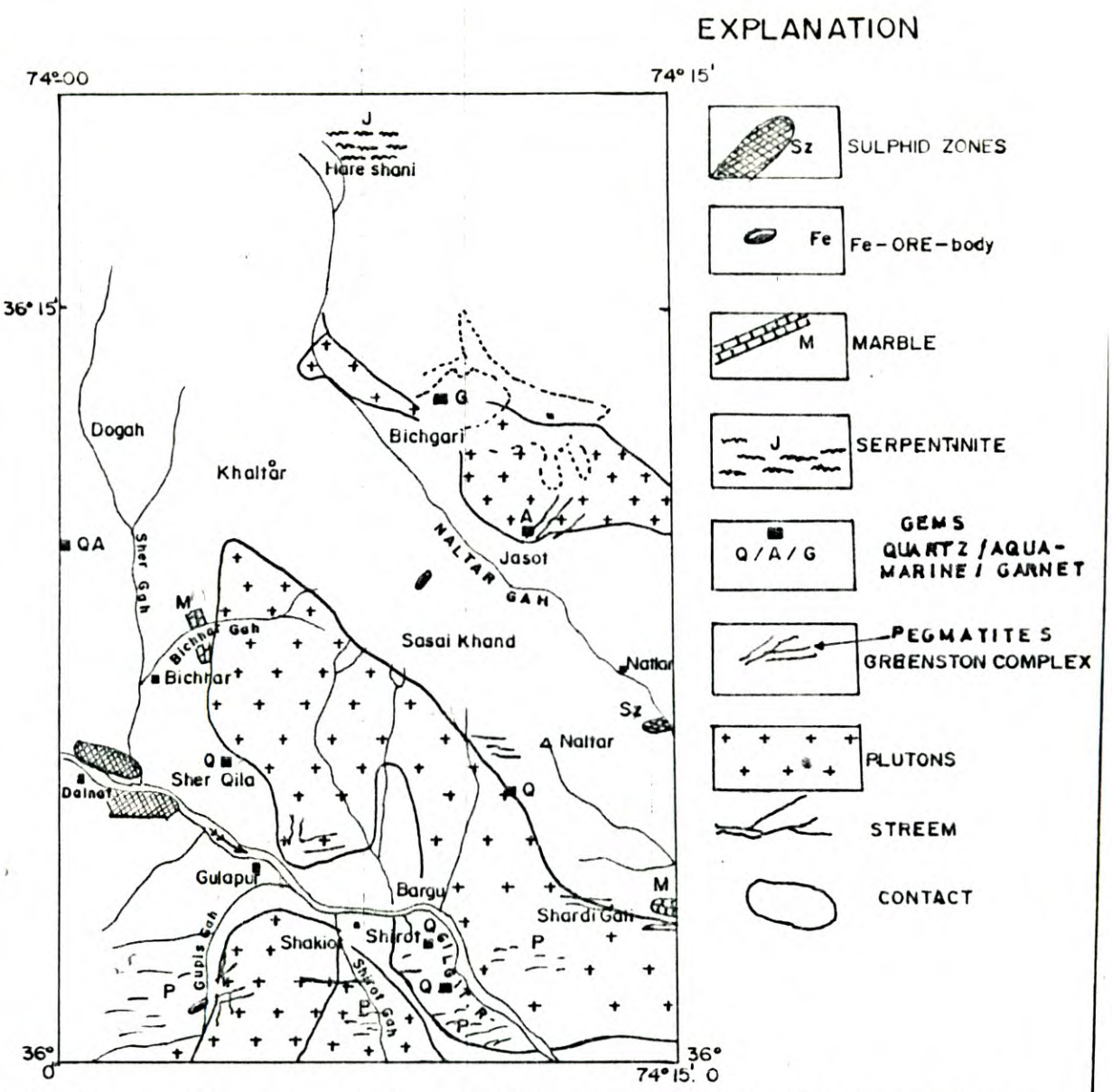

FIG-3 - MINERAL MAP OF NALTAR PUNIAL AREA (42L/4)

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were taken from the surface. Due to the limited extent and low metallic contents, these are considered as insignificant.

Naltar area

Along a tributary of Naltar Gah (GR 958378), a mineralised vein is located within the outcrop of andesitic lavas. The host rocks like andesite, andesite porphyry, dacite and dacite porphyry are observed which are layered. The ore body consists of heamatite, pyrite, chalcopyrite and limonite. The chemical analysis have revealed 23% iron content in it. The ore body is poorly exposed as glacial debris actively comes down the steep slope alongwith snow avalenches during summer and covers the outcrop. This vein is 30-40 cm thick while its extent could not be ascertained.

Bichar Gah area

In Bichhar Gah (GR 888336) pyrolosite dendrites within quartzite have been sampled and chemically analysed. The chemical analyses have shown low manganese content (less than 1%) for below the tenor of this ore. The search for a good manganese bearing zone near this locality was hampered due to cliffy slopes on both sides of this gorge.

Gulapur area

Along Gulapur Gah during the reign of Raja, the former ruler of Punial state, a small blast furnace was established just on the valley floor to process the iron ore present nearby and was abandoned due to thick scree deposition over the iron ore body, leaving no trace of it. This indicates presence of some workable iron ore body.

Marble

Bichhar Marble

In Bichhar Gah, 2 km east of Bichhar village, a lensoid marble body is exposed. This body is in contact with the volcanics, quartzite and

calcareous schists and is 100-150 meter thick and more than 500 m long.

The marble is snow white in colour, crystalline and surgary in texture and mainly composed of calcite. Small euhedral grains of calcite have a poor binding. This body crosses the Bichhar Gah, roughly 300 metre west of the intrusive contact. It can be exploited for calcite which may find its use in industry.

Bichgari Onyx

Near the Bichgari village (GR 971601) along the Naltar Gah, a 4-6 metre wide and 100 m long, small travertine/ onyx marble is deposited. The onyx layerings are of reddish and white colours and is developed along a shear zone. The beautiful onyx may find its use in handicrafts, but the deposits is insignificant economically.

Shani Serpentipites

Nearly 4 km north of the project area, some serpentinite bodies are exposed in the area known as Shani by locals (Fig 3) The ultramafic bodies are serpentinized and fall in the Main Karakoram Thrust zone. These are small vein type bodies with beautiful green and bluish massive serpentine deposits. The serpentine/jade can be cut and polished to produce beautiful handicrafts. The economic significance of such bodies marks these worth investigating in future.

Pegmatites

The pegmatites, zoned and unzoned, have been noted in Shirot, Gulapu , Naltar peak, Jagot nullah and Hirali ridge areas. These pegmatites bear occasioally, quartz crystals of good quality whereas blue variety of quartz is noted only near Naltar peak (GR 006295). Worth mentioning pegmatitic vein is exposed across the western tributary of Shirot Gah (GR 940192) and comprises large microcline and schorl crystals embedded in quartz groundmass. It is a 1 - 1.5 metre thick sheet like body with individual crystals upto 3 cm in

diametre. This pegmatite can be exploited for feldspar and schorl (a black variety of tourmaline). The tiny aquamarine crystals, clear and transparent are noted in Jagot nullah pegmatites.

The crystalline quartz veins have been noted along the intrusive contacts in the pockets especially along Shirot-Henzal foot path (GR 986194), in Jagot nullah (GR 604384) and near Naltar peak (GR 006295). The crystals are white, transparent and clear.

Garnets

Good quality garnet crystals, transparent to transluscent have been noted along Bicgari nallah, opposite the glacier snout (GR 974418). These are blood red in colour and the outcrop samples have crystals, 2-4 mm in diametre. These garnets are developed in the garnetiferous quartzite. The metasedimentary rocks are mainly exposed in the surroundings. The search for gem quality, mineable garnets is proposed.

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