



**OCCURRENCE OF GOLD
IN GARESH AREA, GILGIT DISTRICT,
NORTHERN AREAS, PAKISTAN**

by

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ABSTRACT

Occurrence of gold, silver, copper, molybdenum, lead, manganese, zinc, nickel and cobalt have been confirmed in the sulphide zone of Garesh area. The Sulphide zone is spread over an area of about 3.5 sq km. A total of 186 samples were collected randomly from the area, out of which 49 samples contain gold ranging from 0.02 ppm to 1 ppm, with the threshold value of 0.10 ppm. Silver content ranging from 2 ppm to 8 ppm has been noted in 137 samples. Lead, copper, zinc, nickel, cobalt, manganese and iron ore present in almost all the samples.

Although the values are generally low, but more detailed and systematic sampling may lead to likely discovery of the anomalous areas.

The Garesh area is underlain by metavolcanic rocks of Rakaposhi volcanic complex which have undergone hydrothermal alteration, and resulted different alteration zones. Multicoloured gossan have developed locally. Numerous quartz veins from a few centimeters to a few meters in width are present throughout the area. The quartz veins show vugs and cavities impregnated with sulphides and other precious metals.

Alum developed within the Garesh sulphide zone is locally being excavated.

INTRODUCTION

Purpose and Scope

The purpose of this project is to investigate the presence of minerals containing precious metals, with the scope to give a brief idea on the occurrence of gold, silver and other sulphides in Garesh area, Gilgit District. The mineralization occurs in a hydrothermal sulphide zone, which spreads over an approximate area of 3.5 sq kms.

The field work on this project was carried out during field seasons of 1986 and 1988.

Location and Accessibility

Garesh area is located 35 kms north of Gilgit along the Hunza River and lies in the Survey of Pakistan toposheet No. 42 L/8 (Fig. 1). Gilgit is about 620 kms from Rawalpindi and is connected by an all-weather famous Karakoram Highway (KKH). PIA operates a Fokker service between Islamabad and Gilgit which is subject to the weather conditions. The investigated area can be approached from Gilgit through the KKH. The mineralized zone lies approximately between longitudes $74^{\circ} 17' 08''$ and $74^{\circ} 21' 09''$ E, and latitudes $36^{\circ} 08' 45''$ and $36^{\circ} 10' 18''$ N (Fig. 3).

Field and Laboratory Proceedings

The mineralized zone is rugged, and inaccessible due to the steep gradient, which made almost impossible the systematic sampling on grid pattern, so samples were collected randomly along the accessible outcrop only. However, efforts were made to cover the whole mineralized area. Altogether 186 samples were collected covering different parts of the residual sulphide zone including semi altered schistose rocks. The residual samples were taken from surface to a depth of about 0.3 m. The samples were collected from 1 sq. metre area, in the form of chips of about 1 to 5 cm size. The quartz veins have a lot of sulphide development along fractures and vugs. Some parts of the quartz veins are fully stained and yellow coloured. No native gold was seen in the samples megascopically.

The samples were analysed by the Chemical Laboratories of the Geological Survey of Pakistan, Karachi. The data was statistically analysed and the threshold & the anomalous values were determined by computerizing the data (Fig. 3 and Diagrams).

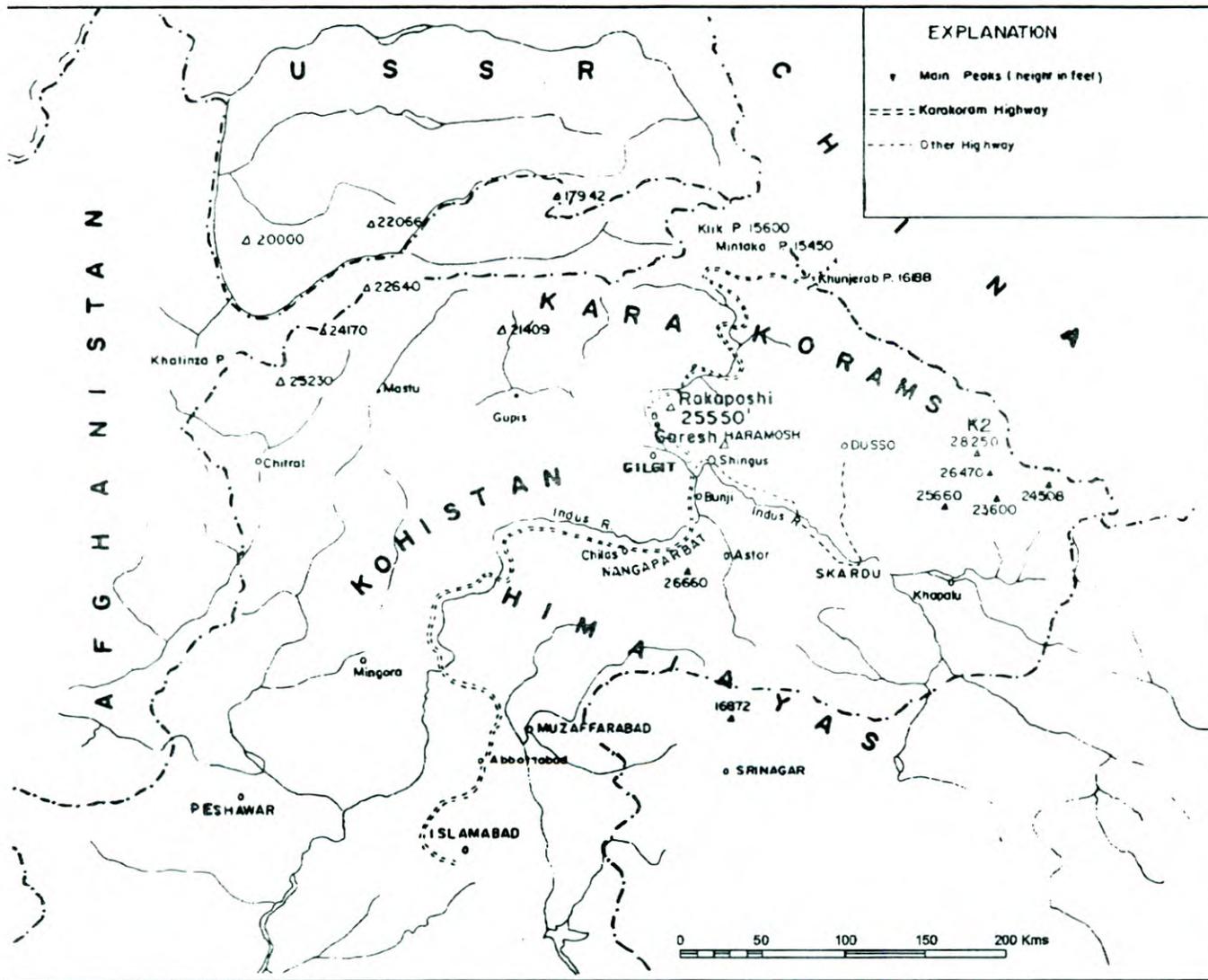


Figure 1. Location map of the Garsh sulphide Zone.

Previous Work

Clark (1952) reported the occurrence of gold in the placers near Nomal along the Hunza River, but could not find its source, which might have originated in the quartz veins, scattered throughout the country rocks. Jankovic (1984) indicated some possibilities of volcanogenic and volcano sedimentary mineralization related to andesite- rhyolite- dacite complexes in the Kohistan island arc. Leghari et al. (1986) confirmed the occurrence of Au and Ag in the sulphide zones of the Nomal area. The authors suggest the quartz porphyry as host rock of the Nomal sulphide zone.

Delli, J. H., (Personal communication) identified the skarn at Markoi in the Barit area during the field work. Later Kausar (1995) described it as Ca - Fe skarn and suggested that the Markoi skarn is related to porphyry copper formed in an island arc setting.

Khan, S. R., et al. (1996) described gold mineralization upto 411 ppm associated with the quartz veins occurring in the alteration zone of quartz - sericite schist, in Jaglot - Holtar area.

Acknowledgements

The authors gratefully acknowledge the suggestion and recommendations given by M. S. Zafar Khan and M. Ishaq Ghaznavi for improvement of this manuscript. Javed Akhtar is acknowledged for computerization of the data.

The authors also appreciate the efforts of Ghulam Safdar and Muhammad Lateef for typing this report.

REGIONAL GEOLOGY

The Northern Areas of Pakistan can be divided into three main tectonic domains, (i) the Karakoram continental block to north (ii) the Kohistan island arc in the middle, and (iii) the Indo - Pakistan continental block to the south. The Kohistan island arc is separated from the Karakoram and Indo-Pakistan continental blocks by the megashears viz. Main Karakoram Thrust (MKT) and Main Mantle Thrust (MMT) respectively. The investigated area covers a part of the Kohistan island arc . The Kohistan island arc is divided into a series of eastwest trending geological units.

The Yasin group consisting largely of marble, partially metamorphosed limestone, shale, quartzite and conglomerate, is interlayered with basalt, andesite and tuff. (Ivanac, et al., 1956; Pudsey et al., 1986).

The meta volcanics previously named as the Green stone complex and the Chalt volcanics have been redesignated as the Rakaposhi volcanic complex (Tahirkheli, 1982). The Rakaposhi volcanic complex includes basalt, andesite, tuff and marble, metamorphosed upto amphibolite grade (Petterson et al., 1990, Khan, T., et al., 1994). In the area lying between Gilgit and Chilas, Khan T. et al., (1994) described the Jaglot group which include (i) Thelichi formation (ii) the Gashu volcanics, and (iii) the Gilgit formation having a medium to a high grade metasedimentary sequence recognized in the vicinity of Gilgit.

The Kohistan batholith constitutes diversified multiphase plutons intruding the volcano-sedimentary sequence during 102 to 30 Ma (Petterson and Windley, 1985).

The Chilas complex consists of gabbro - norite, diorite, dunite and harzbergite (Jan, et al., 1984, Khan, et al., 1989). The Kamila amphibolite is composed of banded and massive amphibolites (Shah et al., 1987). The Jijal mafic - ultramafic complex is composed of granulite, garnetiferous norite, pyroxenite and dunite.

GEOLOGY OF THE AREA

In the investigated area, the Rakaposhi volcanic complex, Yasin group, Kohistan batholith and the MKT shear zone are exposed(Fig. 2).

Rakaposhi volcanic complex

The Rakaposhi volcanics consist of basalt, pillow lava, basaltic andesite, andesite, dacite and rhyolite. The lenses of tuffs and clastic volcanics are common in the Nomal and Garesh area. Small beds and lenses of partially metamorphosed limestone and grey wackes are intercalated with these volcanics.

The section between the Nomal and Chalt has been intruded at many places by apophyses and stocks of granodiorite and tonalite. The quartz porphyry marks the host rock for sulphides in Nomal area.

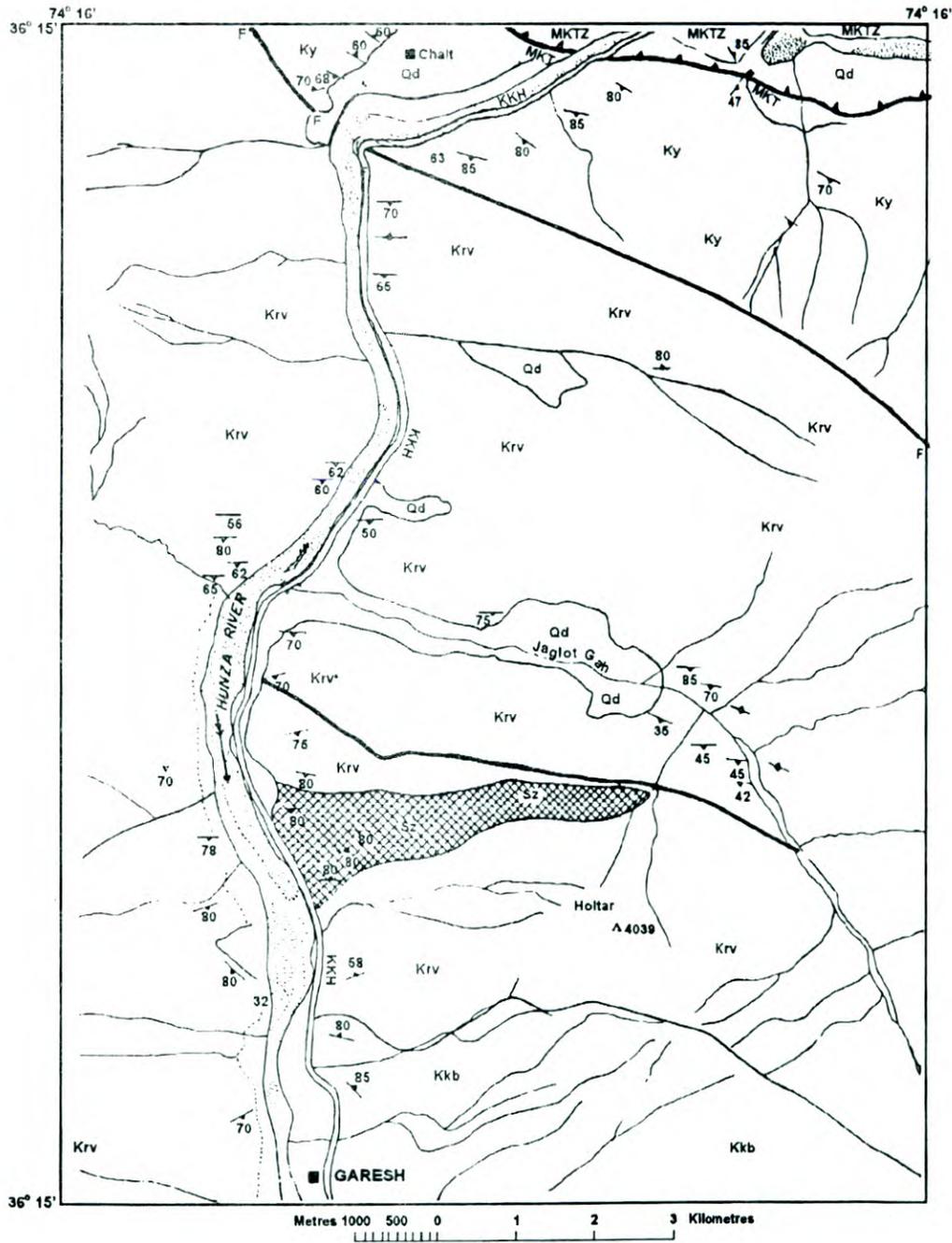
The rocks of mostly basalt and basaltic andesite in composition, are metamorphosed to green schist and amphibolite facies. The sulphide mineralization took place along the fractures and other weak zones. Tahirkheli (1982), assigned an Early Cretaceous age to the Rakaposhi volcanic complex.

Yasin group

The name has been given by Ivanac et al (1956) to a sequence of meta-sedimentary rocks interlayered with the volcanics. Later on, Tahirkheli (1982) extended this Yasin group to the similar rocks in the Hindukush in the west and Baltistan in the east.

The rocks of the Yasin group consist of mainly schists from chlorite to amphibolite grade, maroon shale, marble, partially metamorphosed dolomitic limestone, carbonaceous limestone and quartzite. It is interlayered with andesite, and subordinate rhyolite and basalt. The lower contact of the Yasin group with the Rakaposhi volcanics is faulted. The Main Karakoram Thrust (MKT) marks the upper boundary of this group.

On the basis of fossil assemblage, Tahirkheli (1982), assigned an Early Cretaceous age to the Yasin group.



LEGEND

<p>Quaternary</p> <p>CRETACEOUS</p>	<p>Qd Quaternary deposits</p> <p>Kkb Kohistan Batholith (I-Phase)</p> <p>Ky Yasin group</p> <p>Krv Rakaposhi volcanic complex</p> <p>MKTZ Main Karakoram Thrust Zone (MKT Zone)</p> <p>Sz Sulphide zone</p>	<p>GEOLOGICAL SYMBOLS</p> <p>65 Foliation</p> <p>Vertical foliation</p> <p>MKT Main Karakoram Thrust (MKT)</p> <p>F Fault</p> <p>Contact</p>	<p>NON-GEOLOGICAL SYMBOLS</p> <p>KKH Karakoram Highway</p> <p>Nala (Gah)</p> <p>4039 Height in metres</p>
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Figure 2. Geological map of the Garesh Sulphide Zone.

Main Karakoram Thrust zone

The Chalt ophiolitic melange (Tahirkheli, 1982) has been included in the redesignated Main Karakoram Thrust zone (MKT), which is characterised by its jumbled lithological units. It consists of metasedimentary and meta-igneous rocks. The metasediments include slate, phyllite, phyllitic schist, calcareous schist, interbedded with limestone, siltstone and turbidite (Khan, T. et al., 1988). The igneous rocks are talc carbonate, serpentinized ultramafics, and volcanics - andesite, basalt and rhyolite. Chalt is the type locality where the MKT zone is exposed along the KKH (Fig. 2).

Kohistan batholith (Phase - I)

Ladakh granodiorite of Ivanac et al. (1956), Kailas granodiorite of Stauffer (1968), and Ladakh-Kohistan granitic belt of Jan et al. (1981) has been renamed as the Kohistan Intrusives by Tahirkheli (1982). The composition of the Ladakh Intrusives vary from basic to acidic in chemistry, among which the granodiorite is the most abundant rock unit. Aplite, pegmatite and dolerite dykes are younger in age, but have been included in the Kohistan Intrusives.

Petterson and Windley (1985) renamed as the Kohistan batholith, and divided into three phases viz. I-Phase: deformed plutons formed between 110 and 90 Ma (Late Cretaceous); II-Phase: late undeformed plutons intruded between 85 and 40 Ma Paleocene to Eocene, and III-phase: leuco-granite sills and dykes emplaced between 34 and 25 Ma (Oligocene to Miocene).

In the mapped area, the Matum Das tonalite comprises of sodic pluton series. It is considered to be the early phase deformed pluton of the Kohistan batholith (Debon et al., 1987). It consists of a number of separate intrusive phases, predominantly tonalite granodiorite and quartz porphyry dykes.

The colour of these intrusives is greyish white on fresh surface and yellowish brown on weathered surface.

Extensive hydrothermal alterations viz. sericitization, kaolinization, porphyry and pyritization have been observed in the Matum Das tonalite.

These multiphase intrusives of diversified nature are considered to be calc. alkali in origin. However, Debon et al., (1987) considered these earlier phase intrusives to be tholeiitic, which originated prior to the subduction period.

DESCRIPTION OF GARESH SULPHIDE ZONE

The Garesh sulphide zone located towards north west of the Holtar Peak, is approx. 5 km long in the E-W direction and about 0.7 km wide in average. The area comprises the rocks of the Rakaposhi volcanics having basaltic and tuffaceous composition, but later on metamorphosed to biotite - sericite - actinolite schist and talc schist. The rocks show columnar jointing at places having abundant pyrite grains. The minor altered rocks exhibit a dark grey colour, whereas the more altered show white, green and brown. These rocks are intruded by the granitoids in the vicinity of the investigated area. Hydrothermal activity produced alteration zones of various types and colours within the meta volcanics. Numerous quartz veins from one cm to one metre in width are present in the mineralized zone. These alteration zones show alteration products as (i) epidote, chlorite, amphibole (green), (ii) epidote, biotite, (iii) quartz, sericite (white). Feldspar and ferro-magnesium minerals are completely replaced by sericite, chlorite and amphibole. The mineralization is in the form of veins and stringers.

MINERALIZATION

The surface geology shows that the oxidation process occurred in this sulphide zone which resulted development of limonite, goethite and jarosite. Gossans are locally developed due to oxidation of pyrite and leaching down of the metallic minerals (Fig. 3). Pyrite is common mineral in sulphide zones as well as disseminated in the host rocks. The mode of formation of the sulphide zone is considered to be the hydrothermal alteration of basaltic rocks, later on metamorphosed to talc schist and biotite - actinolite schists. The quartz veins bear sulphides along fractures and vugs. No native gold was seen but the chemical analyses show gold associated with quartz veins in the mineralized area. According to Roedder (1984) gold occurring quartz veins within rocks of the green schist facies metamorphism are formed at 250°C. Other associated minerals are sphalerite, chalcopyrite, malachite staining and pyrolusite dendrites.

GEOTECTONICS AND METALLOGENY

The Kohistan island arc (Tahirkheli and Jan, 1979, Bard et al., 1980), has been developed due to northward directed subduction of Neo-Tethys ocean lithosphere during Late Jurassic to Cretaceous (Searle et al., 1991). It is a tectonic block and consists of variety of volcanics, plutonics, and subordinate sedimentary rocks that have undergone

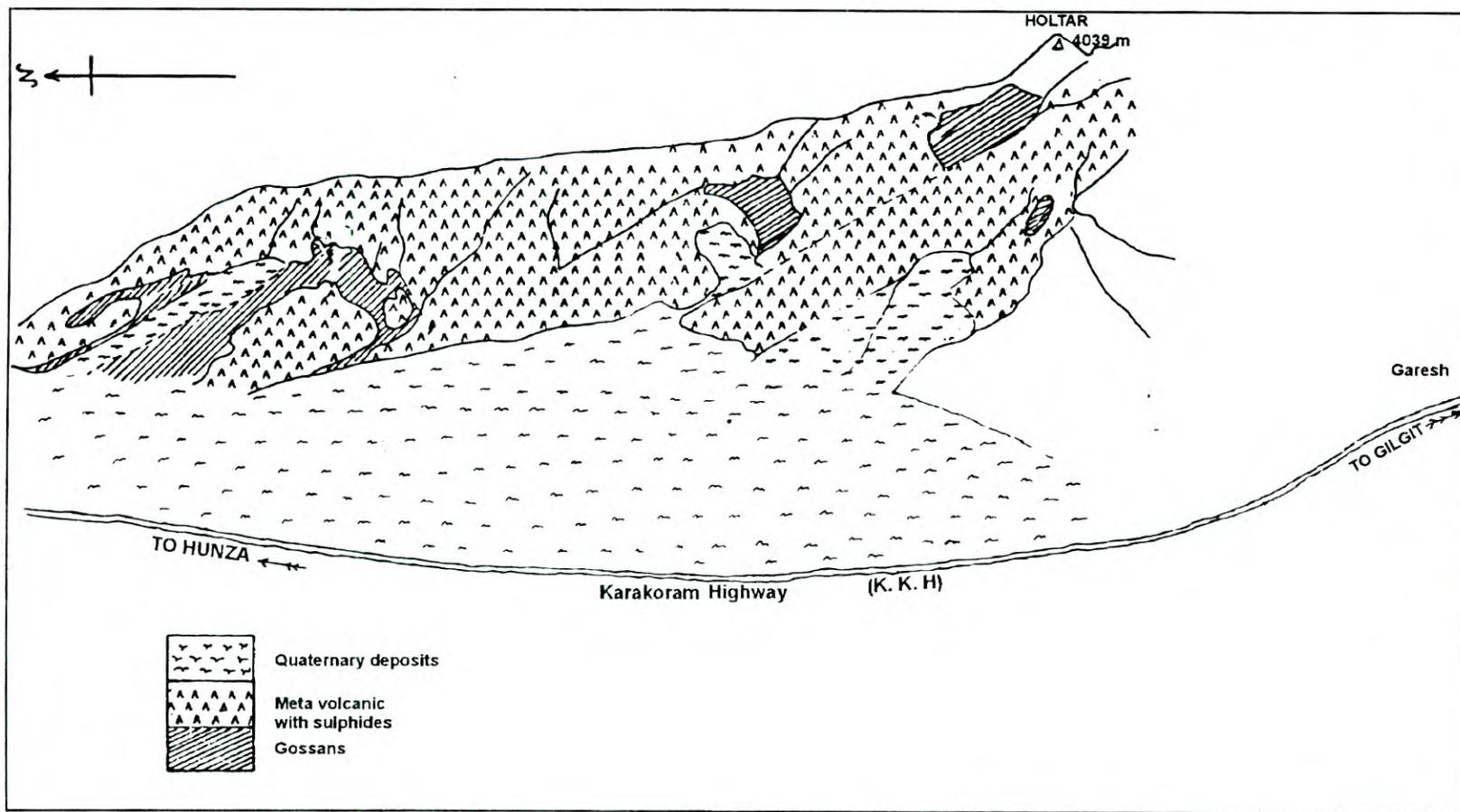


Figure 3. Sketch map of Garesh Sulphide area (Not to scale)

varying degree of deformation and metamorphism. This tectonic block is bounded by Northern Suture (NS) or Main Karakoram Thrust (MKT) on the north and by Main Mantle Thrust (MMT) on the south.

The MKT suture was formed between the arc and the Asian plate during 100 and 73 Ma (Pudsey et al. 1985), which resulted closure of the arc basin. Then the arc became a continental Andean-type margin attached to the Asian plate, and deformed after collision (Coward et al., 1986).

The Kohistan - Ladakh volcanic arc represent about 30-40 km thick pile of calc. alkaline plutono - volcanic rocks, intruded and amalgamated with the intra oceanic metasediments and volcano-sediments.

Following the collision of the Kohistan - Ladakh island arc with the Asian mass during Upper Cretaceous (100 Ma), the island arc sequence was folded, thrust and intruded by subduction related granitoids. Earlier granitoids were deformed, metamorphosed and intruded by later granitoids, throughout the northern part of the island arc.

The collision of the island arc mass with the Indian plate during Early Eocene (55 Ma) resulted in regional scale metamorphism, magmatism, volcanism and uplift in the island arc and Karakoram towards north of the Main Mantle Thrust (MMT).

The volcanism caused the outpouring of pillow lavas, basalt, andesite, dacite etc. in the island arc environments. The pre-collision volcanism in the island arc environments resulted interlayered Jurassic - Cretaceous metasediments, volcanics and volcanosediments of the Rakaposhi volcanics, and Yasin group. The post - collision volcanism resulted the late Eocene volcanics and volcano-sediments of Utror volcanics.

The Kohistan - Ladakh island arc is a well defined geotectonic unit of particular metallogenic importance. The metallogeny of the volcanic island arc is little known, as it has not been systematically prospected and studied from metallogenic point of view. However, on basis of scanty data and geotectonic setting, Jankovic (1984) described following genetic types of ore mineralization (1) podiform magmatic chromite mineralization with ultramafics of Jijal complex; (2) volcano-sedimentary massive copper mineralization (Cyprus type) along ophiolite in mid oceanic ridges; (3) volcanogenic and volcano-sedimentary mineralization related to andesite - dacite - rhyolite complexes (massive sulphide deposits, and the Kruko type manganese deposits); (4) the plutonics viz. diorite, granodiorite, leucogranite may contain Pb, Zn, W, Sn and Mo mineralization.

GEOCHEMICAL INVESTIGATIONS

The chips of host rocks, quartz veins and the residual soil samples were analysed for zinc, lead, copper, nickel, cobalt, manganese, iron, silver and gold, so as to determine their contents and behaviour of their secondary dispersion haloes. The samples were analysed by atomic absorption method, whereas, iron and molybdenum were determined by the volumetric and colorimetric methods, respectively.

The threshold anomaly values, mean and standard deviation of zinc, lead, copper and gold, were determined by computerizing the data on statistical basis (Diagrams and Fig. 4).

Threshold = Mean + standard deviation.

Zinc: The values range from 5 ppm to 149 ppm. The threshold is calculated as 49.4 ppm and distributed in 19 samples.

Lead: The value range from 7 ppm to 110 ppm. The threshold is estimated as 32.3 ppm, and distributed in 19 samples.

Copper: The values range from nil to 195 ppm. The threshold is estimated as 96.4 ppm, and distributed in 16 samples.

Gold: The values in 49 samples range from 0.02 ppm to 1 ppm. The threshold is estimated as 0.10 ppm. The anomalous values range from 0.24 to 1.00 ppm and distributed in 4 samples.

The values of cobalt range from 0 to 24 ppm, manganese range from 25 to 458 ppm, iron range from 0.64 to 13.59% and silver from 0 to 8 ppm and Nickel range from 5 to 64 ppm. Copper, zinc and silver sulphide mineralization decompose readily and migrate to lower levels to form secondary enriched zones.

The Northern Areas experience almost arid climate, high temperature fluctuations, and steep gradient. Hence, the investigated area, does not favour intensive chemical weathering, but mostly physical denudation. However, the frost wedging action during winters tentamounts physico-chemical weathering. The introduction of hydrothermal metalliferous fluids in these volcanosediments is considered to be the post depositional phenomenon and later on weathered to the present state.

The Russian geologists consider that endogenic gold in each region has its own

characteristics, with regional back ground generally within the range of 0.0018 to 0.034 ppm (Jayce, 1984).

However, the gold occurs mostly in quartz vein and subsequently in meta volcanics and gossans. Gold is associated with submarine hydrothermal activity during the formation of the Rakaposhi volcanics. Later on, remobilization of gold took place from volcanic source rock into quartz veins and sulphides due to sulphateric activity.

SUGGESTIONS AND RECOMMENDATIONS

1. Presence of Cu, Zn, Fe, Ni, Co and Pb are noted in quartz veins and metavolcanics, along with their sulphides. Pyrite and arseno-pyrite are good indication for gold occurrence.
2. Mobile sulphide elements viz Zn, Cu, and Ag seem quite encouraging for further prospection for gold.
3. It must be emphasized that the detailed geophysical and geochemical studies on grid pattern basis should be integrated and plotted at a scale 1:5,000.
4. Gold direct analyses should be adopted such as flameless atomic absorption and neutron activation. In such type analyses, the gold anomalies may increase.
5. The arsenic is an excellent path finder for gold. Endeavour should be made to use this tool too.
6. If the later studies prove the area to be promising, the drilling should be aided to investigate it properly. For this purpose light portable drills should be used.
7. The Garesh sulphide zone lies in vicinity of the megashear - Main Karakoram Thrust (MKT), which serve as venue for the mineralized hydrotherms. Properly organized geochemical sampling of different population groups of the mineralized area viz. rock, soil, stream sediments and their statistical evaluation will aid the hunt for secondary enrichment zone.
8. Alum is locally mined from the Garesh sulphide zone, its reserves should be properly investigated.

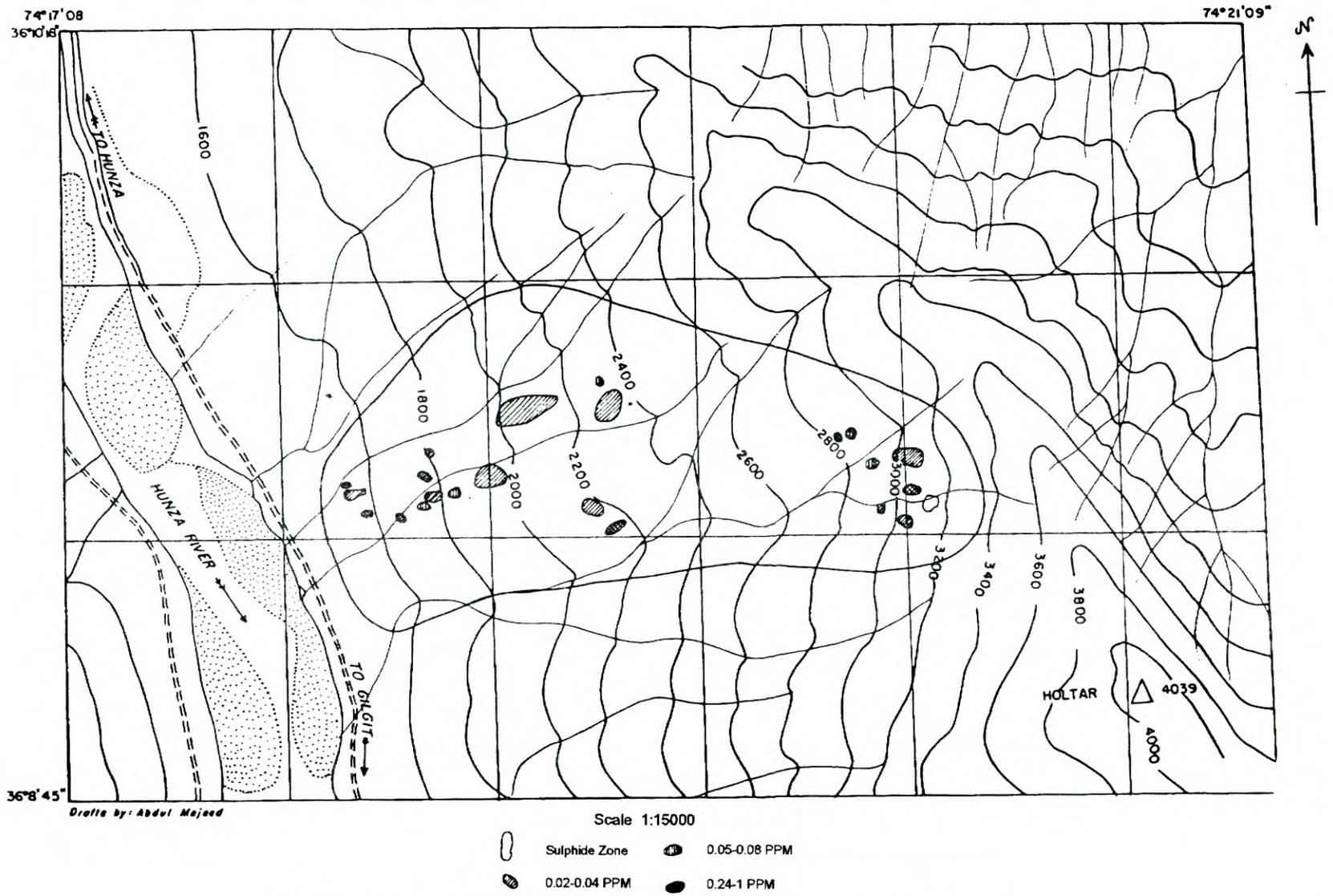


Figure 4. Gold Anomaly map of Garesh area, district Gilgit, Pakistan

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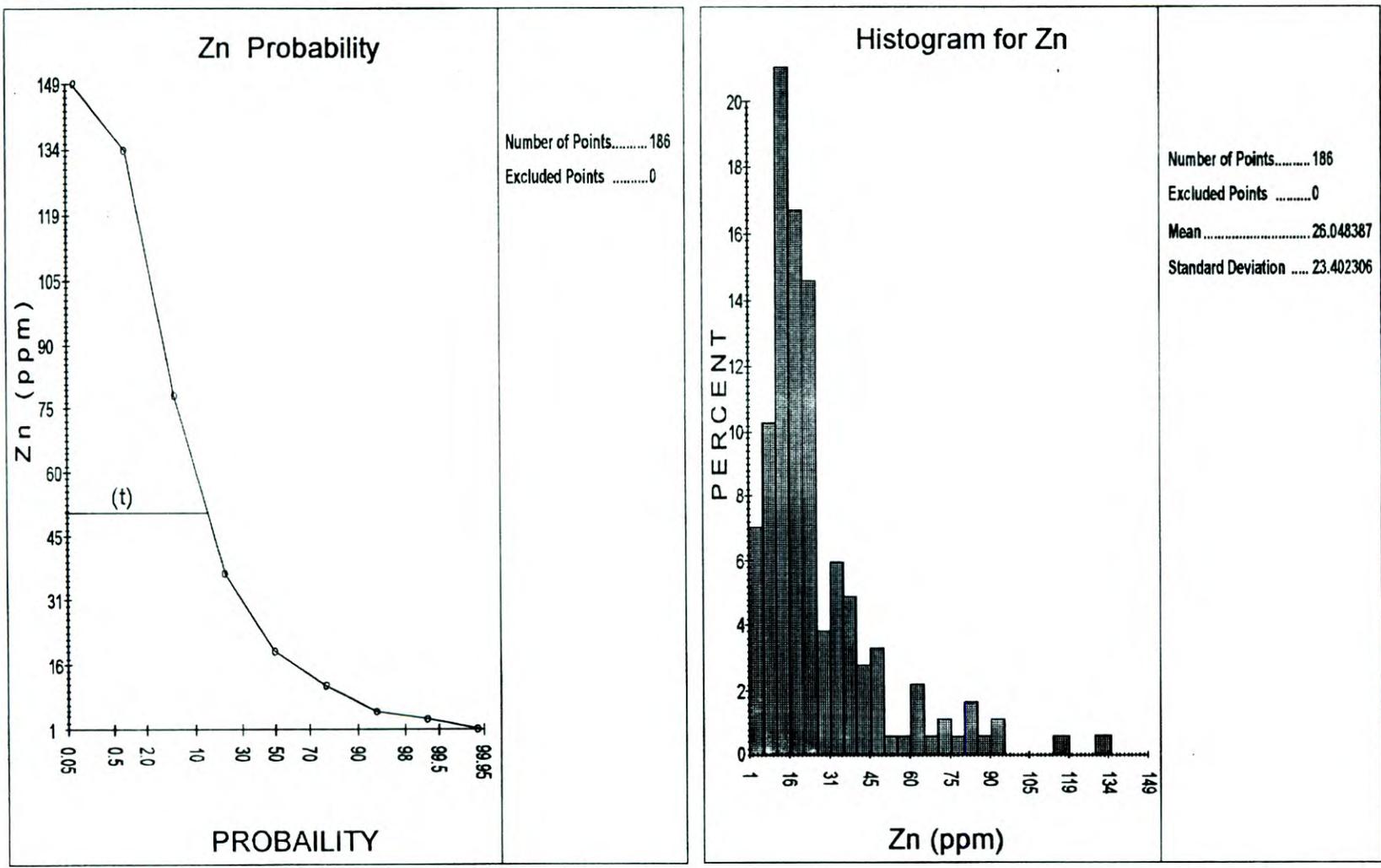


Diagram 1. Histogram and Probability curve for Zinc.

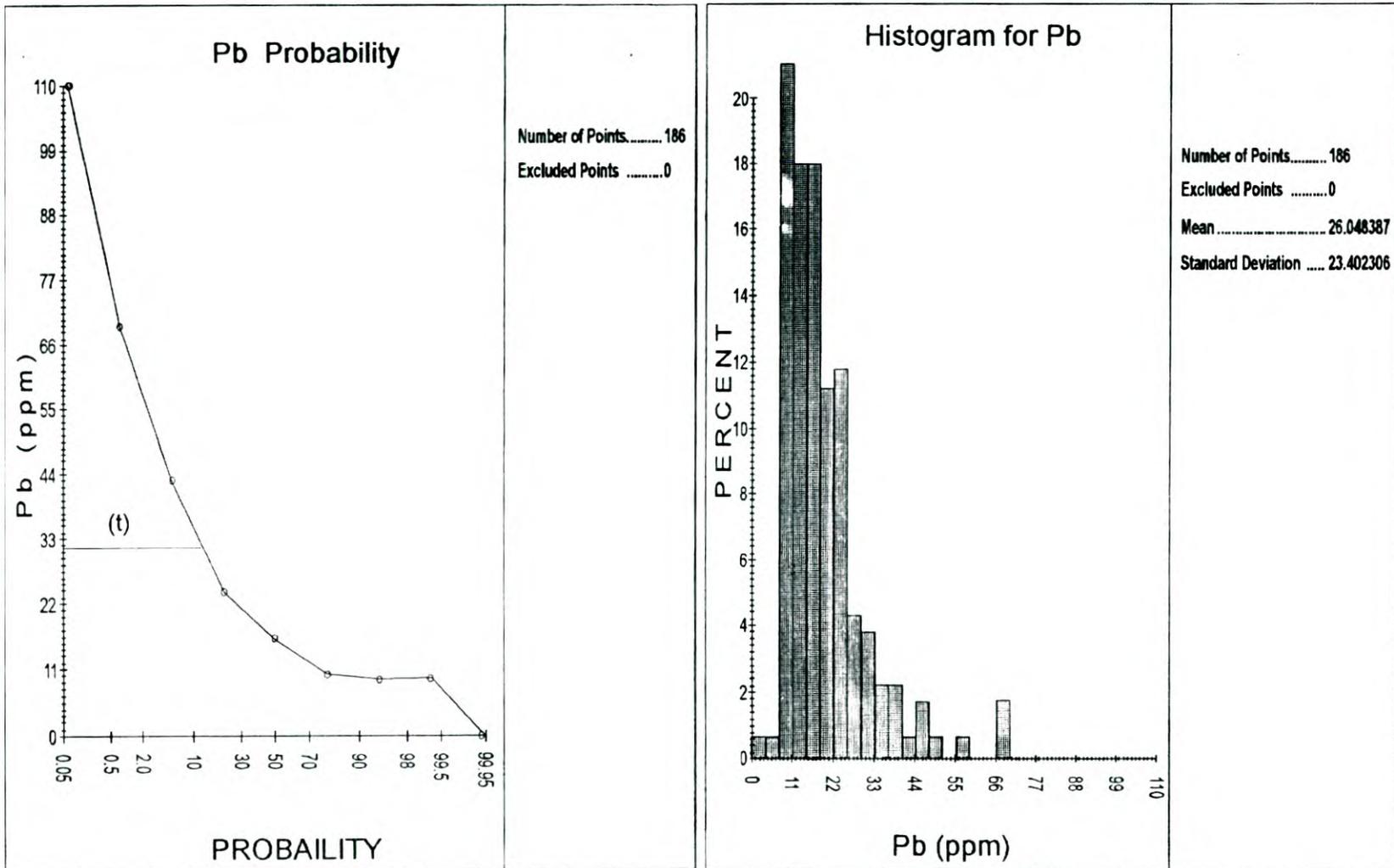


Diagram 2. Histogram and probability curve for Lead..

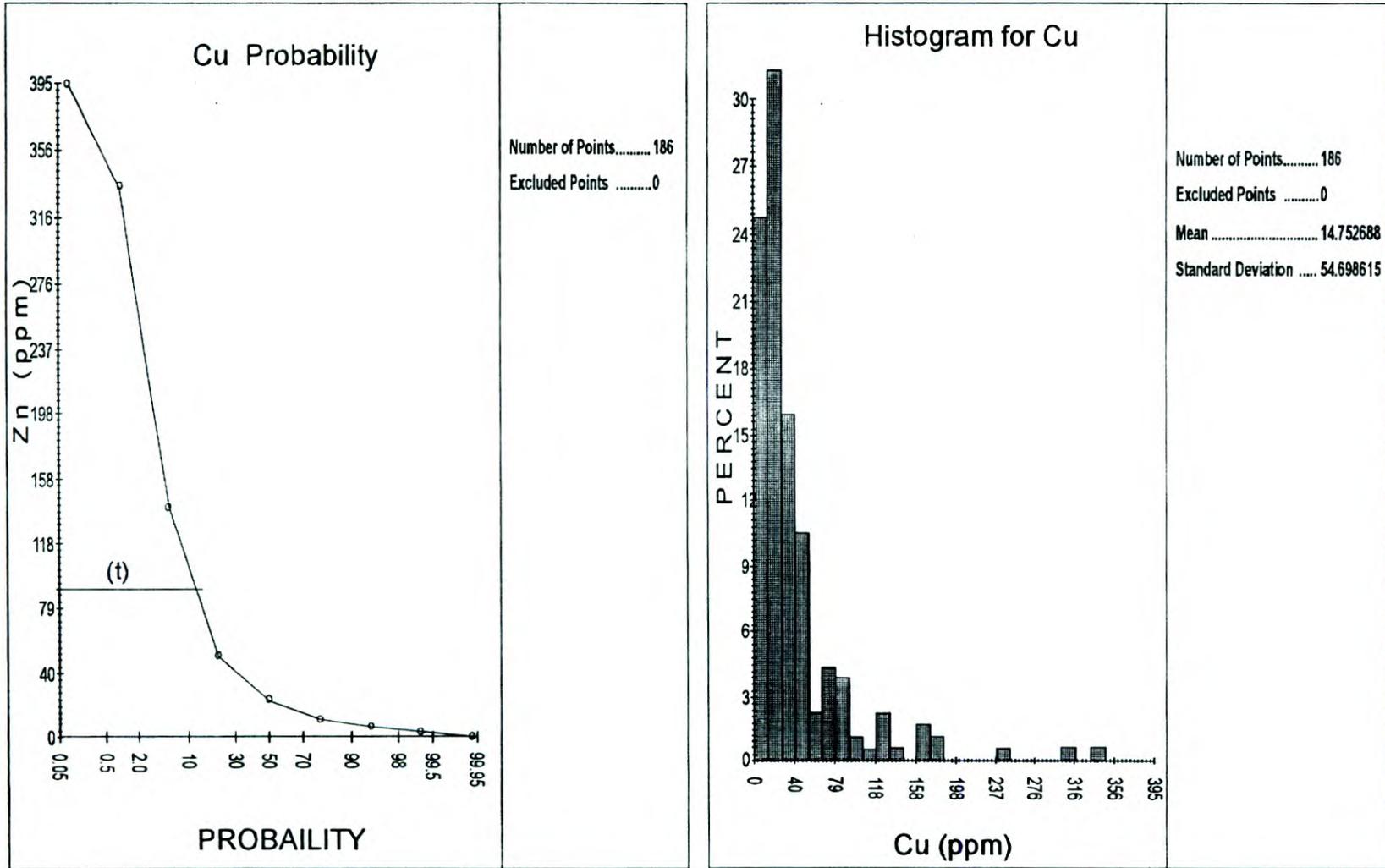


Diagram 3. Histogram and Probability curve for Copper.

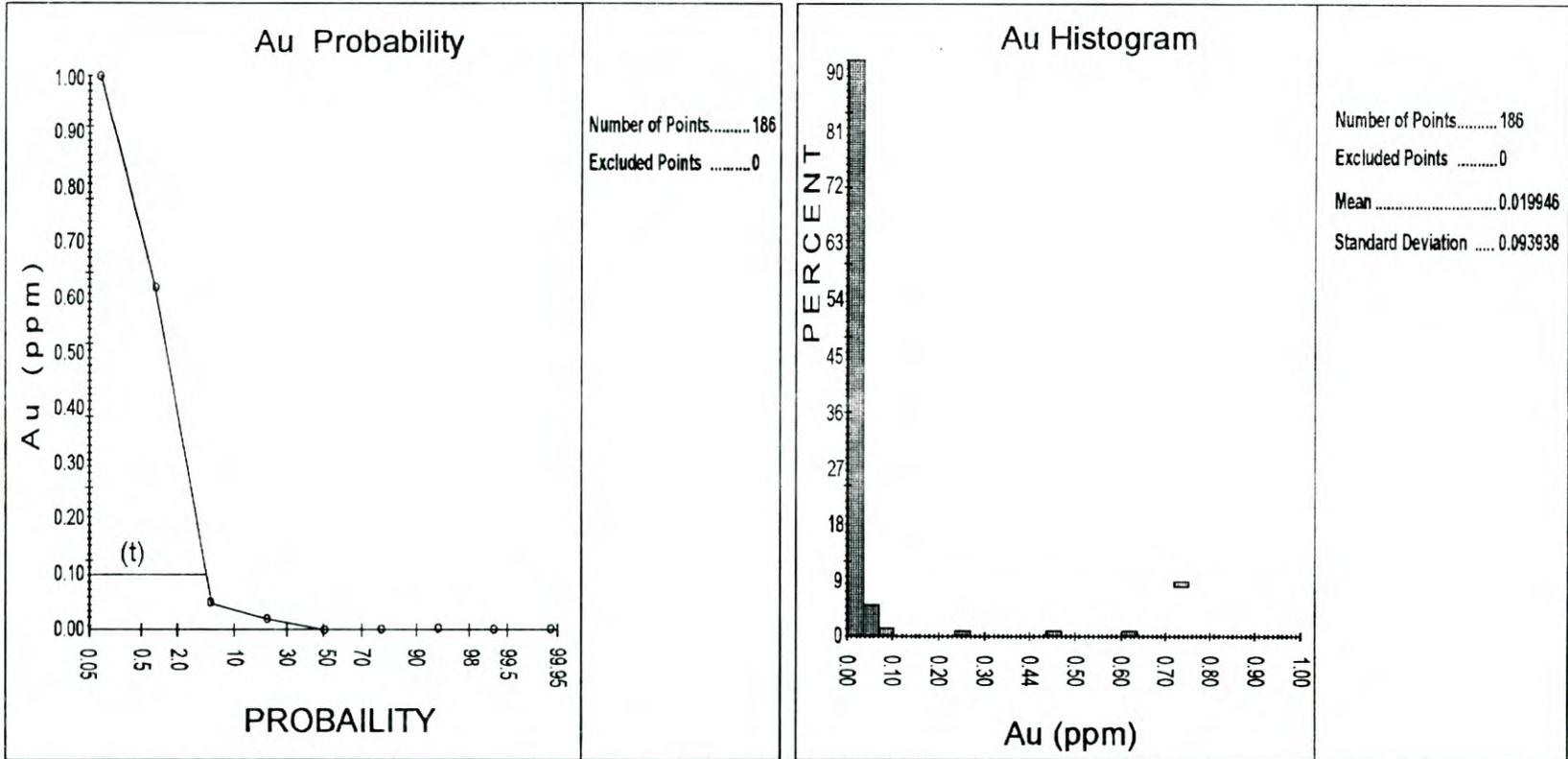


Diagram 4. Histogram and Probability curve for Gold.