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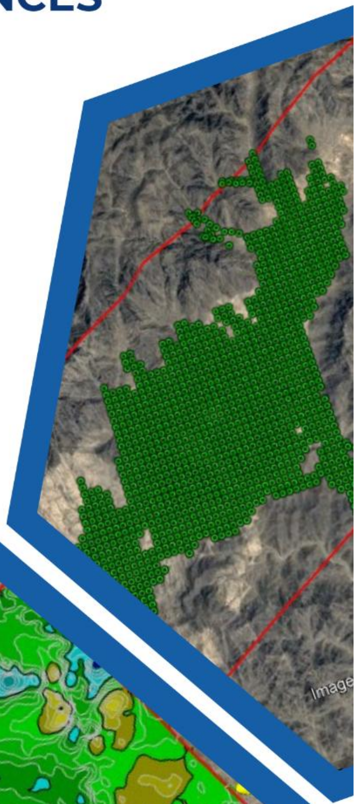

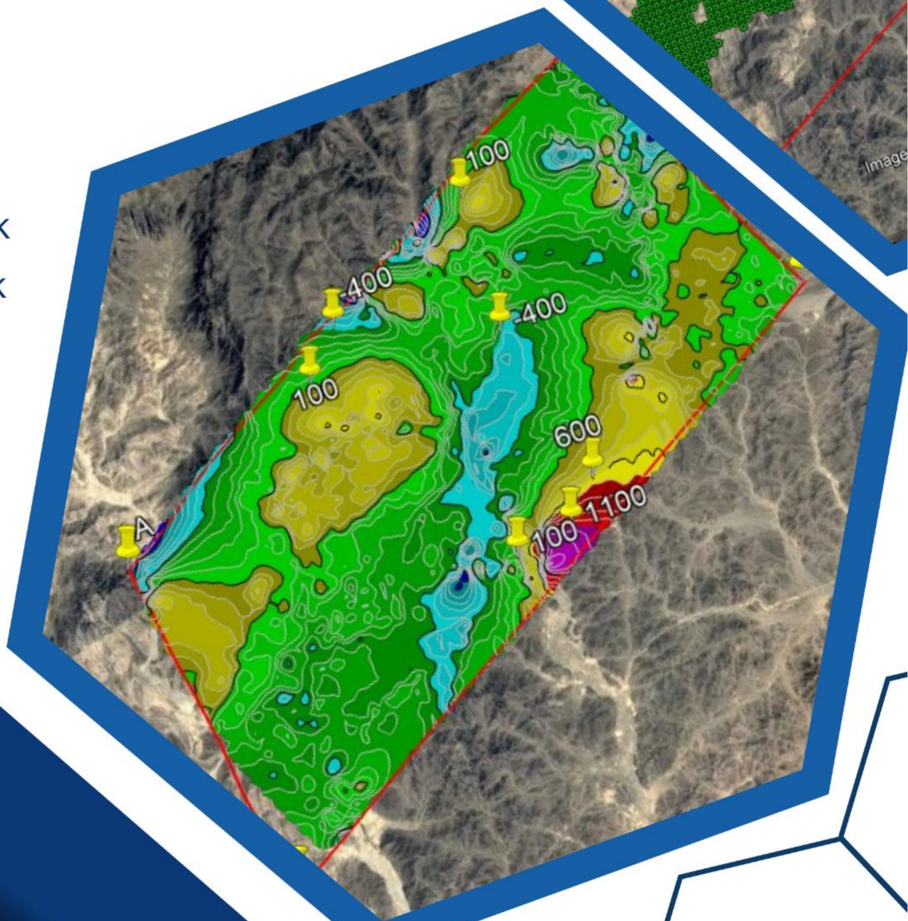

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Spot Sampling for Antimony, Copper, Gold and Industrial Evaluation of other Economic Minerals of Skardu Division, With Special Emphasis on Satpara Sulphide Zones

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ABSTRACT

Gilgit-Baltistan, located at the northern margin of Pakistan, comprises a complex tectonic setting defined by the interaction of the Indian Plate, Kohistan-Ladakh Island Arc, and Eurasian Plate along the Main Mantle Thrust and Main Karakoram Thrust. This geodynamic framework renders the region highly prospective for economic mineralization. The present study forms part of a Geological Survey of Pakistan annual project (2019–20) aimed at spot sampling for antimony, copper, gold and industrial evaluation of economic minerals in Skardu Division. This paper presents the results of a sulphide mineralization zone exposed along the Satpara Lungma. Field investigations were conducted during August–September 2020, including reconnaissance survey, identification of mineral occurrences, and sampling for laboratory analysis. Samples were analyzed at the Geosciences Advance Research Laboratory (GARL), Islamabad. The mineralization is structurally controlled and occurs along a sheared and faulted contact between Deosai Volcanics and Burji La Formation. The sulfide assemblage comprises pyrite, chalcopyrite, sphalerite, and galena, with minor silver values. Geochemical analysis indicates copper values ranging from 0.076% to 0.597%, silver up to 13.2 ppm, zinc up to 76 ppm, nickel up to 29 ppm, and lead showing a significant anomaly of 262 ppm. Iron oxide (Fe_2O_3) content varies from 12.9% to 72.1%, reflecting strong oxidation and iron enrichment within the zone. The elemental associations and mineralogical characteristics suggest hydrothermal activity with probable epithermal origin, controlled by structural features. The occurrence of diorite intrusions in the vicinity further supports this interpretation. The study indicates promising potential for base metal mineralization and provides a basis for detailed exploration and resource evaluation in Skardu Division, Gilgit-Baltistan.

Keywords: Satpara Lake, Sulphide zone, Epithermal, Base Metals, Deosai Volcanics, Diorite intrusions.

1. INTRODUCTION

Gilgit-Baltistan is the northern most part of Pakistan and is famous for its world highest mountains: the Himalayas; Karakoram; and Hindu Kush. Indian occupied Jammu and Kashmir, lie on its eastern, China on northern and Afghanistan at western border. Geologically the area is spectacular as the tectonic contacts between Indian Plate and Kohistan-Ladakh Island Arc which is marked by the Main Mantle Thrust, and between Kohistan-Ladakh Island Arc and Eurasian plate which is marked by Main Karakoram thrust, fall in the area. The tectonic environment of the region suggest that it is a metallogenic province and has potential for the occurrence of economic mineral deposits.

The project entitled "Spot sampling for Antimony, Copper Gold, and Industrial Evaluation of other Economic Minerals of Skardu Division" was an approved GSP project for the year 2019-20. The present paper deals with the Sulphide zones of Skardu division and provide detailed analysis of Satpara Sulphide Zone. In addition to this, geological maps of two three zones of Skardu division are were also prepared.

2. PURPOSE AND SCOPE OF THE STUDY.

The aim of this project was sampling for Copper, Gold, Antimony and Industrial evaluation of economic minerals of the area. During field work; special emphasis was given to Satpara zone and surveys have been carried out in Skardu division to find out the new localities of the minerals

3. METHODOLOGY

Methodology adopted for the research was as follows;

- Desk study and data collection of the study area
- To locate the mineral occurrences in the area from already published reports and maps.
- Sample collection from the selected zones
- Sample testing for evaluation of economic potential.
- Report writing and maps preparation.

4. LOCATION AND ACCESSIBILITY

Skardu city, the divisional headquarter of the Skardu division can be accessed from Islamabad by air on fair day's flights. It can also be accessed by Jaglot-Skardu Road (JSR) which is two-way highway. Skardu can also be accessed from Astor valley via Deosai plateau. All districts of the Skardu division (Map1.) are connected by metaled roads, however, much of the area could only be accessed by foot tracks and off-roads due to its topography.

5. PREVIOUS WORK

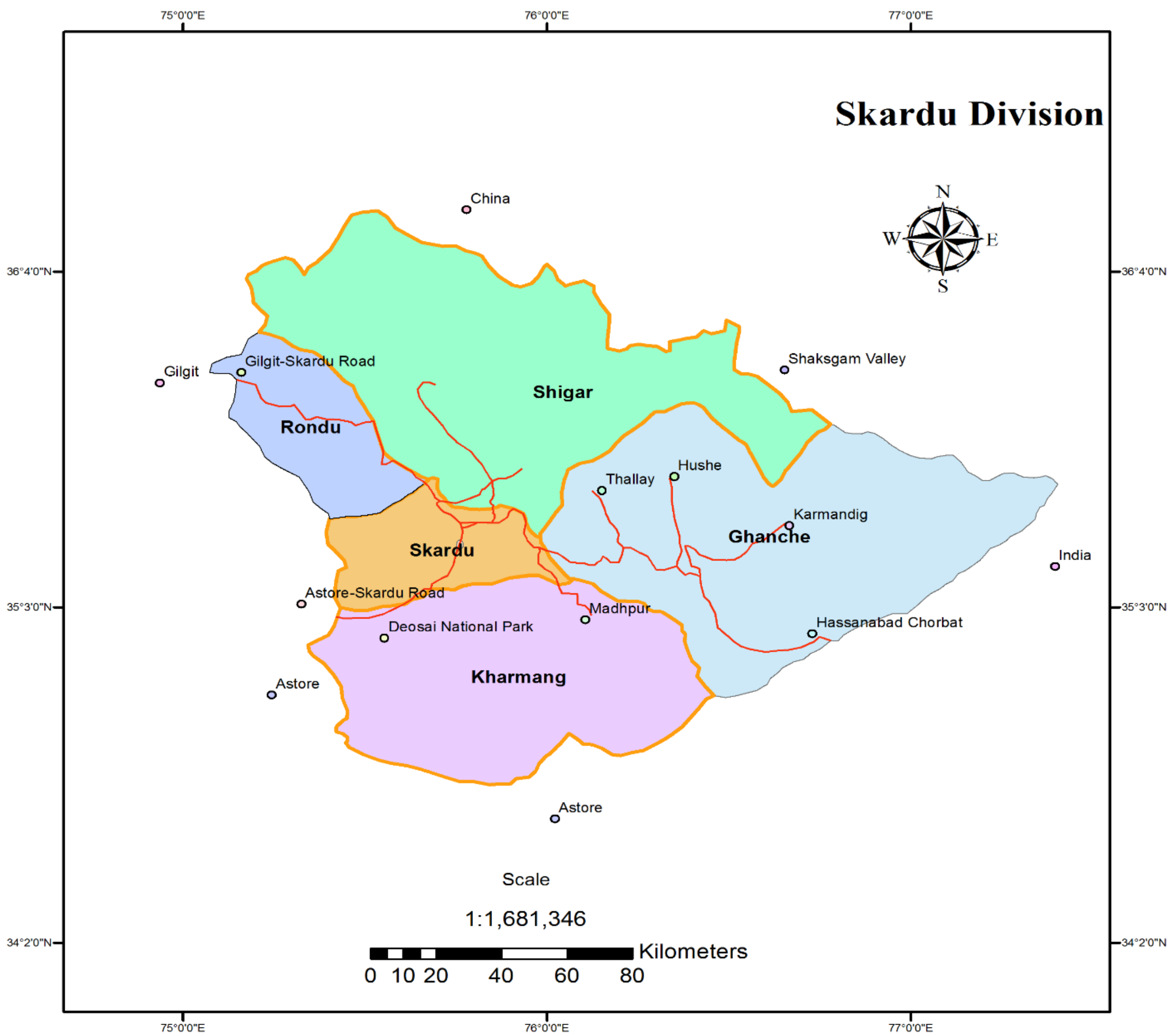
The mineral map of Pakistan (Haider et al., 2018) provides fundamental information about the minerals of the area. (Shah and Khan, 1999) mapped and give geochemistry of the sulphide Mineralization zones of the Skardu and Shigar districts. (Khan et al. 1999), (Shah and Khan, 1999) mapped the quadrangles (43M/15, 43M/16) respectively. This data served the purpose of literature review.

6. GEOLOGY OF THE AREA

6.1 Deosai Volcanics

The name has been assigned to the volcanics and volcano-sediments exposed in the Deosai Plateau by (Tahirkheli, 1982) and are considered to be equivalent to Utror Volcanics of Dir and Swat.

These volcanics are locally mineralized having pyrite cubes, chalcopyrite grains and specks, malachite staining, and manganese dendrites. The mineralization occurs in the form of disseminated grains within the volcanics along the cracks (Shah and Khan, 1999).



Map 1. Location and traverse map of the project area

6.2 Burji La Formation

Desio (1964) named the Burji formation (Burji La formation) for a low-grade metasedimentary unit southeast of Skardu. According to him the formation is composed of green shale, grey-green arenaceous quartz sericite-slate and black calcareous graphitic shales; some beds of grey and white calcareous Schist, crystalline limestone and calcareous conglomerate. Amphibole porphyry and quartz porphyry are also reported in the formation. He found some fossils from the limestone beds of the unit including Pseudomesalia regularis, and Itruvia canaliculata which suggest a late cretaceous age of the unit.

6.3 Katzarah Formation

As described by (Hanson and Shah 2009) the Katzarah Formation, Tsordas Gneiss, Skoyo Gneiss and the Askole Amphibolite of Desio 1964 lithologically belong to the same formation but are exposed at different places and are part of the Katzarah Formation. The formation is composed of metasediments of dark brownish grey in color and are generally hard and resistant. The primary minerals are calcic plagioclase, quartz, and biotite; calc-silicate minerals such as epidote and grossular are common, and aluminous minerals such as muscovite and sillimanite are locally abundant. Fairly clean beds of limestone occur towards the northeast side of the formation. The sediments of the formation are probably derived from argillaceous carbonates and calcareous shale. The age of the formation is considered from Cretaceous to Eocene (shah 2009).

6.4 Yasin Group

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

The rocks of the Yasin Group consist of marble, massive dolomitic limestone, carbonaceous limestone, quartzite, carbonaceous schists and maroon shales. Main Karakoram Thrust (MKT) marks the upper boundary of this group (Shah, S.H., 7 Khan, N.A., 1999).

6.5 Kohistan Batholith

The Kohistan batholith comprises multiphase plutons of calc-alkaline composition, which intrude the Gilgit Formation, Chalt Volcanic group, the rocks of the Thelichi Formation, Chilas complex, and Shamran Volcanic Group. It records some 70 Ma of magmatism from about 102 to 29 Ma (Petterson and Windley, 1991).

Petterson and Windley (1985) suggested that the batholith developed in two environments; the early plutons formed in an island arc set up, whereas much of the batholith was emplaced in an Andean-type continental margin when the arc was juxtaposed to the Karakoram plate after closure along the Shayok Suture or MKT. It is to be noted that much of the Kohistan Batholith appears to be a product of mantle wedge above the subduction zone but certain plutons are alkaline in nature and contain a higher amount of K_2O over Na_2O. Blasi et al. (1980) proposed extensional environments for the evolution of such alkaline rocks of the batholith. The dykes of the Kohistan Batholith were formed after the closure of the northern suture (Petterson and Windley, 1985; Treloar et al., 1989).

6.6 Shigar Volcanics

The Greenstone complex of Ivanac et al. (1956) has been named as the Shigar Volcanics in the Baltistan because of their maximum exposure in the Shigar Valley. Shigar Volcanics consist of very diverse characteristics and mostly metamorphosed and having abundance of green epidote and chlorite. The meta-sediments viz. limestone, marble, phyllite, schist and paragneiss are intruded by mostly interlayered meta-volcanics viz. andesite, dacite, dolerite, basalt, trachyte and lamprophyre. These metasediments and metavolcanics were later on intruded by the plutonics of varied composition. These rocks were laid down in the mid oceanic ridges during sea floor spreading (Shah, S.H., 7 Khan, N.A., 1999).

6.7 Karakoram Metamorphic Complex

Desio (1964) grouped all the metamorphic units lying south of the central batholith (Karakoram Batholith) as Karakoram Metamorphic Complex. The unit is composed of metasedimentary rocks, para-gneisses and marble. The unit is intruded by various zoned and complex pegmatites. The Darkot group in the Yasin Valley and the Baltit Group in Hunza are stratigraphic equivalent of the Karakoram Metamorphic Complex. The age of the complex is considered as Permian.

6.8 Karakoram Batholith

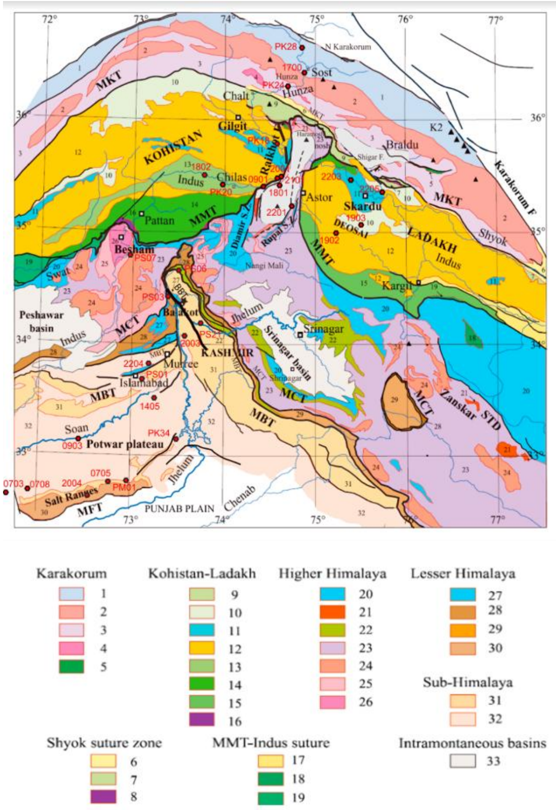
Many magmatic bodies have a hybrid isotopic signature suggesting that somewhere during genesis, transport and emplacement, magmas assimilated other rocks or mixed with other magmas. Where and how hybridization takes place is seldom documented. Here, we investigate a magmatic system in the Eastern Karakoram, Ladakh, NW India, comprising an anatectic zone, and a network of sheets, stocks and plutons exposed in the Pangong Metamorphic Complex within the Karakoram Shear Zone, as well as the Karakoram Batholith. These granitic rocks have an isotopic signature indicative of a mixture between mantle and crustal sources. In the anatectic region, calc-alkaline granitoids and their meta-sedimentary country rocks underwent water-fluxed partial melting at upper amphibolite facies between 20 and 14 Ma ago. Anatexis gave rise to leucosomes and intrusive rocks that have a range in composition from leuco-tonalite to leuco-granite. Those related to the partial melting of calc-alkaline rocks contain hornblende, whereas those related to Bt–psammites contain two micas± garnet. Leucosomes rooting in different source rocks merge with each other and homogenize as they link up to form a hierarchy of magma channels, feeding into stocks, plutons and ultimately into the Karakoram Batholith. The voluminous leucogranites of the Miocene Karakoram Batholith result from water-fluxed intra-crustal melting of sources with crustal and mantle signatures, and that mixing occurred within the source. (H. Richardt et al., 2010).

6.9 Nanga Parbat Gneiss

The name Nanga gneiss is proposed by P. Misch for a series of complex and injected gneisses that make up the Nanga Parbat Haramosh Massif. The unit includes biotite gneiss, injected schistose gneiss with augen gneiss, marble, greenstone, quartzite, phyllite and other rocks. The rocks of the units are considered basement rocks of the Indian plate and the age of the formation is Pre-Cambrian. Geological map of the area has been given in Map 2.

7. SATPARA SULPHID ZONE I

The sulphide mineralization zone lies at the confluence of Shikar nala and Satpara lungma at (35° 07′ 25′′ N, 75° 35′ 37′′ E). The zone is oxidized and altered. Structurally it lies at the contact of calcareous metasediments of Burji La formation and the Deosai volcanics. The contact is highly sheared and faulted. The sulphide minerals include pyrite, galena, sphalerite, chalcopyrite, and silver. Eleven (11) samples were collected from this zone and ten (10) samples were tested in Geosciences Advance Research Laboratory (GARL), Geological Survey of Pakistan Islamabad. Test results have been given in Table 01. The epithermal origin of the sulphide mineralization zone is probable owing to its local formation along the highly sheared zone. The occurrence of diorite intrusions in the vicinity of the zone further strengthens this view. Field photograph and google earth image of this Sulphide zone can be seen in Figure 1 and 2. Geological map of the Satpara Sulphide Zone is prepared and incorporated as Map 3.



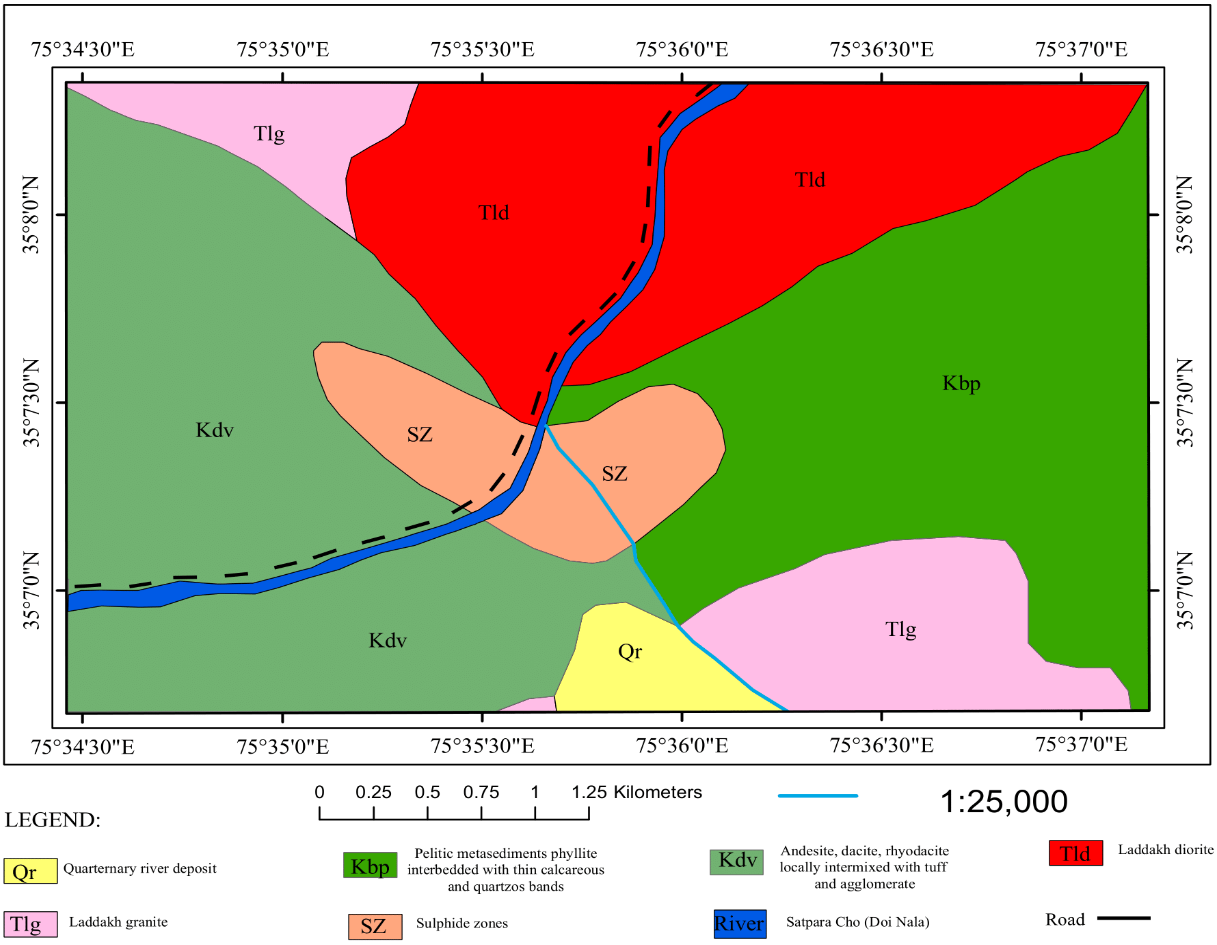
Map 2. Geological Map of the Northwestern Himalayas, modified from Pecher et al., (2008)

Table 01. Test Results of Samples from Satpara Sulphide Zone I

Sample ID	Au (ppm)	Cu (%)	Ag (ppm)	Zn (ppm)	Ni (ppm)	Pb (ppm)	Fe2O3 (%)
J-315 (SD-1)	**BDL**	**0.35**	**9.1**	**37**	**19**	**82**	**34.2**
J-316 (SD-2)	**BDL**	**0.076**	**10.7**	**24**	**3**	**4**	**29.6**
J-317 (SD-3)	**BDL**	**0.52**	**7.5**	**59**	**23**	**BDL**	**NR**
J-318 (SD-4)	**BDL**	**0.59**	**11.2**	**63**	**29**	**BDL**	**51.4**
J-320 (SD-6)	**BDL**	**0.085**	**8.25**	**76**	**15**	**28**	**18.3**
J-321 (SD-7)	**BDL**	**0.375**	**7.25**	**29**	**18**	**BDL**	**25.3**
J-322 (SD-8)	**BDL**	**0.435**	**9**	**52**	**25**	**262**	**12.9**
J-323 (SD-9)	**BDL**	**NR**	**NR**	**NR**	**NR**	**NR**	**72.1**
J-324 (SD-10)	**BDL**	**0.1135**	**13.2**	**27**	**4.2**	**9**	**23.6**
J-325 (SD-11)	**BDL**	**0.597**	**11.2**	**32**	**29**	**24**	**NR**
Ranges	**6**	**1**	**0.1**	**50**	**25**	**10**	

Figure 1. Outcrop level field photograph of the mineralized Zone

Figure 2. Outcrop photo of the sulphide zone



Map 3. Geological Map of the Satpara Sulphide Zone I (Modified after Shah and Khan; 1999).

7.1 Analysis

The provided table details the test results for ten samples (J-315 to J-325) from the Satpara Sulphide Zone. The samples showing variable concentrations of base and precious metals, as well as iron oxide. Gold (Au) is consistently below the detection limit (BDL) in all samples. Copper (Cu) concentrations range widely from a low of 0.076% in sample J-316 to a high of 0.597% in J-325. Silver (Ag) concentrations are also notable, peaking at 13.2 ppm in J-324. Zinc (Zn) and Nickel (Ni) show moderate concentrations, with Zn reaching 76 ppm in J-320 and Ni reaching 29 ppm in samples J-318 and J-325. Lead (Pb) exhibits a significant anomaly in sample J-322 (262 ppm), while it is BDL in several other samples (J-317, J-318, J-321). Iron oxide (Fe_2O_3) content is highly variable, from 12.9% to 72.1%, with several values not recorded (NR).

Geochemically, the presence of various elements like Cu, Ag, Zn, Ni, and Pb suggests a complex mineral system, likely involving a suite of sulfide minerals. The high Fe_2O_3 content indicates significant iron mineralization, possibly as iron oxides (e.g., hematite, magnetite) or as part of the primary sulfide minerals themselves (e.g., pyrite, chalcopyrite). The variable concentrations and specific elemental associations (e.g., the high Pb in J-322) point towards different styles of mineralization or varying degrees of hydrothermal alteration and weathering across the zone. The "Ranges" provided at the bottom of the table represent background or threshold values for the area. The mineralogy of the zone involves primary sulfide minerals such as chalcopyrite ($CuFeS_2$), sphalerite (ZnS), galena (PbS), and potentially pyrite (FeS_2) or pyrrhotite (FeS), which can host trace elements

8. SATPARA SULPHIDE ZONE II

The mineralization zone lies near the Satpara village in Satpara valley on left bank of the Satpara lake (Fig 3) (35° 11′ 22′′ N, 75° 36′ 44′′ E). The zone is oxidized and altered. The minerals include pyrite and chalcopyrite. Geological map of the zone is prepared on 1:75,000 and given as Map 4.

9. MINERALIZATION ZONE III

This mineralization zone lies near the bridge at Shigar River in Skardu Valley on the right bank of River (35° 23′ 44′′ N, 75° 41′ 46′′ E) The zone is oxidized and altered. Four (04) samples collected for Titanium from this zone for further analysis. Geological map of the zone is prepared and given in Map 5.

10. INDUSTRIAL EVALUATION OF ECONOMIC DEPOSITS

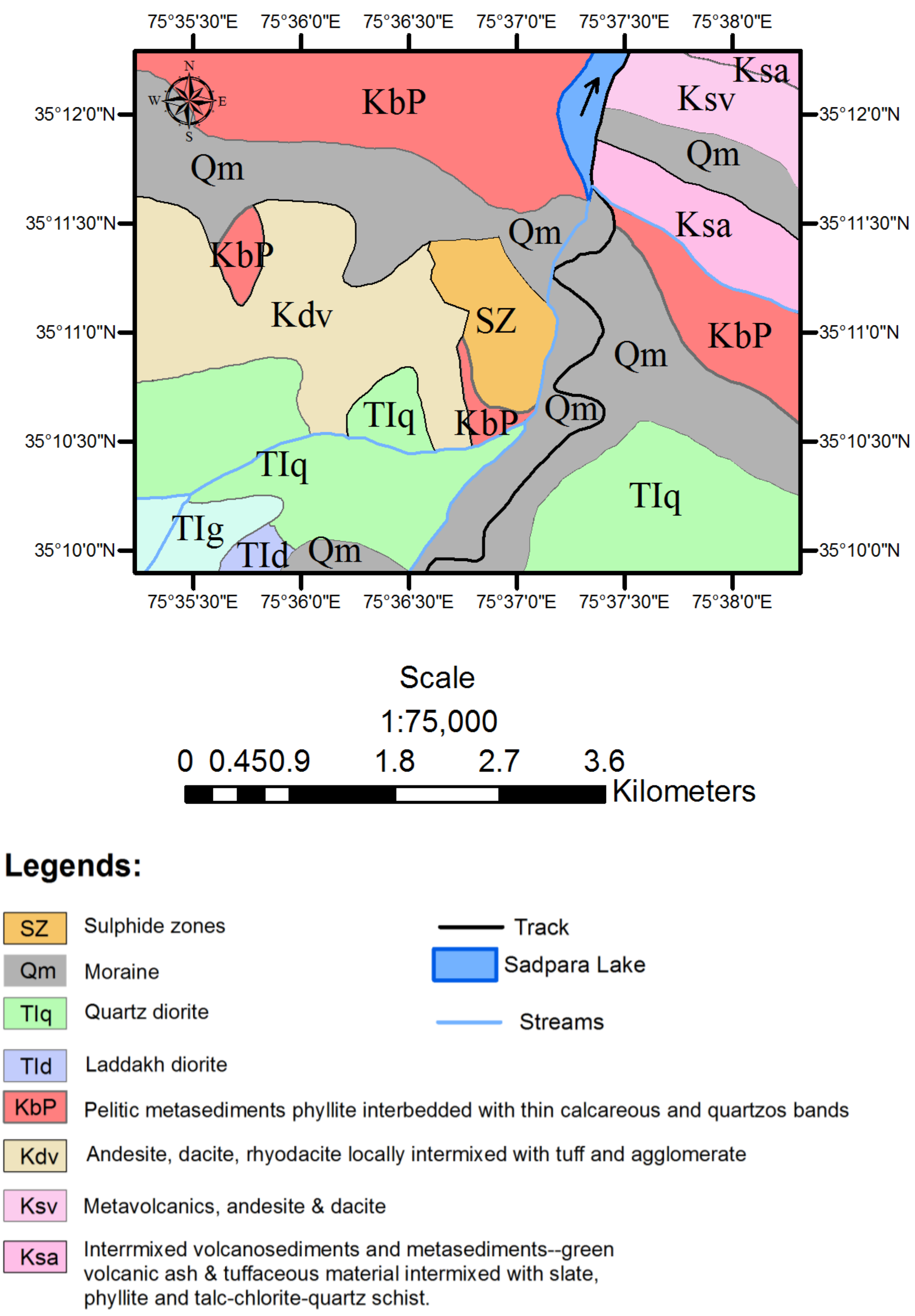
Sulphide mineralization give birth to the economic minerals used for the industrial purposes or otherwise i.e. copper, gold, nickel, zinc, Silver, cobalt, iron coupled with others. The sulfide minerals are major source of world supplies of a very wide range of metals and are the most important group of ore minerals (David J. Vaughan, 2021).

10.1 Antimony

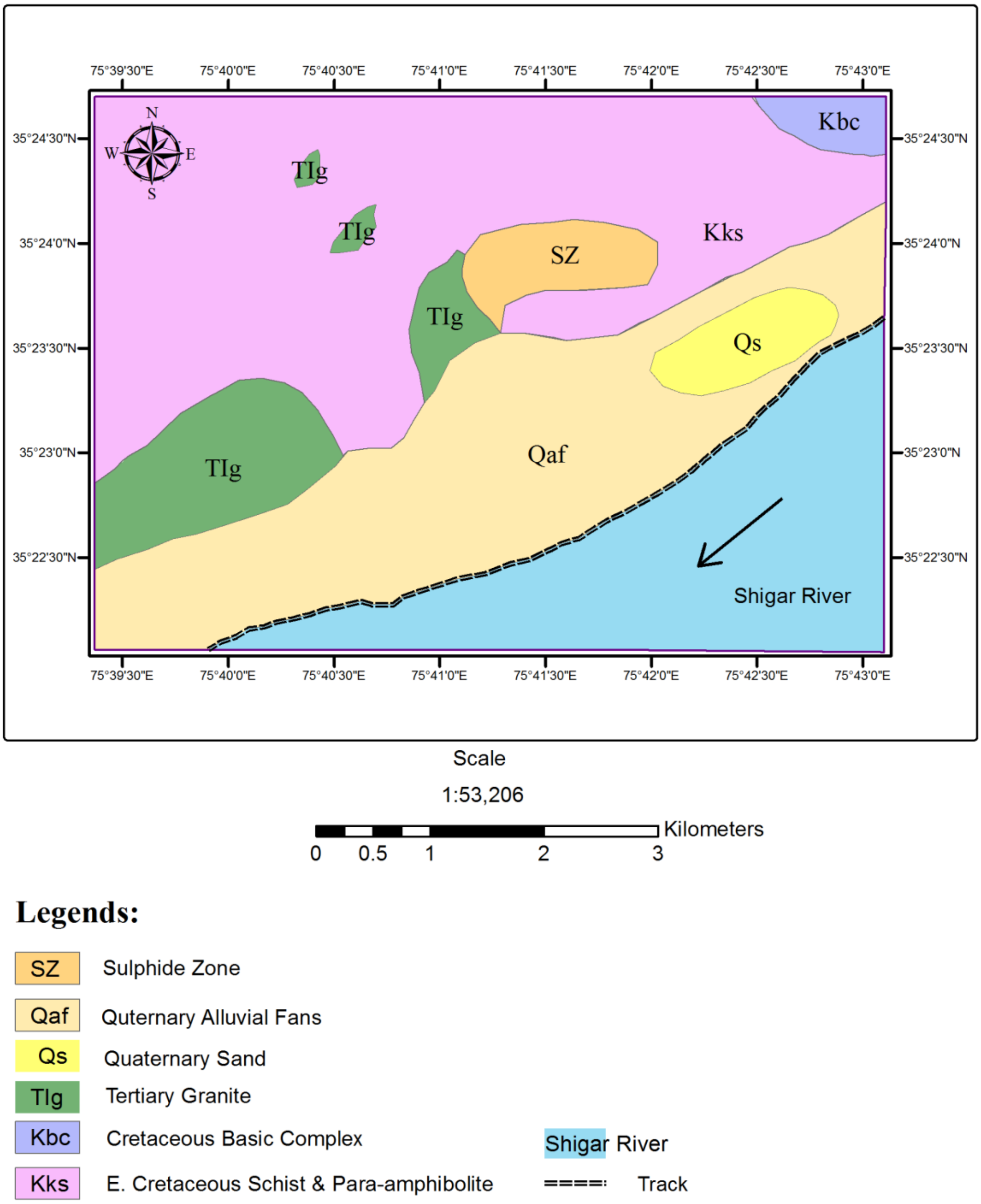
Antimony is a semi-metal element that its chemical properties run parallel to the lead, bismuth and arsenic. On industrial scale antimony is not known as case in the Gilgit-Baltistan, Skardu Division. A location situated in the Stak-Nala, Gilgit-Baltistan, antimony was reported by the locals. Sample collection was not possible at the time due to site accessibility issues.

10.1.1 Industrial Evaluation

Antimony also is used as an alloy that ameliorate the strength and hardness of lead and also for the semiconductors, diodes, infrared detectors, batteries and bullets. Whereas antimony compounds are used in paint pigments, enamels, glass and pottery.



Map 4. Geological map of the Satpara Mineralized Zone II (Modified after Shah and Khan; 1999).



Map 5. Geological map of the Mineralization Zone III (Modified after Shah and Khan 2000).

11. Serpentine Deposits

Serpentine is a large group of minerals that fit the generalized formula: (X) 2-3(Y) 2O5 (OH) 4. In this formula, X will be one of the following metals: magnesium, iron, nickel, aluminum, zinc, or manganese; and, Y will be silicon, aluminum, or iron. The appropriate generalized formula is thus (Mg,Fe,Ni,Mn,Zn)23(Si,Al,Fe)2O5(OH)4. The primary serpentine minerals are chrysotile, antigorite, and lizardite. Serpentine minerals form by the hydrothermal metamorphism of peridotite, dunite, and other ultramafic rocks. Ultramafic rocks are rare at Earth's surface but are abundant at the oceanic Moho, the boundary between the base of the oceanic crust and the upper mantle. They are metamorphosed at convergent plate boundaries where an oceanic plate is pushed down into the mantle. This is where they are subjected to hydrothermal metamorphism. The source of water for this process is seawater entrained in the rocks and sediments of the oceanic slab. During hydrothermal metamorphism, olivine and pyroxene minerals are transformed into or are replaced by serpentine minerals. Some of the metamorphic rocks produced here are composed almost entirely of serpentine minerals. These serpentine-rich rocks are known as "serpentinites." Extensive areas of Earth's surface are underlain by serpentinites. These areas occur near present or ancient convergent plate boundaries. They are locations where remnants of an oceanic plate are exposed at the surface. The remnant portion of the plate was either thrusted up onto land, accreted onto the edge of a land mass, or exposed by uplift and deep weathering.

These areas of exposed oceanic plate are known as ophiolites. They are often the source of valuable minerals that might include magnetite, chromite, chrysoprase, jade, and serpentine.

11.1. Industrial Evaluation

Serpentine has been used as an architectural stone for thousands of years. It is available in a wide variety of green and greenish colors, often has an attractive pattern, works easily, and polishes to a nice luster. It has a Mohs hardness of 3 to 6 which is softer than granite, and usually harder than most marble. This low hardness limits its appropriate use to surfaces that will receive abrasion or wear, such as facing stone, wall tiles, mantles, and window sills.

In the dimension stone trade, serpentine is often sold as "marble." It might also be described as “serpentine marble" or given a trade name that does not include the word "serpentine." This is a tradition of the industry and is usually not a misidentification of the material. This practice severely irritates some geologists.

Attractive serpentine can be cut into a wide variety of gemstones. Gemstone-quality serpentine is easy to polish, and beautiful finishes are possible. However, it usually polishes to a waxy luster. It is most often cut into cabochons and beads. They usually display a range of green, yellow, and black colors and often have magnetite, chromite, or other minerals as interesting inclusions. Some specimens of serpentine have a wonderful green color, clarity, and translucence. Some varieties of serpentine can be carved into beautiful stone sculptures. Fine-grained, translucent material with a uniform texture and without voids and fractures is preferred. Serpentine is relatively soft and carves easily. It also accepts a nice polish.

Serpentine sculptures range in size from under one centimeter to several meters in height. Bowls, vases, desk sets, clock bases, animals, fruit, flowers, legendary figures, deities, busts, and statues are all common objects made by artists working with serpentine. A small workshop is found in Shiger, where locals cutting Serpentine into different ornamentation objects such as flowers and desk sets. They are also using it as a powder medicine for different diseases, which can prove hazardous for health due to its Asbestos content.

Serpentinite rock units have been considered as repositories for the disposal of waste carbon dioxide produced when fossil fuels are burned. Injecting carbon dioxide into subsurface rock units in the presence of water can produce magnesium carbonate and quartz in an exothermic reaction similar to the one shown below.

$$Mg3Si2O5\ (OH)\ 4 + 3CO2 + H2O \dashrightarrow 3MgCO3 + 2SiO2 + 3H2O$$

Numerous studies and small-scale tests of geological sequestration of CO2 have produced promising results, but the procedure has not been placed into commercial practice.

Some varieties of serpentine have a fibrous habit. These fibers resist the transfer of heat, do not burn, and serve as excellent insulators. The serpentine mineral chrysotile is common, found in many parts of the world, is easily mined, and can be processed to recover the heat-resistant fibers. The use of chrysotile and other serpentine minerals with an asbestiform habit as insulators has been widespread. They were widely available, effective in their applications and inexpensive to produce. By the middle of the 20th century, they could be found in most buildings and vehicles. They were used to make wall and ceiling tiles, flooring, shingles, facing material, pipe insulation, stoves, paints, and many other common construction materials and appliances.

After they were discovered to be connected to lung and other cancers, their use was mostly discontinued, and a campaign to remove them from many of their uses began. Removal programs have been ongoing for decades and are still being done today. It has been one of the costliest removal programs in history.

12. GOLD

The occurrence of gold in sands of Indus River and its tributaries in the Karakoram and Himalayas is well known. Samples have been collected for further analysis from the granitoids of Karakoram Batholith in Hushe valley and Kundus Nala, quartz veins of hydrothermal altered zones near Machlu village, and Volcanics of Shyok suture zone (Fig 3).

12.1. Industrial Evaluation

Gold has been used for centuries for jewelry, decoration, standard for monetary systems in many countries, chemical industry, electronics, alloy, dentistry, medicine and in aerospace to avoid from infrared rays inside the spaceship. With reference to the available tests result table no. 1, there is no chances of gold on industrial level.

Figure 3 Hydrothermal Alteration Zone near Machlu village.

13. TOURMALINE

A variety of gemstones is being mined in the Shigar valley, Skardu, Pakistan. These include beryl (goshenite and aquamarine), and few nice crystals of tourmaline were found near the shyok suture zone (MKT), Dassu area. Field photographs of the embedded crystals of Tourmaline could be seen in Fig 4. Garnet (almandine–spessartine), apatite, topaz, fluorite, zoisite, clinozoisite, and axinite, mostly occurring in complex or zoned pegmatites and metamorphic rocks. These have been analyzed using electron probe micro-analyzer and X-ray diffractometer. The mineral chemistry of each gemstone is similar to its respective typical gemstone variety with homogenous chemical composition. Field and chemical characteristics suggest that beryl, tourmaline, garnet, apatite, topaz, and Fluorite are occurring in zoned pegmatites which are largely formed by magmatic hydrothermal fluids in the cavities and vugs within the intermediate zone. However, zoisite, clinozoisite, and axinite may have a metamorphic and/or metasomatic origin.

13.2. Industrial Evaluation

In the recent era, gemstones are mainly used for ornamental, spiritual practices to restore energy fields, gain peace, and promote love and safety. In the study area we found jade (Machlo, Skardu) and tourmaline in the Shigar valley.

Figure 4. Tourmaline crystals embedded in granitic rock, found in Shighar Valley along Northern Suture (MKT)

14. MARBLE OF SHIGAR VALLEY

Marble is a non-foliated metamorphic rock consisting of course crystals primarily from limestone and dolomite. Marble is capable of taking a polish (Mousa Bani Baker, 2017). It is well known rock being used for flooring worldwide.It is being used in the form of shaped tiles and also in random cuttings.

Marble powder can be used as filler in concrete and paving material and helps to reduce the total void content in the concrete. Marble powder can also be used as an admixture in concrete so that the strength of the concrete can be enhanced. We can reduce the environmental pollution by utilizing this marble powder for producing the other products. Marble dust is mixed with concrete, cement or synthetic resins to make counters, building stones, sculptures floors and many other objects (Raju K and Johny B,2016).

14.1. Industrial Evaluation

Various parameters are used for the industrial evaluation of marble i.e. uniaxial compressive strength (UCS), Schmidt hammer rebound number (N), slake durability, moisture content, and specific Gravity tests has been developed for a particular limestone and marble deposit (Nadeem Abbas et. al., 2019).

The strength of the marble being mined from Shigar Valley is not impressive for floor use because of its sugary texture. Field photographs of marble of Shigar Valley are given in Figures 6 and 7.

15. CONCLUSION

The Skardu Division in Gilgit-Baltistan exhibits significant potential for economic mineralization due to its unique geological and tectonic setting, marked by the interaction of the Indian Plate, Kohistan-Ladakh Island Arc, and Eurasian Plate. The study focused on spot sampling and industrial evaluation of antimony, copper, gold, and other economic minerals, with a special emphasis on the Satpara Sulphide Zone.

Field investigations and geochemical analyses revealed promising occurrences of sulfide minerals, including pyrite, chalcopyrite, sphalerite, and galena, along with notable concentrations of copper, silver, zinc, nickel, and lead. The mineralization is structurally controlled, with evidence pointing to hydrothermal activity and an epithermal origin. The presence of diorite intrusions further supports this interpretation. While gold was found to be below detection levels in the tested samples, other minerals such as antimony, serpentine, and marble show potential for industrial applications, including construction, jewellery, and manufacturing.

The study highlights the need for further exploration and resource evaluation to fully understand the economic potential of the region. The findings provide a foundation for future research and development, which could contribute significantly to the economic development of the region.

Figure 6. Marble being mined from Quarry at Shigar Valley

Figure 7. Sugary texture of the marble is visible in the photograph.

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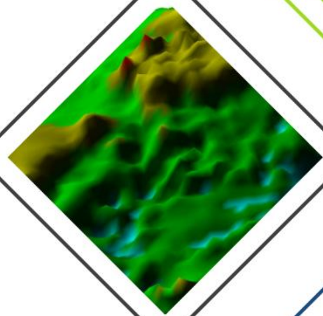

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