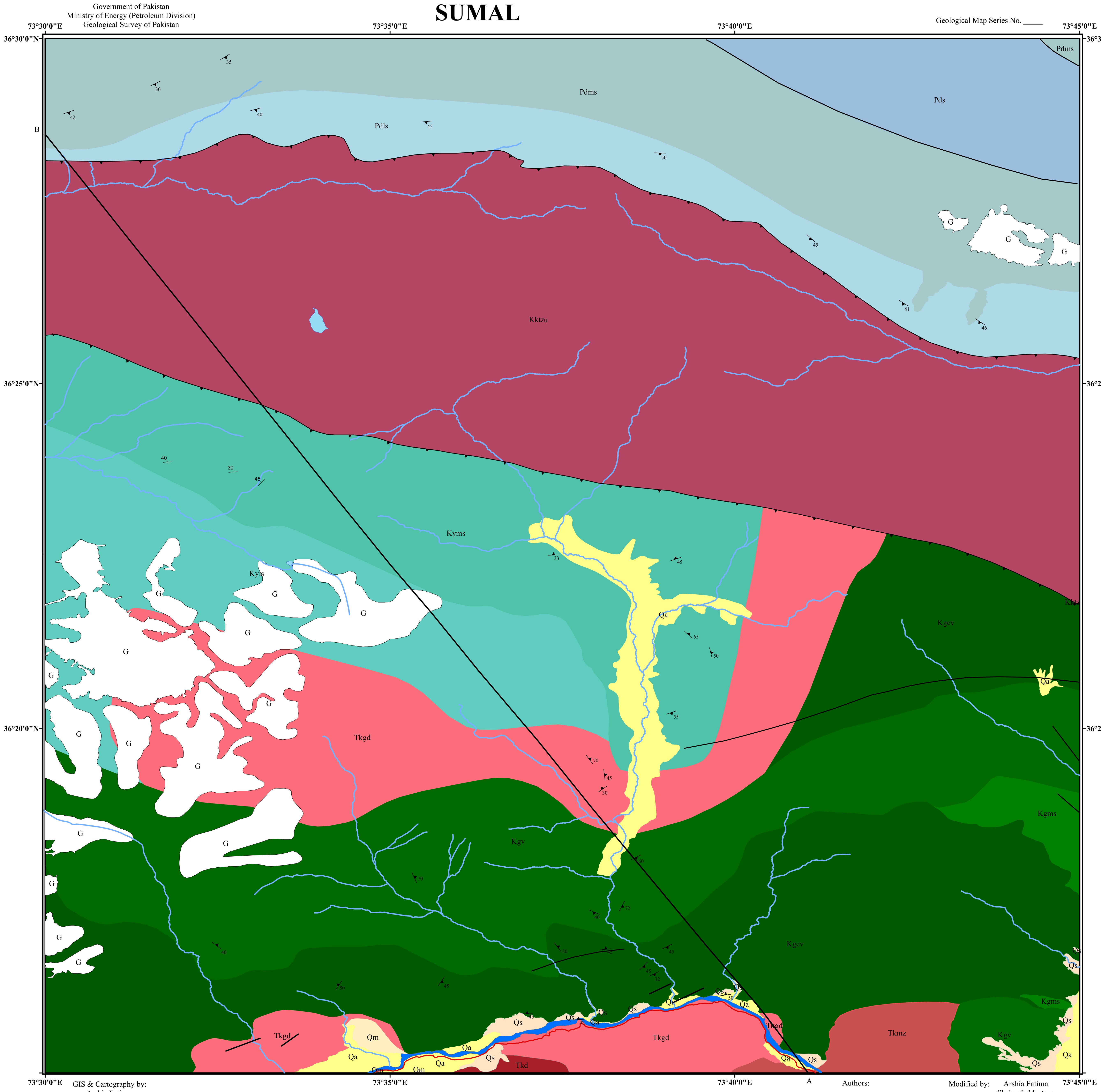
Government of Pakistan
Ministry of Energy (Petroleum Division)
Geological Survey of Pakistan

SUMAL

Geological Map Series No. ______



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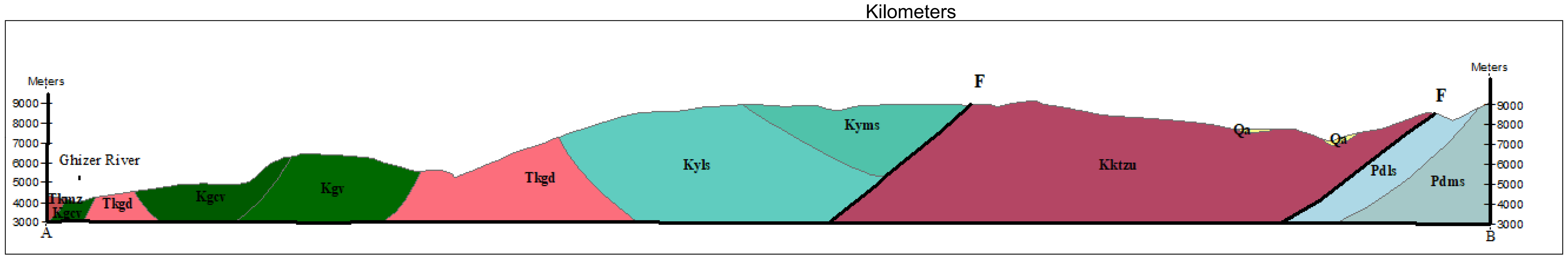
Issued by Director General, Geological Survey of Pakistan

Scale 1:50,000

0 1 2 4 6 8 10
Kilometers



CROSS SECTION A-B

Legend

Cenozoic	Quaternary	Holocene Recent		Qa	Alluvial deposits
		Recent		Qs	Scree
		Sub Recent		Qm	Moraine
Mesozoic	Cretaceous to Tertiary		Kohistan Batholith	Tkd	Diorite
				Tkgd	Granodiorite associated with granite and volcanics along with pods of pyroxenite.
				Tkmz	Mixed zone comprising diorite and metasediments
	Early to Late Cretaceous		Yasin Group	Kyms	Phyllite, slate, quartzite, argillcaeous limestone associated with metasediments.
				Kyls	Limestone, semicrystalline limestone, dolomitic limestone, quartzite associated with metavolcanics
			Main Karakoram Thrust Zone/Ishkuman Sheared Zone	Kktzu	Mylonite, green schist, andesite (greenstone), ultramafics, serpentine, talc carbonate with minor slate and phyllite.
			Greenstone Complex	Kgv	Meta-volcanics-andesite (greenstone), ultramafics, serpentine, talc carbonate with minor slate and phyllite.
				Kgcv	Meta-sediments and meta-volcanics
				Kgms	Marble
Paleozoic	Late Carboniferous to Permian		Darkot Group	Pdms	Slate with minor quartzite, phyllite associated with meta-volcanics
				Pds	Meta-sediments including quartzite, andalusite bearing hornfels slate, phyllite and argillaceous limestone
				Pdls	Semicrystalline dolomitic limestone with minor quartzite

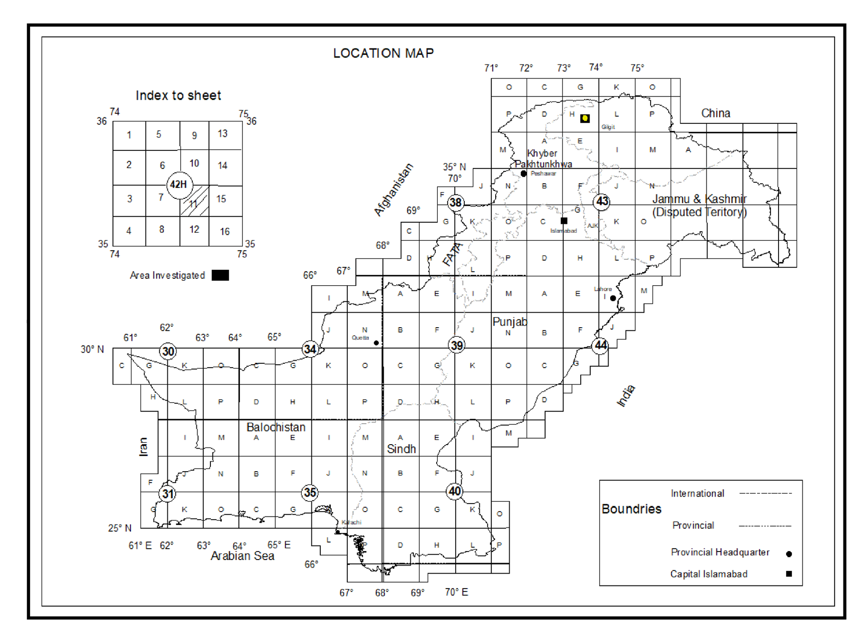
Geological Symbols

- Dip_Strike
- Foliation
- Faults
- Thrust Fault
- Basic_Dykes
- Nalas
- Syncline
- Anticline

Topographic Symbols

- Ghizer River
- Nalas
- Metalled Road Gilgt to Chitral
- Lake
- Glaciers
- Locations
- Cross Section Line

S. NO.	SAMPLE NO.	AREA	LAT.	LONG.	Ni (ppm)	Cr (%)	Sb (%)	Cu (ppm)	Co (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)
1	SMMA 4	SUMAL	36 23 14	73 37 07	-	-	-	96.8	N/D	58.09	35.37	N/D
2	SMMA 5		36 23 14	73 37 07	-	-	-	41.78	N/D	1.93	33.32	N/D
3	SMMA 6		36 23 09	73 37 05	-	-	-	41.03	N/D	27.18	8.5	N/D
4	SMMA 7		36 23 36	73 36 11	0.06	0.08	0.03	58.58	N/D	5.71	6.55	N/D
5	SMMA 8		36 23 36	73 36 11	0.04	0.06	0.01	28.42	N/D	670.65	BDL	N/D
6	SMMA 9		36 23 37	73 36 10	0.02	0.04	0.01	53.74	N/D	BDL	1.8	N/D
7	SMMA 10		36 23 37	73 36 10	0.02	0.07	0.05	50.63	N/D	BDL	3.37	N/D
8	SMMA 26		36 17 29	73 37 58	BDL	-	0.03	64.09	N/D	N/D	N/D	N/D



EXPLANATORY NOTES

The study area (Survey Of Pakistan topographic sheet NO. 42-H /11), covering Sumal and surrounding areas in the Ghizar district, is located at a distance of 80 km northwest of Gilgit, a capital city of Gilgit-Baltistan, Pakistan. The project area is accessed from Islamabad, capital of Pakistan through Karakoram highway. The climatic conditions in this region are very extreme and the hottest months are June and July in which the temperature reaches up to 30^0C and in winter the temperature reaches up to -20^0C. It is a region of high altitude terrain with very steep slopes. The relief of this terrain is extremely high.

It lies in the north-western part of the Kohistan Island Arc adjacent to the Ishkuman Sheared Zone or Main Karakoram Thrust Zone, a major thrust separating the Kohistan Island Arc from Karakoram plate. The stratigraphic sequence is mainly composed of the rocks of Darkot Group, Greenstone Complex, Main Karakoram Thrust Zone (i.e. ophiolitic melanges), Yasin Group, and Kohistan Batholith (i.e. batholithic plutons). Each of these units is described separately in the following text, explaining the nomenclature used.

Darkot Group

The Darkot Group is the name given to the sediments and metamorphics of Upper Palaeozoic rocks which outcrop between Darkot village and Darkot Pass. In this section, slates, limestones, quartzites and garnet-mica schists comprise the group- The slightly more metamorphosed section of the Darkot Group, south of the Karakoram Granodiorite in the Yasin valley was examined by Hayden (1914).

The Darkot Group contains the oldest rocks of the region, although, it is generally found overlying the younger. The marked variation in the lithology of the Darkot Group is largely the result of varying metamorphic effects. A gradual increase in regional metamorphism has been traced from west to east. In the north western portion near Yasin valley the sediments of the Darkot Group are only low grade metamorphics such as slates. The limestones present have not been converted to marbles. In the north-eastern portion surrounding Ishkuman valley regional metamorphism is higher, and slates and some marbles are found, whereas, north of the batholith, the Darkot Group rocks are not highly metamorphosed. The rock types are similar to those of the type section, but the sequence is broken by a complex system of faults. Slates and limestones are the main rock types of the area with interbedded quartzites near Khaibar. The contact between the batholith and slates is sharp and the intrusive nature of the granodiorite is revealed only by small veins which intrude a few yards into the slates. The age of the Darkot Group may be given as Permian with the possibility of the lower beds extending into the Carboniferous.

Greenstone Complex

An assemblage of lavas, tuffs, agglomerates, meta-gneisses, quartzite, limestones and calc-silicate rocks which crop out in an almost meridianally trending belt between Hanuchal and Hopar, and Roshan and Sor Laspur is as Greenstone

Complex. It includes the metamorphic succession in the south of Gilgit and many basic xenoliths in the Ladakh Granodiorite- This unit has been called a complex because there is no certainty of the continuity of volcanic activity 01 sedimentation. The field term "Greenstone" has been used as it describes the broader characteristics of the color and lithology of the Complex. In accordance with the code of nomenclature adopted this Complex should have been given a locality name but because of the variation in lithology and the lack of a suitable locality name, the term 'Greenstone" is used.

Main Karakoram Thrust Zone (MKTZ)/ Ishkuman Sheared Zone (1SZ)

The Main Karakoram Thrust Zone or ISZ is a faulted contact that separates the rocks of the Eurasian plate from that of the Kohistan Island Arc (KIA). This suture zone is formed as a result of the collision of KIA with the Eurasian plate. The ISZ is comprised of ophiolitic mélange, incorporating rocks like mylonite, greenschist, andesite (greenstone), ultramafics, serpentinite, volcanic and marine sediments (talc carbonate) with minor slate and phyllite. The different types of sedimentary and volcanic rocks present on the northern side of the KIA are separated from slates and quartzites of the Eurasian plate by this mélange. The rock bodies present along this 4krn thick mélange are limestone, quartzite, volcanic greenstone and altered rocks like serpentine in a slate matrix (Pudsey, 1986).

Yasin Group

The Yasin Group has two major divisions, one has sedimentary rocks with meta-volcanics, whereas, the second has metamorphic-metasedimentary rocks. First division represents the northern part of the KIA and they arc the youngest Tethyan remains comprised of mainly sedimentary and volcano-clastic rocks. It consists of volcanic suite of lavas, tuffs and agglomerates containing lenses and beds of fossiliferous, massive and shaley limestones of Cretaceous. The volcanic rocks are metamorphosed to greenschist facies due to the collision of two tectonic plates.

The second division of the Yasin Group comprises of slate, phyllite, silty quartzites and argillaceous Limestone associated with meta-volcanic. The limestone is highly fossiliferous and contains gastropods, lamellibranchs, corals and forams. The limestones were deposited as a littoral facies of the Cretaceous epicontinental basin during a period of volcanic activity which interrupted the deposition by ejections of tuffs, agglomerates and thin lava flows. The Yasin Group has been overfolded 'with the Darkot Group and now rests on the Greenstone Complex to the south and to the north, the relationship of this group with the Darkot Group appears to be disconformable.

Kohistan Batholith

The major component of the KIA is represented by Kohistan Batholith. The area covered by this series along E-W direction is 300km and along N-S direction is 60 km. Different rock bodies found in this batholith are granodiorite, diorite, hornblendite, hornblend gabbro, leucogranite and metasediments. The Kohistan Batholith is formed as a result of three stages of magmatic intrusions. The geochemistry of first stage is characterized by two magma types, the first

type of magma is represented by medium to high-potassium diorites, while the second is low-potassium trondhjemites. The stage two pluton within the KIA covers up to two-thirds of the batholith. The silica content varies from low to high in these rocks. Most of the rock samples within this group are from medium to high potassium in composition. The stage three pluton present within the KIA forms the minor part of the batholith which intruded after the formation of ISZ or MKTZ.

Alluvial, Scree and Glacial Deposits

Small unconsolidated deposits of alluvial, scree and glacial origin occur throughout the region. These irregular deposits have not been mapped or studied in detail. Remnants of high and low-level terraces exist along the valley sides and recent gravel and boulder beds occur along the rivers. Large alluvial screes, at their maximum angle of rest, have formed on the steeper slopes and now cover extensive areas. Numerous terminal, lateral and medial moraines and glacial deposits are found throughout the region, although, at the present time, glacial deposition is confined to the higher altitudes. These superficial deposits were formed at different times since the conclusion of the main folding movements.

Geological History

The oldest rocks examined were the limestones, slates, quartzites and other metamorphics of the Darkot Group of the Upper Palaeozoic. A few granite pebbles were found in the slates but the pebbles were well rounded and had travelled a great distance. No other signs of this older granite were seen. The Upper Palaeozoic sediments were laid down in the Tethys Sea which was extensive at that time. The sediments which are predominantly slates indicate deep-water conditions; they are generally unfossiliferous, although, one horizon of interbedded slates and limestones contain abundant marine fauna. Towards the end of deposition of the Darkot Group an indication is given of the great volcanic period to follow. Near Chalt, and north of Yasin, pillow lavas are found near the top of the sequence. The volcanic outburst increased in magnitude and gave rise to a great thickness of tuffs, agglomerates and lavas. At least part of the region was submerged during this time; this is shown by the presence of small lenses of limestones and quartzites in the volcanics, and pillow lavas. Neither the age nor closure of this volcanic cycle is known, but there was a period of erosion before Cretaceous deposition commenced.

In Lower Cretaceous time, a shallow arm of a larger epeiric sea entered the region. This sea transgressed the softer sediments of the Darkot Group and probably had its shoreline at the boundary of the Darkot Group and the Greenstone Complex, approximately east and west of Yasin, the massive resistant volcanics in the Greenstone Complex forming the land which bordered this transgression. A short period of volcanic activity gave rise to tuffs, agglomerates and thin lava flows which are now found inter-bedded with fossiliferous Lower Cretaceous limestones containing a rich littoral marine fauna. This volcanic action possibly marks the end phase of the great volcanic period which gave rise to the Greenstone Complex and is definitely related to the Cretaceous volcanicity which occurred further south in the Indian sub-continent.

At the close of the Cretaceous Period, or early in the Tertiary Period, began the great folding movements which produced the Himalayan Range of today. In this region, the sediments of the Cretaceous Yasin Group and the underlying sediments of the Darkot Group were overfolded upon the massive volcanics of the Greenstone Complex, and batholiths of granodiorite were introduced along the fold axes. It is not possible to determine the age of the folding and intrusion within the Tertiary Period because of the absence of fossiliferous sediments younger than Cretaceous, but Wadia (1939) and other investigators of Himalayan Geology agree that movements commenced late in the Eocene Epoch. The main folding is believed to have occurred in the Middle Miocene Epoch, and was followed by thrusting from the north in the Midd1e or the Upper Pliocene. Minor movements have continued in the Pleistocene and Recent times. These movements initiated the present cycle of erosion during which only superficial deposits have accumulated.

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GEOLOGICAL MAP OF THE SUMAL QUADRANGLE 42 H/11 GHIZAR DISTRICT GILGIT BALTISTAN PAKISTAN 2023