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THE GEOLOGY OF THE GANDGHAR RANGE, DISTT. HAZARA, N. W. F. P.

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ABSTRACT

The Gandghar Range is located on the western tip of the Hazara district, Due to its isolated position it could attract a few geologists during the past. In the Geological Map of Pakisan (1964), the Range is partly mapped as Precambrian and partly Silurian-Devonian.

The Gandghar Range exposes a suite of metasedimentary rocks, comprising of slate, phyllite, phyllitic-slate, schists, quartzite, and crystalline limestone. Five lithological units are differentiated which have been correlated with the Palaeozoic sequences of the southern Hazara and the Attock - Cherat Range. The oldest unit is the Mohat Nawan Limestone and the youngest is the Pirthan Limestone which are respectively homotaxial to the Shahkotbala Formation of the Attock - Cherat Range and the Sirban Formation of the Abbottabed Group in the southern Hazara. The former is placed in the Upper Ordovician - Lower Silurian and the latter in the Permo - Carboniferous.

INTRODUCTION

The Gandghar Range forms a prominent physiographic feature on the western tip of the Hazara district and isolates the Haripur plain from the Indus valley.

Hazara district, during the past, has received several visits of the geologists to decipher its most intricate but interesting geological history. The Gandghar Range, because of its isolated position, could attract a few of them, consequently very little published account on its geology is available.

This paper has been written to introduce the geology of the Gandghar Range under the light of new researches carried out in the adjacent areas in the southeastern Hazara and the Attock - Cherat Range, lying towards east and west respectively.

Previous Work.

The earliest mention of the Gandghar Range was made by Middlemiss (1896) while describing the marmorised and brecciated limestone associated with the Hazara Slate Series, showing peculiar stromato-poroidal structure. He considered the limestone as an integral part of the Hazara Slates. On the basis of characteristic features the limestone was correlated with the Kakarhatti limestone of Simla area.

Cotter (1934), while working in the Kala Chitta Hill in the Attock district, paid a visit to the southern tip of the Gandghar Range and especially described the Slate Series, which, he correlated with the pelites exposed around Attock.

After independence a team of geologists from the Geological Survey of Pakistan, headed by A. H. Khan, while working in Hazara, had extended geological mapping to the Gandghar Range (1949). The results of this investigation are lying as unpublished report in the Geological Survey of Pakistan. In his report A. H. Khan differentiated three major lithological units in the Gandghar Range, (*a*) the Hazara Slate Series, (*b*) the Infra-Triassic Limestone, and (*c*) the Tanol Quartzites, thus following the earlier classification of the Hazara rocks by Wynne (1873) and Middlemiss (1896). The team also paid a visit to the slates exposed in the vicinity of Attock and on the basis of similar lithological characteristics, correlated them with the Hazara slates of the Gandghar Range.

During 1952-56, a larger part of the outcrop exposed on both the sides of the Indus River, upstream of Ghazi village, was geologically mapped to select a suitable site for the construction of a dam. The author had participated in this project which resulted in preparation of large scale geological maps of the dam site and the reservoir area. During this investigation the western foothill of the Gandghar Range upstream of Ghazi was investigated and more attention was paid to differentiate various rock types and to record associated structures, thus very little was accomplished on stratigraphy.

In the Geological Map of Pakistan (1964) the eastern half of the Gandghar Range is mapped as Precambrian, whereas the western half is shown as Silurian - Devonian.

Physiographic Features.

The Gandghar Range spreads in an area of about 240 square miles; 30 miles long and on average 8 miles in width. It trends to northeast - southwest

direction which coincides with the strike of the rocks. Its southern end terminates in the Haro River alluvium and the northern extension is delimited by the Siron River.

The Gandghar Range is bounded by the Haripur plain on the east and the Indus valley on the west. The old Indus terraces on the western flank of the Range form narrow strip between Tarbela and Ghazi villages, for a distance of about 12 miles. Downstream of Ghazi the Indus valley gradually widens and near Ghurghushti plain stretches for over 10 miles across, between the Indus River and the western foothills of the Gandghar Range.

The Gandghar Range forms the main drainage-divide between the Haripur plain and the Indus valley. The eastern drainage is captured by Dor and Haro rivers through numerous seasonal khwars which ultimately carry the water to Indus.

The Gandghar Range varies in elevations from less than 1,500 feet near the extreme ends, the north and south, culminating to 4,401 feet above sea level at Pir Than which is located near the central part of the range. The other notable elevations are Kangar (4,168 feet), Chanarkot (3,936 feet), Bandi-di-Cho (3,470 feet), Dharchitti-di-Cho (3,368 feet), Sirikot (3,364 feet) and Dharchitti (3,368 feet). Most of these elevations are located in a radius of about 10 miles from Pir Than, which forms the commanding height.

The Gandghar Range is narrow on the top with relatively steeper eastern face. It supports thin and scattered vegetation except in a limited area around Pir Than where pine trees are grown. Due to dearth of water inhabitation is sporadic.

The foundation of the eastern abutment of the earth fill Tarbale Dam is located near Dal village, in a ridge, 1,743 feet above sea level, on the western foothill of the Gandghar Range.

STRATIGRAPHY

The Gandghar Range exposes a suite of metasedimentary rocks which have been correlated with the Palaeozoic sequences of Hazara and the Attock-Cherat Range. The rock formations are arranged in the following sequential order :

		App. Thickness
5.	Pir Than Limestone	+ 900 feet
4.	Tarpakhi Quartizite	+ 350 feet
3.	Baghdarra Limestone	+ 90 feet
2.	Sirikot Slates	+ 2500 feet
1.	Mohat Nawan Limestone	+ 140 feet

Mohat Nawan Limestone.

This limestone is exposed in three isolated sections; two located on the western fringe and another along the eastern foothill of the Gandghar Range. The type section of this limestone is exposed near Mohat Nawan village, located about half a mile upstream of Tarbela Dam axis, where it is developed in a hillock in about two square miles area. Another section exposing this limestone occurs about two miles northeast of Ghazi village on the northern side of Kundi Darra. Its major outcrop is, however, exposed on the eastern foothill of the Range near Sari in Haripur Plain which extends southward beyond Gadwalian village.

The Mohat Nawan Limestone is thin bedded, medium to finely crystalline. It is yellowish-brown, and light to dark grey, the former being more prevalent. The limestone is impure, containing clay, silica and magnesia as the main ingredients. Thin bands of phyllitic slates, occasionally calcareous, also occur as intercalations. Sporadic carbonaceous bands are also noteworthy. The limestone is generally decomposed as a result of which solution channels and solution caves are quite frequently recorded. Due to differential weathering, the limestone has developed surficial groove and rib features. The base of this formation is covered by alluvium.

Sirikot Slates.

The Sirikot section exposes the thickest development of dominantly pelitic formation consisting of slate, phyllitic slate, phyllite and subordinate mica and quartz schists. The Sirikot Slates are developed on the westarn face of the Gandghar Range. They are thin bedded, fine-textured and light to dark grey. The slaty cleavage is not well-developed as a result of which uniform and clean slates are raraly obtained. Bands of graphitic slate and graphitic phyllite are well-pronounced throughout the formation. Limestone is associated with this formation as pockets and lenticles. They are yellowish brown and light grey, coarse to medium crystalline.

Quartz veins and veinlets are very common. They usually form zig-zag pattern. Heamatite lenses and limonite speckles are also associated and show uneven distribution. Dolerite sills are the common intrusions. A few sporadic intrusions of very coarse to medium and light-coloured granite are also recorded in the Sirikot Slates along the Kandal - Tarbela road.

Sirikot Slates have got a normal contact with the underlying Mohat Nawan Limestone.

Tarpakhi Quartzite.

Quartzite extends for about 10 miles between Tarbela and Sobra villages on the western foothill of the Gahdghar Range where it attains the maximum thickness of over 350 feet. It gradually pinches out near the northern and southern extensions. Quartzite on the eastern flank is developed between Seri and Momahiya village for a distance of about 4 miles and in this section its maximum thickness is about 180 feet.

Tarpakhi Quartzite is white to light grey, brown and yellowish-brown. It is thin-bedded, fine to medium-textured and is hard and compact. The grains are angular to sub-rounded and the cementing material is arenaceous. Subordinate bands of arenaceous phyllitic slate occur as thin intercalations. Dolerite intrusions are common which occur as sills and dykes.

Baghdarra Limestone.

This limestone is exposed on the southern tip of the Gandghar Range and crosses the southern slope of Pir Than peak with northeast - southwest strike. The limestone is thin-bedded, fine to medium crystalline. It is light to dark grey on weathered faces and dark grey to black on fresh faces. Nodular feature is confined to the surface and the fresh faces are usually homogeneous. Clay and silica are the important impurities, light coloured argillaceous streaks are noteworthy on the surface. Thin argillaceous bands occur as intercalations. Dolerite intrusions are common.

Pir Than Limestone.

This limestone caps the highest peak of the Gandghar Range. It attains maximum thickness in Pir Than section and gradually tappers on the north and south within a radius of about two miles of this peak.

The Pir Than Limestone is thin- to thick-bedded, medium crystalline. White, light grey, yellowish-brown and pink are the common colours. Silica and clay are the main impurities. Bluish-grey cherty bands are frequently noted. Iron staining is quite conspicuous.

On the eastern slope of the Gandghar Range, between Pir Than and Dharchitti, a bed of quartzite and quartzitic sandstone is associated with this limestone. The quartzites are thin-bedded, medium- to coarse-textured and display light grey to pinkish-brown hues. This bed appears to have been displaced and apparently underlies the Pir Than Limestone. This quartzite bed is tentatively correlated with the Kakul Formation of the Abbottabad Group (Latif 1970). At places, yellowish-brown ferruginous bands, between six inches

to two feet thick, are also associated with the Pir Than Limestone. One such occurrence has been located near Choi, on the eastern slope of Pir Than peak. Heamatite and limonite are the iron ores associated with the ferruginous bands. Their development is thin and erratic.

Pir Than Limestone has been chemically analysed for phosphate. Out of 35 samples, collected randomly from bottom to top in Bandi - Pir Than section, 25 samples revealed phosphate content between 2 and 11%. In the dolerite sills which frequently intrude the Pir Than Limestone, phosphate content ranged upto 7%. Under microscope dolerite did not reveal apatite which suggests that phosphate was derived from the country rocks.

Pir Than Limestone samples collected on the eastern slope of Gandghar Range revealed some distorted impression of fossils.

CORRELATION

The rock fotmations of the Gandghar Range have been correlated with the Palaeozoic sequences of the Attock - Cherat Range (Tahirkheli, 1970) and south-eastern Hazara (Latif 1970) as shown in the following table.

TABLE 1

CORRELATION OF ROCK SEQUENCES IN VARIOUS AREAS

	PERIODS	HAZARA LATIF—70	GANDGHAR RANGE TAHIRKHELI—72	ATTOCK—CHERAT RANGE TAHIRKHELI—70
ERA MESOZOIC	TRIASSIC	HAZIRA FM.	PIRTHAN LIMESTONE	SHEKHAI LIMESTONE
PALAEOZOIC	PERMIAN	GALDANIAN FM	TARPAKHI QUARTZITE	
	CARB-	SIRBAN FM		
	DEVONIAN	KAKUL FM	BAGH DARRA LIMESTONE	KHATTAK LIMESTONE
	SILURIAN UPPER	TANOL FORMATION		
	SILURIAN MIDDLE		SIRIKOT SLATE	MANKI SLATE
	SILURIAN LOWER		MOHAT NAWAN LIMESTONE	SHAKOT BALA FORMATION
	ORDOVISION			
	CAMBRIAN	LANGRIAL LST HAZARA SLATE	BASE NOT EXPOSED	BASE NOT EXPOSED

STRUCTURE

An interesting structural feature recorded in the Gandghar Range is the swing in the strike of the rocks near its southern termination. This is conspicuous in the Sirikot Slates exposed to the north of Jamra village. Here the strike of the rocks is east to east-north-east. When followed further northward, the strike gradually swings to northeast and north which ultimately becomes the prevalent strike of the rocks in the Gandghar Range.

The Attock - Cherat Range is separated from the Gandghar Range by a wide stretch of alluvium. On the basis of orographic trend and the strike of the rocks, the Gandghar Range appears to be the extension of the Attock - Cherat outcrop.

The Gandghar and the Attock-Cherat Ranges were aligned during the Palaeozoic period—which had formeda barrier to check the northward encroachment of the Tethys during the Mesozoic and Tertiary periods. As a result of this no sediments of post-Permocarboniferous age are either found associated with the Gandghar Range or encountered in the vast metasedimentary terrain further north. A deap basin had existed along the southern fringe of the Attock - Cherat and Gandghar Ranges where thick sediments were deposited during Mesozoic and Tertiary periods.

There are two major folds; a syncline passing along the crest of the Gandghar Range, very well conspicuous in the Bandi - Pir Than section, and another adjacent anticline running parallel to this syncline with its eroded axial part conforming to the present channel of the Indus River. The eastern flank of this anticline forms the western foothill of the Gandgar Range. These two major folds include many smaller folds which are visible in the Sirikot Slates.

The Tharpakhi Quartzites near Tarbela village overlie the Sirikot Slates with a normal contact. These quartzites gradully increase in thickness southward and in the sections at Tharpakhi, south of Mohat, Dal and Sobra villages they underlie the Sirikot Slates, which appears to be as a result of overfolding. The quartzites encountered along the eastern foothill of the Gandghar Range north of Seri village also dip under the Sirikot Slates with a faulted contact.

ECONOMIC GEOLOGY

Slates.

As discussed earlier, the Sirikot Slates comprising of slate, phyllitic slate, and phyllite are extensively developed in the Gandghar Range. The slate horizons are usually squeezed and the slaty cleavage is generally not well-

developed. However, in some areas located in the vicinity of Sirikot, Salamkhand, Chumyari and Thalikot villages, a few scattered and localized sections are recorded in the Sirikot slates which retain well-developed slaty cleavage striking parallel to the bedding plane. These sections contain commercially exploitable slate bands which range in thickness from 20 to 80 feet and extend for a few hundred feet in strike direction. Most of the quarries opened up by the locals to extract slates of various sizes are located in these sections. The largest size slates are of $3\frac{1}{2} \times 1\frac{1}{2}$ feet dimensions.

Two types of slates extracted from these quarries may be distinguished. One is dark gray to black which is hard and compact, and another is light gray to greyish-brown, with shiny flakes of sericite. The latter is not as durable as the former. The slates are usually utilized in the graves but some are used for paving the houses.

Crystalline Limestone.

The Abbottabad Group is represented in the Gandghar Range by light to dark grey and greenish-gray siliceous and dolomitic limestone. The limestone is medium crystalline, medium- to fine-textured, and thin-bedded to massive. The massive variety is usually developed along the skyline of the ridge.

The massive blocks range in diameter from one to over five feet and some of them, with uniform texture and greenish-gray hue, get good polish. At present a lease holder for marble is working in Baghdarra area. Most of the crystalline limestone blocks extracted from this area are sent to the marble factory for cutting and polishing. The limestone deposit in the Gandghar Range may yield about a quarter million cubic feet of crystalline blocks of over two feet diameter. Due to their erratic distribution along the skyline of the ridge, the cost of qnarrying and transportation will have to be considered before planning their commercial utilization on large scale.

Phosphate.

The crystalline limestone of the Abbottabad Group, discussed earlier, also revealed phosphate mineralization which in Gandghar Range ranged up to 12% in a dozen samples collected in an area of about three squar miles between Bandi-di-Cho and Chamyari villages. The dolerite sills, which frequently intrude the limestone, also showed phosphate concentration which in three samples ranged up to 7%. The phosphate-rich limestone occurs in thin bands and has erratic distribution. A detailed investigation of the Pirthan Limestone will throw some light on its economic propects for commercial utilization.

Graphite.

The Sirikot Slates, containing thick cabonaceous bands, extend all along the strike direction on the western face of Gandghar Range. The important localities where samples were collected for ascertaining fixed carbon content are Baghdarra, Bandi, Surma Lari near Chamyari and near Thapla bridge close to the northern termination of the range along Kandal-Tarbela road. The fixed carbon in these samples ranged from 8 to 18%. Two selected samples collected from the squeezed parts of the isoclinal folds reveal 22 and 26% fixed carbon. The fixed carbon content of the carbonaceous bands in the Sirikot Slates is commercially low to be considered for the extraction of graphite. The commercial grade graphite should contain over 40% fixed carbon and should occur in large reserve to make it commercially exploitable.

Quartzite.

Thin- to thick-bedded quartzite of white, light grey and pinkish brown hues are extensively developed on both the eastern and the western faces of the Gandghar Range. The quartzite is medium- to fine-grained and the cementing material is arenaceous or argillaeeous; the former being more prevalent. The white variety is very pure, containing from 98 to 99.5% Si 0_2. The iron content ranges from 1 to less than 0.5%.

The quartzite from the Gandghar Range is presently being utilized to manufacture special type of cement for the Tarbela Dam Project at Wah Cement Factory, for which between 150 and 200 tons of pure white quartzite is consumed monthly. Besides, quartzite has also got other uses, as an abrasive and for the manufacture of silica refractories. A pure white quartzite of medium- to coarse-grained texture may also be used in the glass industry.

Soapstone.

Thin scattered lenticles of soapstone are recorded in the Sirikot Slates and in the Pirthan Limestone. The soapstone is white to light grey and is usually located close to the dolerite sills. Due to erratic distribution and thin development, the soapstone does not hold good prospect for commercial exploitation.

Dolomite.

Dolomite beds in the Hazara district are associated with the Abbottabad Group and, in the Gandghar Range, the dolomitic limestone and dolomite bands are recorded in the Pirthan Limestone. Dolomite is white to light grey and in thickness the beds vary from 3 to 20 feet. Eight samples collected from Bandi

and Pirthan section revealed between 16 to 26% magnesia. The Iron content ranges form 0.2 to 1.2%.

Dolomite of the Gandghar Range holds promising future. The range is accessible both from Haripur and Ghazi, as a resunlt of which the transportation expenses will not be high.

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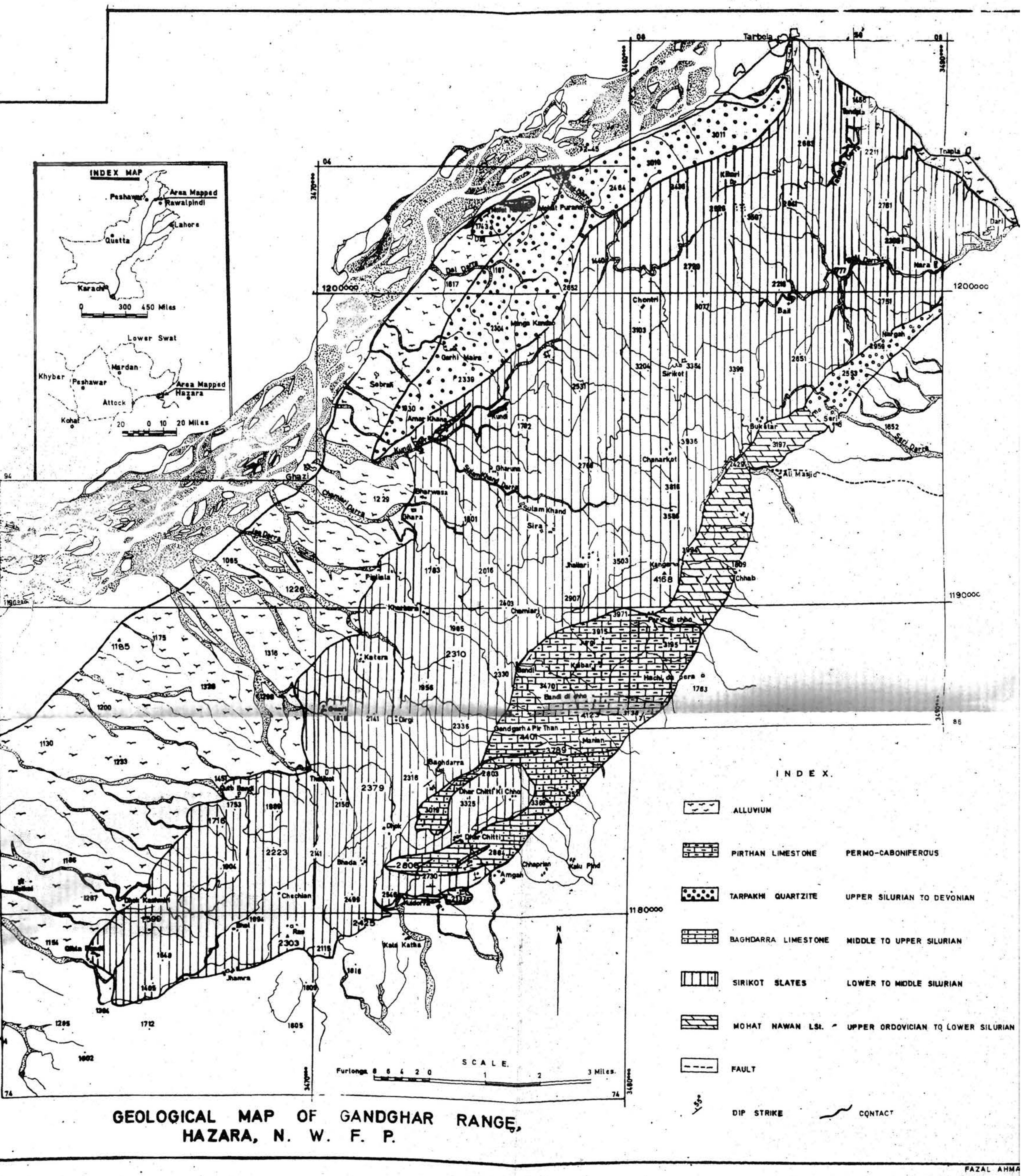

GEOLOGICAL MAP OF GANDGHAR RANGE, HAZARA, N. W. F. P.