Fig. 9. Mega-fossils in Bakhtai Formation.

Fig. 10. Grooved features in Shahkoṭbala Formation.

Two major thrust faults, running along the northern and the southern fronts of the range, traverse the area in the east-west direction. The northern thrust is the result of overturning of the southern flank of an anticlinal fold. Another anticlinal fold skirts the Attock-Cherat Range on the south in the Nizampur valley. The northern limb of this fold is intact. The southern limb is eroded away and is buried under the alluvium. The Attock Shales are folded into assymmetrical parallel isoclinal folds with their axes dipping towards the north. The faulting pattern in the Attock-Cherat Range yielded imbricate type structures which are conspicuously observed all over the area.

INTRODUCTION

The Attock-Cherat Range exposes A. B. Wynne's Attock Slate Series (1873) which remained a controvercial issue for the geologists of the subcontinent for nearly a hundred years. Many geologists during pre- and post-independence time have worked on these rocks and recorded their views in the Geological Survey publications and elsewhere.

The author, in association with M.I. Ahmed and the late Namazi (1951), while preparing large scale geological maps of the Manki coal showings had a chance to examine these rocks for the first time. During this work the survey was confined to a few isolated sections, covering a limited area near Bakhtai, Shakhai and Jabba Khattak villages — along the northern fringe of Cherat mountain where Eocene shale containing coal pockets are exposed. The work was purely of economic nature and very little was accomplished on the stratigraphy and the age of the rocks.

In the fall of 1964, the author was deputed from the G.S.P. to Peshawar University on a teaching and research assignment. The first programme planned after taking up the new job was to make a comprehensive geological survey of the Attock Slate Series with a view to distinguish and describe various mappable lithological units, and to supplement the already much publicised work with some fresh observations shedding more light on the stratitgraphy, tectonics, and the age of these rocks. Prior to this publication, short papers were published from time to time on various aspects of the Series.

The Series takes its name from a small town (located on the eastern bank of the Indus River), which used to be the district headquarters but now abandoned; the district still retains this name. The slates were first examined at Attock where they are exposed in easily accessible sections forming low, parallel ridges, ranging in elevation from 1300 to 2079 feet and spread over an area of about 50 square miles. The last remnant of these outcrops is an isolated hillock near Kamra village in the Attock Plain about eight miles east of Attock. Beyond this point, the eastward extension of the slates is concealed under thick alluvium for over fifteen miles, til

they crop out again in the mountains of southern Hazara.

West of the river, the outcrops extend into the Peshawar Plain without any interruption, and culminate to 4546 and 5033 feet elevations at Cherat and Jalala Sar respectively. These two peaks form commanding heights overlooking the Peshawar Plain. Between Attock and Mir Kalan — a hamlet located on the eastern fringe of the Cherat peak, the general trend of the range is parallel to the east-west strike and corresponds with the main structural line of the area. Beyond Mir Kalan, the Cherat Range swings to the northeast, involving the strike and the main structural features of the area, and ultimately merges with Nizampur-Kohat ranges in Darra Adam Khel tribal territory.

The geological setting and structure have strongly influenced the general landscape of the area. More resistant limestone and quartzite form steep cliffs, whereas, slates and shale form gentle slopes.

The Cherat Range spreads in approximately 360 square miles area, measuring 36 miles in length and 8 to 12 miles in width. Sahibzada, in his paper on the Geomorphological Analyses of the Peshawar Region (1962) has named the Cherat Range after the Khattak tribe who inhabits this area. The larger part of this range exposes rocks that have been regarded as the extension of the Attock Slates by the previous workers. Thus the Attock-Cherat Range—which is related to the Attock Slate controversy—stretches between Kamra hillock, located in the Attock Plain in the east, and Dag village. situated on the Pabbi-Cherat road in the Peshawar Plain in the west. Beyond Dag, the slate and shale are lost under the alluvium. The northern side of the Cherat Range is bounded by Peshawar Plain which is drained by the Kabul River and its five tributaries, namely Shah Alam, Naguman, Sardaryab, Khayalc and Jindai.

The southern extension of the Attock-Cherat Range is delimited by the Nizampur valley, which emerges from the eastern slope of the Cherat Range and extends eastwards. On the other side of the river it merges into the Attock Plain and thus isolates the Attock-Cherat Range from the Nizampur and Kala Chitta outcrops of the Triassic to Pleistocene age. The Cherat Range forms a steep escarpment overlooking Nizampur and is cut by dry nalas which expose excellent geological sections of Mesozoic—Tertiary sequence.

The only outcrops situated close to the Attocks in the Peshawar Plain are those of the Nowshera reef, stretching in east-west direction along the northern bank of the Kabul River. On the basis of fossils, Teichert and stauffer (1965) have dated the reef to be Siluro-Devonian. The contact of the Attock slate and Nowshera reef is nowhere exposed, the two being separated by thick alluvium, about five to six miles wide.

Acc. No. 31

PREVIOUS WORK

The Attock Slate Series has got a long and interesting history of investiga Due to scanty literature available to the author at this stage, it would not be pos to give an exhaustive review on all the researches carried out from time to time. (first geologist in the subcontinent who examined these slates was Wynne (1873) the Geological Survey of India. He placed the slates and the other associated r in a single undifferentiated unit and considered them to be Palaeozoic, with a p bility of being Silurian. Also, he correlated the Hazara slate with the Attock slat lithological grounds and considered them to be stratigraphically equivalents.)

Waagen (1880), who followed Wynne, strongly advocated the claim of ce Carboniferous fossils found embedded in a sample of a black slate, which was lab Punjab in the Geological Museum, as belonging to the Attock Slates. Lydd (1883), on the basis of his observations in Kaghan valley and Lower Kunha Hazara, supported Wynne in assigning probable Silurian age to the Attock Slate. did not agree with Waagen and considered his evidence for connecting the f with the Attock Slate only circumstantial.

Griesbach (1882), who had made a traverse across the Cherat Range betv Jallozai and Mir Kalan villages in the western tip of the area, could not be convi by his predecessors' view on the age of the Attock Slate. He differentiated var lithological units and specially mentioned the slate and shale which he did not sider to be older than Cretaceous. In this section Griesbach did not find any bed c than the Jurassic limestone. On the basis of this observation he concluded: previously considered that the Attock Slates form part of the Cherat hill and are in the Peshawar Plain near Jallozai, but in the section traversed none of the divis can be looked upon as anything so old as the Attock Slates are supposed to be."

Middlemiss (1896), who produced a very exhaustive account on the geolog Hazara, also considered the Attock Slates to be identical to the Hazara Slates because of their unfossiliferous nature correlated them with the great Azoic slate schistose formations of the Outer Himalayas in Gharwal and Kumaon (In Himalaya) which underlie the Kuling-Carboniferous system.

Wadia (1932) had extensively covered the slate belts of the Outer Himalayas described several sections of Dogra Slates and Hazara Slates both of which, in t were correlated with the Attock Slate. He described the Attock Slates as undi entiated, consisting of dark slates with few thin beds of sandstone and limestone meated by trappean intrusions and representing the Extra-Peninsular Vindhyans.

Cotter (1933), while mapping the geology of the Attock district and part of

southern Hazara, also described the Attock Slates and regarded them to be of Precambrian age. Cotter especially mentioned a well marked unconformity between the Attock Slates and the overlying Kioto Limestone (Jurassic) of the Kala Chitta hill in the south which, according to him, represents the absence of the whole of the Palaeozoic sequence and also, probably, the Lower and Middle Triassic.

Coulson (1937), while working in Peshawar and Khyber areas, had also paid a visit to the Cherat section which was earlier traversed by Griesbach in 1880. He thought the Cherat ridge to be the northern limb of an anticline which has been foundered by strike-faulting. He described various rock types encountered between Dag and Mir Kalan villages and especially mentioned a series of shales with lenticular limestone, at times algal and containing unidentified fossils which looked similar to Griesbach's Dag Shales. On the basis of their contact relationship with the underlying Dungan Limestone he considered these shales and slaty shales to represent Chharat Series of Pinfold (1918) of the Upper Eocene age. Coulson also mentioned a strike fault of very large throw to the north of Cherat against highly contorted slate and schist which, according to him, correlate with the Attock Slates.

Among the later publications, Sir Pascoe (1950) has discussed the age of the Attock Slates and his views are, "The Lowest known fossiliferous rocks in the Salt Range of the Punjab which belongs tectonically to Attock-Hazara mountain system contain a fauna having affinities with the well known Olenellus fauna, indicating horizons near the top of the lower or bottom of the Middle Cambrian. Above these horizons, there is no trace of any slate series conformable to the Simla or Attock Slate, and there are no exposures showing such a formation below these Cambrian beds. From this it seems likely that the slate series is older than Cambrian and assignable to the Late Puranas (Precambrians)."

The United Nations' Lexicon (1956) described the Attock Slates:

"Named by A. B. Wynne after the town on the Indus. Unfossiliferous dark or black slates, limestones, and sandstones of an olive, sometimes liver colour, are also with intrusions and interbedded trap. They are identical with the slate series of Hazara where they underlie Infra-Triassic with marked unconformity and are now regarded as probably part of the Purana Group."

Besides, Krishnan (1956) and Wadia (1959) in their books on the geology of India; Gansser (1964) in Geology of the Himalayas; and Baker and Jackson (1964) in the Geological map of Pakistan have also described the Attock Slates to be undifferentiated and Precambrian.

This chapter will be incomplete without giving due credit to those geologists who made important contributions to the understanding of the Attock Slate in the form

of unpublished documents, now lying with the Geological Survey of Pakistan progress reports or field notes. Among these workers the names of the followin are worth mentioning: A. H. Khan, Abdul Mannan Khan, Mesbahuddin Ahme S. N. H. Rizvi, Mumtazuddin Ahmed (1949-50), M. I. Ahmed, Late Nama (1951-52), A. N. Fatmi (1953), C. R. Meissner, J. M. Master (1959-60), Waheeduddi Ahmed, and Farhat Hussain (1963-65).

All of these geologists considered the Attock Slate undifferentiated and plac them in the Precambrian. M. I. Ahmed (1952), J. M. Master and C. R. Meissn (1960), who investigated these slates east of Jallozai and Dag villages, did not consid the shale and slaty shale to be as old as the Attock Slate. Master and Meissner h differentiated these rocks by calling them "Formation X" in their report.

REGIONAL GEOLOGY

The Attock-Cherat Range by virtue of its central location holds pivotal positi in the regional geological set up of northwest West Pakistan. Tectonically t range belongs to Hazara, Khyber and Kala Chitta-Kohat mountain system whi are closely located and form major geological provinces.

Two types of lithological elements have been distinguished in the Attock-Che Range. One is low grade regionally metamorphosed geosynclinal sediments, mos phyllite, slate and limestone, which constitute major part of the Palaeozoic sequen This belt is developed along the northern face of the Attock-Cherat Range runni parallel to, and apparently dipping under the Nowshera reef outcrops. These ro may be correlated on lithological basis with the similar rock outcrops in Swa Lower Swat in the north, Khyber in the west and Hazara-Kashmir in the e The slates continue farther east and west into India and Afghanistan respectively where they are developed in extensive areas. The geosyncline appears to h developed during Ordovician period. Shallow and warm conditions were se probably, during Upper Silurian when large scale reef building had started.

A dominantly sedimentary belt, exposing rocks of the Mesozoic-Tertiary e is developed along the southern face of the Attock-Cherat Range and has go tectonic contact with the metasedimentary belt. The oldest rock exposed in this is of the pre-Middle Jurassic age. A thick, and monotonous sequence of Spiti shale points out to the formation of another geosyncline during the Mesozoic w appears to have existed during the Triassic-Jurassic period till the start of the Cr ceous. This geosyncline is also very extensive and has extended for several hund miles into India and Afghanistan. The Mesozoic-Tertiary sequence of the Att Cherat Range may be correlated on lithological and faunal basis with the rock Kohat, Kala Chitta, Salt Range and southern Hazara.

STRATIGRAPHY

Sequence.

Thirteen mappable lithological units have been differentiated in the Attock-Cherat Range. Of these, four belong to the Palaeozoic, four to the Mesozoic and five are placed in the Tertiary. Phyllite, slate, slaty shale and limestone are extensively developed and constitute major part of the stratigraphic sequence. The pelites of the Attock-Cherat Range are divided into two parts which could not be done by the previous workers because of their juxtaposed contact. Both of these slate formations have yielded fossils, on the basis of which the older — called Manki Slate — has been assigned Lower to Middle Silurian age and the younger — named Attock Shale — has been placed in the Middle Jurassic-Cretaceous.

Two mappable units, belonging to one formation, have been distinguished in the Cretaceous. The lower one is quartzite and hard sandstone with intercalated slaty shale; the upper one is dominantly calcareous, consisting of yellowish brown flaggy limestone.

The Darwazai Formation which is dominantly calcareous, also contains maroon slaty shale on the top and constitutes a mappable unit in this section, but elsewhere it becomes thin. Therefore the maroon slaty shale is tentatively considered to be a part of the Darwazai Formation.

The sequence of mappable lithological units in the Attock-Cherat Range, as differentiated by the author is shown below in descending order of superposition. All of these units are sufficiently distinctive and have got all the requisite qualifications to be treated as formations.

Recent and Subrecent		Alluvium	
		UNCONFORMITY	
12.	Pleistocene	Jallozai Formation. 70 ft.	Soft sandstone, shale and gritstone
		UNCONFORMITY	
11.	Miocene	Murree Formation. + 500 ft.	Maroon sandstone and shale
		UNCONFORMITY	
10.	Upper Eocene	Bakhtai Formation. 60 ft.	Shales usually predominate, with yellowish brown and grey limestone containing shells of mega-fossils

9.	Lower Eocene	Lakhrai Claystone. 140 ft.	Brownish red to maroon soft, silty shale and gri with calcareous bands
8.	Palaeocene	Cherat Limestone. 80 ft.	Light to dark grey lime stone with shale par ings. Gritstone usuall at the base, with chert i sandy matrix
		UNCONFORMITY	
7.	Cretaceous	Hissartang Formation. 450 ft.	b. Upper member: th bedded to massive, fine laminated, yellowi brown and grey lim stone a. Lower member: whi grey, brown quartz and hard sandstone w intercalated slaty sh
6.	Middle Jurassic-Cretaceous	Attock Shale. + 2000 ft.	Monotonous series shale and slaty shale v lenticular sandy and s bands and limet pockets
5.	Pre-Middle Jurassic	Darwazai Formation. 270 ft.	Thin bedded, whit light green and yello green dolomitic limes with dendrites, over with gradational cor by a bed of red ma slaty shale
		UNCONFORMITY	
4.	Permo-Carboniferous	Shakhai Formation? 340 ft. Limestone?	Thin bedded to mas crystalline, dolo limestone with thin l ed quartzite and shale at the base; tains igneous intru

UNCONFORMITY

Middle to Upper Silurian	Khattak Limestone. 85 ft.	Thin bedded to massive, grey to sooty black, crystalline limestone with argillaceous streaks and laminations. Dolerite intrusions present
Lower to Middle Silurian	Manki Slate. 1000 ft.	Phyllite, slate and slaty shale with lenticular sandy bands. Limestone occurs as pockets. contain dolerite sills
Upper Ordovician to Lower Silurian (Base not exposed)	Shahkotbala Formation. 230 ft.	Yellowish brown and thin to thick bedded, sandy, crystalline limestone with pitted and grooved features; underlain by green and greenish grey, sandy and slaty shale, contains dolerite sills

LITHOLOGY

Shahkotbala Formation.

The Shahkotbala Formation is the oldest lithological unit exposed in the Attock-Cherat Range. It constitutes two lithologies, slaty shale and slate, overlain by limestone. It has restricted occurrences as compared to the other metasedimentary rocks; its maximum development is recorded in the northwestern foothill of Cherat Range, between Shahkotbala village and Shakhai nala, where it forms conspicuous low and sharp, arcuate ridges. Towards east, for a distance of about 30 miles till Kund village, it is not traceable and appears to have been disrupted as a result of faulting.

In the hillocks around Kund village this formation forms thin isolated pockets; one of them is exposed in the road cutting about a mile east of the Kund Rest House. The last outcrop, exposing this formation on the western bank of the Indus, is located on the western tip of the old Khairabad village. On the eastern bank of the river the formation is located in the outcrops north of the railway track in the form of isolated linear lenses associated with the slate and phyllite.

The slaty shale and slate of this formation are less pelitic as compared to the Manki Slate which overlies them. Sandy and gritty bands are frequently associated

and in most of the sections dominate the sequence, giving a typical psammitic l
They are hard, indurated and usually cleaved along more than one plane, which re
in splintery pieces. Their fissility is insufficient to produce slate of economic
Light green, greenishgrey and brownishgrey are the common colours displaye
the slates. Thin bands of yellowish brown limestone are present near the
Quartz veins and specks of decomposed limonite are quite common.

These slates are overlain by white, light to dark grey and yellowish brown,
bedded to massive dolomitic limestone. It is siliceous, medium crystalline
medium- to fine-textured. It also occurs in banded form, with alternating
careous and argillaceous layers which on weathering yield solution grooves,
limestone is generally decomposed and weathered surfaces are cavernous, pitted
corrugated. Hydrothermal quartz veins are common; some of these vein
associated wi'h heamatite mineralization which occur as pockets and lenses anc
best be seen in a few sections in Jabba Khattak nala. The other igneous intru
are dolerite sills.

The base of this formation is not exposed. The limestone is fossiliferou
contains obliterated impressions of fossils. Some samples of the limestone col
from the top of this formation, in a section south of Uch Khattak village,
examined by Hussain (1970), University of Karachi. He tentatively ide
Bryozoa; *Rhombopora* and *Bythopora* which are the typical Lower Palaeozoic f
This is further confirmed by the identification made by Kalkins, Oliver and M
(1970) of the United Stated Geological Survey, who tentatively identified Pala
Bryozoa, probably of the same age. On the basis of this result, coupled with th
tigraphic position occupied by the formation, the Shahkotbala Formation is as
an age range from Upper Ordovician to Lower Silurian.

Manki Slate.

The Manki Slate constitutes the thickest stratigraphical unit in the metasc
tary suite. It is extensively developed in the northern foothill of the Cherat I
west of the Indus River. Its type section is an isolated hillock, locally called
Ghar, located about six miles south of Nowshera. On the eastern bank of the
river, Manki Slate occupies more than half of the area underlain by sedimenta
metasedimentary rocks.

Manki Slate is composed of slate, phyllitic slate and phyllite with subor
lenticular limestone. The sandy and gritty bands are noteworthy throughc
formation. They usually occur as intercalations with individual bands rang
thickness from a few inches to 20 feet. A strongly developed slaty cleavage is
nent in the Slate near Manki, Ziarat Kaka Sahib and in a few other eastern ou

cleavage is localized and is frequently parallel to the bedding but becomes mar- ' oblique in the cores of minor folds and near the overturned limbs. The e marks are locally observed which are usually confined to sandy bands. The hering product is usually in the form of rectangular chips. Grey, greenish and brownish grey are the common colours associated with the weathered ces whereas the fresh faces are light grey or light greenishgrey.

In thin sections slight metamorphic effects are observed. The development of rite is visible in most of the sections cut from phyllite whereas biotite is not an mmon constituent. The quartz grains appear to have yielded to pressure and e been rearranged but the development of lineation is not complete. Another ortant feature is the presence of heamatite which, in most of the sections, shows metallic lustre. The binding material is argillaceous which has been mainly ed to sericite, giving a silky sheen to the hand specimen.

Limestone occurs as pockets and lenses, usually prominent near the base. Two es of limestone are distinguished. One is light to dark grey in fresh faces and monly displays calcite veining. Another type is thin-bedded, more argillaceous, owish brown on fresh and weathered faces. The easily approachable section, where h the types can be examined, is in the road and railway cuttings at Kund village.

Hydrothermal quartz veins and dolerite sills are quite frequently recorded in the nki Slate and at Kund the former usually fill the fractures. Among the three sets fractures, the vertical and oblique ones usually have associated quartz veins. rbonaceous bands are also developed in the slates and one such band is exposed in lim Khawar near Tangaru village about four to five miles southeast of Kund. Thin ticles of impure soapstone, giving light green sheen, are also sporadically distributed the Manki Slate near Kund. At present these soapstone showings are being mined smaller scale and are locally consumed.

Manki Slate has got a gradational contact with the underlying Shahkotbala rmation. The passage bed is yellowish brown calcareous shale and argillaceous nestone ranging in thickness from a few feet to more than 30 feet.

The Manki Slate has not yielded any fossil yet. The fossiliferous horizon in the wer Shahkotbala Formation is located very close to the contact of the Manki Slate. nce the age of the Shahkotbala Formation is Upper Ordovician to Lower Silurian, e Manki Slate, by virtue of its conformable contact, can safely be placed in the ower to Middle Silurian.

Chattak Limestone.

Due to its typical lithological characteristics, it is a valuable stratigraphic unit

in the Attock-Cherat Range to help in deciphering several unfossiliferous problemma sections in the metasedimentary suite. Its stratigraphic position, in the outcro west of the Indus River, was a confusing issue because of its intimate associati with both the Manki Slate and the younger Attock Shale. It is very prominent the eastern bank of the Indus around Attock where it forms conspicuous ridges a escarpment. On the western bank of the Indus, the easily accessible outcrop this limestone is over Raja Hodi railway tunnel, about a mile south of Khairab Its maximum development is recorded in Shakhai nala where it is about 80 feet thi but due to folding its apparent thickness is much exaggerated.

Khattak Limestone consists of light grey to black thin bedded to massive,medi to fine-grained crystalline limestone, with subordinate grey and ferrugine shale on the top. On the basis of lithology, the limestone can be divided into tl parts:

(*c*) The top bed is between 20 to 60 feet thick and displays a typical nod feature on weathering. The fresh faces are homogeneous. It is thi thick bedded, light grey on exposed surface and dark grey to sooty blac fresh faces. It contains argillaceous laminations and streaks distrib both horizontally and vertically, usually surrounding the nodules. fractures are prominent and usually contain heamatitic fillings, prob derived by leaching. This bed has got widespread distribution.

(*b*) The middle horizon is composed of thin-bedded crystalline limestone v is light to yellowish grey on weathered surface and dark grey on fresh f It is fine textured and homogeneous. It contains light coloured argilla and calcareous laminations usually developed parellel to the bedding p

(*a*) The lower bed is thick bedded to massive, dark grey to sooty blacl medium- to fine-textured. Its occurrence is restricted to a few isolated tions west of Shakhai nala. In a few sections, it contains emb clastic material derived from the older Manki Slate and Shahk Formation.

Shales also make up a thick unit in this formation. They are thin-bedde display white, light grey, greenish grey and greyish brown colours. Brown hean bands are also common. Two sections on the eastern bank of the Indus shov maximum development. One is along the road cutting north of the Attock and another is near Rumia village, about six miles east of Attock. Due to foldi faulting the shale bed is usually squeezed and disrupted in the other sections.

The Khattak Limestone shows a gradational contact with the Manki [illegible] bed consists of white to light grey, thin bedded, and relatively sof

nd slaty shale, composed of quartz, sericite, calcite and epidote, listed in decreasing rder of abundance. These shales are being quarried in Sangrobi Ghundai for naking slate pencils for the school boys.

The Khattak Limestone has not yielded any fossil. The clastic material found mbedded in this limestone at two places, one at Sangrobi Ghundai and another in a bed on the top of Raja Hodi railway tunnel, were derived from the older Manki Slate and the Shahkotbala Formation. This suggests that the Khattak Limestone is younger than the latter two, thus its age is post-Manki, more likely Middle to Upper Silurian.

Shakhai Limestone. Formation ?

The Shahkhai Limestone is exposed between Shakhai and Uch Khattak nala for a distance of about three miles, with thickness ranging between 20 and 340 feet. It forms ridges and escarpment. This limestone is not traceable elsewhere — except in a section about two miles east of Khawari village where it is involved in a thrust fault and forms a thin band underlying Khattak Limestone and Manki Slate. The unit comprises three lithologies; limestone is dominant, with soubrodinate quartzite and shale. It overlies the Khattak Limestone with a well marked unconformity.

The bottom bed is composed of quartzite and quartzitic sandstone which usually contains greenish grey shale partings. The quartzites are thin bedded, medium- to very coarse-textured, with rounded to subrounded quartz grains, pointing out to a shallow depositional environment. The cementing material is both magnesian and siliceous.

Overlying this bed is thin bedded to massive, medium- to fine-grained crystalline limestone which contains varying proportion of primary silica and magnesia. Grooved and ribbed features are commonly displayed by it on weathering. On lithological basis the limestone is divisible into three parts.

The lower bed is between 20 to 30 feet thick, thin bedded, white to light grey, fine-textured and crystalline. The proportion of magnesia is higher than silica. Marble band occurs in this bed but blocks of economical size are not available. The middle part is 5 to 15 feet thick and fragmentary. It is white, light grey, yellowish grey and yellowish brown with fine- to very fine-texture. The fragments are usually angular to subangular and have been derived from the older beds of the formation.

The upper part is 60 to 280 feet thick and is developed on the top of the ridges. It is light grey, yellowish grey, yellowish brown and reddish brown, thick bedded to massive, medium crystalline and medium- to fine-grained. Primary silica and magnesia are two important constituents present in the limestone. The development

of primary silica is relatively higher ranging from 10 to 25 per cent in randomly picked eight samples examined under microscope. The weathered rocks yield typical grooved and ribbed surfaces.

No fossil has been recorded in this formation. Petrographic studies were conducted to compare the Shakhai Limestone with the samples of the Abbottabad Formation collected from the type section near Abbottabad in Hazara. Both the limestone were found to be identical in composition and lithology. Therefore the Shakhai Limestone is correlated with the Abbottabad Formation which has been placed by the previous workers (Marks and Ali, 1961) in the Permo-Carboniferous.

Darwazai Formation.

The Darwazai Formation is exposed along the southern face of the Attock-Cherat Range, skirting the northern rim of the Nizampur valley. The easily accessible section is located on Nizampur road about two miles downstream of the Attock bridge. Darwazai village is located about two furlongs north of the hillock exposing this formation on the western side of the road. This outcrop extends to the eastern bank of the Indus and the prominent Dakhner Fort, now abandoned, is built over this

The formation attains maximum thickness in Darwazai section where it is about 270 feet thick. Further west, two isolated outcrops are located about one and half mile west of Anzari village, and at Amiru village. Between Mir Kalan and west of Qamer Mela, the Darwazai Formation shows more or less continuous development with thickness ranging between 20 and 80 feet.

The Darwazai Formation consists of thin bedded dolomite and dolomitic limestone with a typical white to light greenish sheen on fresh faces. The weather surface yields light yellowish green or yellowish grey colours. It is fine- to very fine textured and is porcellaneous. Manganese dendrites are well developed. Pockets and lenses of yellowish brown and khaki coloured sandy limestone occur near the top. Ferruginous lenses and bands are also recorded at different stratigraphic levels. In the outcrop in Mir Kalan village, a greenish grey mottled shale bed between five to seven feet thick occurs at the base. In this section, about six feet thick massive bed of dolomitic limestone, not encountered elsewhere, is also developed in Darwazai Formation.

At Darwazai, the dolomite and dolomitic limestone is conformably overlain by thin bedded, red and maroon, slaty shale. This bed constitutes a mappable unit in this section but elsewhere it thins out and is usually found intermingled with dolomitic limstone. About two to three miles west of the road near Darwazai Charsa the maroon slaty shale, in turn, passes on gradationally into the overlying Attock Shale which on the basis of fossils, has been assigned a Middle Jurassic-Cretaceous

age. On the basis of this, the age of the Darwazai Formation should be pre-Middle Jurassic. Lithologically, the Darwazai Formation is correlated with the Kingriali Formation of the Cis-Indus Slat Range and Kala Chitta hill in the south which is assigned an (?) Upper Triassic age.

Attock Shale.

The Attock Shale has got an extensive distribution in the Attock-Cherat Range and constitutes the thickest lithological unit in the Attock Group. In the outcrops west of the Indus River, the Attock Shale spreads for over six miles across the Cherat ridge, forming thick monotonous sequence of shale and slaty shale with intercalated siltstone. A yellowish brown concretionary limestone is associated with this formation as thin bands and detached pockets, confined to various stratigraphic levels.

The shale and slaty shale display light to dark grey, greenish grey and yellowish brown colours on the weathered surfaces. The fresh faces are usually grey and greenish grey. Due to typical fractures developed in the shale the weathering products are usually sharp needle-like splintery fragments. The siltstone is grey and greenish grey when fresh but the weathered surfaces yield pink and brown colouration. In thin section, the siltstone is made up of very fine angular quartz grains and the cementing material is generally argillaceous. The siltstone band occasionally contains flat pebble breccia. At places, lenses of greywacke and sub-greywacke are associated with siltstone bands which show flute-casts, convolute foldings and graded bedding. Ripple marks, cross bedding and ball and pillow structures are the other important features preserved in these beds. These evidences shed ample light on the environment of deposition and support the idea that the Attock Shale represents flysch type deposits (M. A. Khan, personal communication).

In the western outcrops south of Manki, the siltstone forms conspicuous bands in the Attock Shale. The bands range in thickness from 2 to 10 feet and predominate in most of the sections. In the eastern outcrop the silty part of the formation gradually diminishes and pelitic shale and slaty shale become dominent.

The limestone bands and pockets in the Attock Shale are sparingly fossiliferous. One such pocket, occuring on the top of the ridge north of Hissartang village, yielded shells of pelecypod and gastropods. The samples from this limestone were examined by Dr. Norman Sohl of the United States Geological Survey, Washington D.C. He found a low spired opisthobranch and high spired nerinied with simple internal structure of the chambers in this assemblage and suggested that the probable age range of the limestone is somewhere between Middle Jurassic and the Cretaceous.

Hissartang Formation.

The Hissartang Formation constitutes two mappable lithological units, shown

separately on the map; the quartzite and compact sandstone with intercalated sl shale, and the overlying limestone with thin argillaceous and arenaceous bands. Bo of these are developed along the southern face of the Attock-Cherat Range whi skirts the Nizampur valley, usually forming the slopes of the steep escarpments.

Between the northeastern slope of Jalala Sar and Darwazai Charpani village, a distance of about 30 miles, these beds continue without any interruption witl thickness of 150 to 450 feet. The limestone bed gradually diminishes in thickn east of Hissartang and terminates at elevation 1947. The quartzite bed contin further eastwards in the outcrops along the eastern bank of the Indus river anc exposed for a distance of about two thousand feet, gradually merging with the und lying Attock Shale at elevation 1872. Beyond this point, the Hissartang Format does not appear in the outcrops east of Attock.

White, light grey, greenish grey, rusty brown and pinkish brown are the comm colours displayed by the quartzite on the weathered surfaces. The white quartz band, 5 to 12 feet thick, forms a conspicuous horizon in these beds. It is thin thick bedded, hard, medium- to fine-grained and contains decomposed specks limonite. The argillaceous intercalations are recorded everywhere in the area; wh due to squeezing, have become hard and indurated and range between slaty sl and slate. Sandy and silty bands, which are not persistant laterally, are also pres

The upper member of the Hissartang Formation comprises of thin-to medi bedded and fine- to medium-textured crystalline limestone which displays white,li grey, yellow and yellowish brown colouration. It contains thin lenses of grey sl and cherty bands, usually developed near the middle part and not-persistant later A thin bedded limestone near the contact of quartzite shows fine laminations. T the top, the white and light grey flaggy limestone is strewn by thin, wavy veinlets wl appear to be the depositional features originated as a result of compressional for when the sediment was wet. The author has tentatively diagnosed these feature stylolites.

The contact of quartzite and limestone is normal and at two sections, r Anzari and Amiru villages, the field evidences favour a gradational contact. fossil has been found in these beds. The age problem has been solved by recor their stratigraphic relationship with the associated formations.

The Hissartang Formation is overlain concordantly by the Palaeocene Limest A ferruginous bed, displaying a well marked unconformity between the Hissart Formation and the overlying Palaeocene Limestone, is present all over. This st graphic relationship suggests that the age of the Hissartang Formation is pre-Terti The base of the Hissartang Formation is in contact with the Attock Shale and

ntact is well displayed in Darwazai Charpani section. On the eastern bank of the lus, the quartzite intercalated with slaty shale gradually merges into the Attock ale and this anomalous relationship is well marked at elevation 1872. The Attock ale has already been dated to be Middle Jurassic-Cretaceous in age on the basis of sil. Thus the Hissartang Formation, on the basis of the field evidences, can ely be placed in the Creteceous.

erat Limestone.

This limestone is developed along the skyline of the Cherat Range over which erat town is situated. Its outcrop is exposed along the southern escarpment of the ock-Cherat Range, either forming shear cliffs or outliers over the Attock shale. as a finely uniform lithology. It is yellowish brown, brownish grey and light to k grey in colour, fine to coarsely crystalline, very hard and compact, and is thin ded to massive. The limestone weathers into rounded nodules and looks brecciat-

The nodularity is surficial. In fresh surface the limestone is very smooth and s strong foetid smell. Calcite veins are common. The limestone is fossiliferous contains *Miscellanea Spp.*, *Lockhartia Spp.*, and *Discocyclina Spp.* etc. It cons yellowish green and greenish grey, friable and splintery shale partings in the er part.

The base of the Cherat Limestone exposes a well marked ferrugineous unconfor-. In the outcrops on the eastern bank of the river, east of Dakhner Fort, the of Cherat limestone exposes 2 to 4 feet thick, gritty bed which is white and lly stained rusty brown. It is made up of rounded to subrounded fragments of tz, chert and small limonitic nodules. The cementing material is largely arena-s. The Cherat Limestone, on the basis of fossils, has been assigned a eocene age.

rai Claystone.

This formation is exposed at two places, Lakhrai and Dag, in the northern foothill herat ridge. In the former section, its thickness is about 20 feet, whereas, in the r section, which was measured by Meissner and Master (1959-60 unpublished), s a thickness of 140 feet. It consists of sandstone, shale, loose and soft clay; le to yellowish brown, dull red and mottled. It contains fragments of chert in y matrix. Limestone and sandstone bands measuring between 2 and 15 feet thick lso present.

The Lakhrai unconformably overlies the Cherat Limestone. It is correlated with Miami Khel claystone of the Kohat district which was mapped by the earlier gists as a part of the Murree Formation. Meissner and Master (1959) have entiated this horizon as a separate mappable unit on the basis of lithology and ratigraphic position. They assigned it a Lower Eocene age.

Bakhtai Formation.

Bakhtai Shale was the first name assigned to this formation in 1952 by M Ahmed. The outcrops of these rocks are well exposed in Bakhtai nala which r be considered the type section. It is also developed on the northern slope the main Cherat ridge where their true stratigraphic position is ascertained.

The formation consists of medium to dark grey, weathering to yellowish bro thin bedded, at places nodular, sandy limestone which contains inter-bedded s splintery, greenish grey shale and slaty shale. Silty bands in the shale are comm The limestone contains shells of Ostrea and the shales contain pockets and le of inferior coal which has been mined on a smaller scale near Jabba Khattak, Shal and Bakhtai villages. At present, most of the pits are abandoned except the c located near Jabba Khattak. The base of this formation exposes 5 to 20 feet t gritstone of white to light grey colour, containing fragments of chert.

Meissner and Master (1959) have described this formation in Dag section w *Lockhartia hunti*, *Nummulites spp.*, *Radiolaria* and *Ostracoda* are indentified ir limestone, confirming a Lower Eocene age for it.

Murree Formation.

The Murree Formation, exposed in the western extremity of the area around and Bakhtai villages, unconformably overlies the Bakhtai Formation. It is isocli folded and forms low and sharp ridges on the southern slope of the Cherat Ra It thins out eastwards and the last remnant of the Murrees is located in an er exposure in a nala about a mile and half south of Palosai village.

The formation is composed of sandstone, siltstone and shale: the forme being dominant. The sandstone is dark grey, brownish grey and in places pu It is medium-to very coarse-grained and some times grades into gritstone or co merate. The shale is predominantly purple or reddish brown which gives a ge tone to the formation. Calcite veining is a common feature.

The Murree Formation was first distinguished at Murree in the Rawal district by Wynne in 1873 who called it the Murree Series and assigned it a Mi age.

Jallozi Formation.

The type section of this formation is located about a mile and half sou Jallozai village, in the upper reaches of Bagh Khwar, where it unconfor overlies the metasedimentary rocks. The other sections where this formatio examined in detail are located near Spinkhak, Ziarat Kaka Sahib and Dag villa

Three beds have been distinguished in the Jallozai Formation. The Lower bed is white to light grey, sometimes brownish grey, medium-to very coarse-grained, thin bedded, soft sandstone. Its thickness ranges between 10 and 25 feet. Concentration of light and dark components in different layers imparts the sandstone some degree of banding. Microscopic examination of this sandstone has revealed the following components: calcite (40-45%), orthoclase and sodic plagioclase (12-18%), lithic fragments (18-21%), quartz (15-19%), muscovite and biotite (6-8%), pyroxene and hornblende (3%). On the basis of this composition the rock is classified as calc-lithic arenite (Jan, 1968).

The sandstone is conformably overlain by light yellow and yellowish brown, soft friable shale—which at Jallozai section has got a thickness of about 10 feet. This bed is eroded away at most of the other sections except in a nala east of Jallozai village. The shale appears to have been derived by the erosion of Bakhtai Formation which is extensively developed to the south of this area. The top bed is loosely packed gritstone which shows thick development in a section across the nala about a mile and half west of Dag village. The bulk of this material is derived from the Murrees. The sandstone bed is folded which appears to have been affected by the last Himalayan upheaval during the Lower Pleistocene period.

Alluvium.

The unconsolidated surficial deposits derived from the adjacent hills, cover the foothill slope mantling the rock outcrops. Downstream, in the nalas, they form terraces, at places more than 100 feet thick. They also form valley fills in the lowlands and fan material in front of the escarpments. Lenticular deposits of gravels, cobbles, sands and silts of fluvial origin are also extensively developed which point out to the encroachment of the Kabul and the Indus rivers in these areas. Three types of alluvial deposits can be identified (Saif, 1970):

1. Fine sand and clayey matter which usually occurs at the base of the surface deposits. It is between 10 to 25 feet thick and may be distinguished by its moderate compaction.
2. Incoherent gravels, loosely packed and embedded in a sandy matrix. Red staining due to leaching of iron is conspicuous. They also incorporate, at places, thin lenses of fine clay.
3. Cemented gravels, hard and compact, and occuring in the form of large lenses in red stained loose gravels.

IGNEOUS INTRUSIONS

Hydrothermal quartz veins and dolerite sills are the igneous intrusions found associated with the rocks of the Attock-Cherat Range. The dolerite sills are confined to the Palaeozoic metasedimentary rocks exposed along the northern face of the

Cherat Range. They are not found in the Mesozoic and Tertiary rock format which is suggestive of the fact that their age is pre-Mesozoic.

The sills are yellowish brown, medium-to fine-grained and are concordant t structure. They are metamorphosed and partly or completely decomposed. M ralogically, they are composed of plagioclase and augitic pyroxene with acce iron ore, although alteration in many of them has produced various new min The rocks in thin sections usually display ophitic to sub-ophitic texture. Alter has proceeded to different degrees in different samples. Some of the sampl totally altered, while others are nearly fresh.

Plagioclase making about 45-50% of the rock is sodic labradorite occ mostly as thin elongated grains. Partial alteration to clay and epidote is a co feature. A few of them appear to be zoned but in most cases the zoning, if present, has been destroyed by alteration.

Augitic pyroxene, making about equal proportion of rock as plagioclase is c less to pale pinkish and commonly surrounds plagioclase, partially or comp It is generally altered to chlorite and rarely to fibrous green amphibole. Most alteration is on the margins and along the fractures but in some samples they ar pletely altered. Brown oxide (?after pyroxene) is also noted along the grain m

Iron oxide makes about 8% of the rocks. Much of it is equidimensional bu is distinctly elongated or skeletal. It shows partial alteration to leucoxene a and thus may be confidently identified as ilmenite although some may be ma Brownish secondary iron oxide (or hydroxide) also occurs commonly along fi and around some grain boundaries. Much of it is after primary ore but some from pyroxene. Minor quantities of quartz have been identified in some sections.

In very altered samples, there is abundant epidote and chlorite, and minc material grown at the expense of plagioclase and pyroxene. Iron ore is again altered to leucoxene and brownish oxide. In one of such sections, part of the mass is colourless in ordinary light but opaque under crossed polars. This to be igneous glass.

The hydrothermal quartz veins are the youngest igneous intrusions association with both the Palaeozoic and Mesozoic rock formations. They ar filling the fractures and vary in thickness between an inch to ten feet. H copper and antimony minerals are usually associated with these veins.

STRUCTURE

The overall geometry of the major structures of the Attock-Cherat

RUCTURE:- (21)
The over all gometry of major Struct. of A.C. Range is.
apparent from the attached map and the cross sections. The main structural line runs east-west, which corresponds to the general trend of the range. The rocks generally dip to the north at angles varying between 25 and 70 degrees. Along the southern front of the range, the dips are comparatively steeper. The predominant east-west strike gives way to northeast-southwest trends near Kund Rest House and Mir Kalan, located on the northern and southern fronts of the range respectively.

The Attock-Cherat Range records evidence of recurring orogeny that began during the Upper Palaeozoic and continued intermittently until the last Himalayan orogenic movement, which occurred somewhere between the Lower and the Middle Pleistocene. The effects of the Himalayan orogenies are very significant throughout the area.

D.R.C. Kempe (personal communication) thought that the Attock-Cherat Range might be an eastern limb of the antiform structure of the Khyber mountains. The core of the southern part of this structure has been eroded away and is now occupied by the Peshawar valley plain. The Attock-Cherat Range is structurally aligned, also, with the Hazara mountains in the east. The trend of the outcrops and the strike of the formations run parallel to one another in the two areas.

Two major thrust faults, striking east-west, run along the northern and southern fronts of the Attock-Cherat Range. These have given rise to several ancillary faults of smaller magnitude having similar trend. There are several other faults which strike across the major thrusts; some of them are not easily recognisable because of uniform lithology of the Attock Shale. The pattern of faulting has imparted imbricate structures which are conspicuous in several sections.

The northern thrust is the result of the overfolding of the southern limb of an anticlinal structure in the metasedimentary rocks, which make up the northern face of the Attock-Cherat Range. Folding in the metasedimentary rocks appears to have occurred during pre-Mesozoic age. Along the thrust-plane, an inverted sequence of the metasedimentary rocks is exposed which unconformably rests upon the younger Attock Shale of the Mid. Jurassic-Cretaceous age.)

To confirm this thrust on the basis of minor structural features, a study was conducted by Ashfak and Wakil (1969). The area selected for this study was located in the eastern outcrops of the range on both the banks of the Indus. The main emphasis was laid on the joint patterns of the two group of rocks on either side of the thrust plane. The study helped to recognise three sets of joints, out of which, the joints forming ENE set, were differentiated to be much older than the remainders. They were common in the Manki Slate, thus suggesting not only an older age but also pointing out to a distinct unconformity between the Manki Slate and the

younger Attock Shale, which has been thrust over by the former.

In the outcrops about two miles east of Uch Khattak village near elevation a distinct angular unconformity is marked between the metasedimentary rocks Palaeozoic age dipping towards east, and the Mesozoic-Tertiary rocks, consist Attock Shale, Cherat Limestone and Bakhtai Shale, dipping towards west. Alo contact in a nala, the Cherat Limestone, with squeezed shale, contains sca coal pockets. This angular unconformity had helped the author in isolati metasedimentary suite of the Palaeozoic age from the rocks of the Mesozoic-T sequence, prior to the discovery of fossils in the former.

Another anticlinical structure in the Attock-Cherat Range occurs alo southern face which involves the rocks of Mesozoic and Tertiary eras. The nc limb of this structure, though involved in the thrust, is still visible, whereа southern flank is eroded away and buried under the alluvium in the Nizampur This thrust has been created as a result of gradually increasing pressure fr north which has pushed the Attock Shale over the younger Cherat Limestone Palaeocene age. The latter in turn rests conformably on the Hissartang For of the Cretaceous age.

The rocks occupying the core of this eroded anticline are those of the D Formation of the Lower Jurassic-Upper Triassic age — the oldest lithologi in the Mesozoic-Tertiary sequence of the Attock-Cherat and probably the Kala Chitta Ranges. Field relationship, particularly the involvement of Limestone in the faulting indicates a post-Palaeocene age of these thrust

The intermediate zone between the two thrust faults is predominantly c by a thick monotonous sequence of Attock Shale, which, due to their inco nature, has yielded more than the surrounding arenaceous and calcareous roc result of the increasing pressure the shale were squeezed and folded into a trical isoclines with their axes generally dipping at angles between 20 to 70 towards the north. A few isolated and scattered outcrops of Cherat Limes usually found capping the Attock Shale with, usually, a thrust running a northern flank.

CONCLUSIONS

On the basis of this investigation the author concludes that:

1. The Attock Slates are not undifferentiated and consist of thirteen mappable lithological units. Of these, four belong to the Palaeozoic, fo Mesozoic and five are placed in the Tertiary.

2. The pelite of the Attock-Cherat Range, which was previously considered to be differentiated, has been divided into two parts, the Manki Slate and the Attock ale; the former is placed in the Lower to Middle Silurian and the latter has been signed a Middle Jurassic-Cretaceous age. Their stratigraphic control is based the fossils.

3. Two types of geosynclinal sediments are encountered in the Attock-Cherat nge. The older, ranges in age from Upper Ordovician to Middle or lower part of e Upper Silurian. The larger part of this sequence consists of slate, phyllitic slate d phyllite, with interlayered silty and sandy bands.

The younger geosyncline covered this area during the Triassic-Jurassic and the iments represent thick deposit of shale and slaty shale with intercalated siltstone d greywacke. The author believes that this type of sediment was deposited in deep-osyncline and it truely represents flysch type sedimentation. The presence of ywacke and other characteristic depositional features like graded bedding, flute rks and convlute bedding give support to this conclusions.

4. The Shahkotbala Formation is the oldest lithological unit. On the basis of e fossils it has been assigned an Upper Ordovician-Lower Silurian age. The base of is formation is not exposed. No Precambrian rocks have been found in the ttock-Cherat Range.

5. The contact of the Palaeozoic metasediments with the Mesozoic-Tertiary cks is tectonic; the former unconformably rest upon the latter.

6. The Manki Slate, which forms the northernmost outcrops of the Attock-nerat Range, is separated from the Nowshera reef outcrop by a wide belt of alluvium. he Manki Slate apparently dips under the reef.

7. The dolerite sills are frequently recorded in the Palaeozoic formations posed along the northern face of the Attock-Cherat Range. Such igneous intrusions e totally absent from the younger Mesozoic and Tertiary sediments. This is ggestive of the fact that the age of the dolerite sills is pre-Mesozoic, most likely ermian.

The hydrothermal quartz veins are younger in age and intrude both the esozoic and Tertiary formations. These veins contain sporadic showings of timony, copper and heamatite.

8. Five major structural elements have been recognised in the Attock-Cherat ange.

(*a*) Two major thrust faults, running in the east-west direction, cut the Attock-Cherat Range along the northern and southern fronts.

(*b*) Two major anticlinal folds skirt the northern and southern faces of th range involving the Palaeozoic and Mesozoic-Tertiary rocks respectively

(*c*) The intermediate zone shows the maximum development of incompeten Attock Shales which are squeezed and folded into tight assymmetrical isc clinal folds with their axes dipping towards north.

9. The southern outcrops of the Attock-Cherat Range, skirting the Nizampt valley and belonging to the Mesozoic-Tertiary eras, extend to the south and ai located in the adjacent Kala Chitta due probably to folding.

10. On the basis of the above observations the author recommends that tl old names—the Attock Slate Series or 'Undifferentiated Attock Group'—as sugges ed by the Stratigraphic Committee of Pakistan at Rawalpindi in 1963, should l replaced by the more appropriate name 'the Attock Group'. The recently assign name 'Attock Slate Group' is not acceptable because, besides slate, other rock typ form important constituents of the series.

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LOCATIONS

			Topo-Sl
Attock	Lat. 33° 54′ N.,	Long. 72° 14′E.	43 c/
Amiruh	Lat. 30° 50′ N.,	Long. 72° 1′E.	43 c/
Bakhtai	Lat. 33° 51′ N.,	Long. 71° 53′E.	38 o/
Cherat	Lat. 33° 49′ 5′′ N.,	Long. 71° 54′ 5′ E.	38 o/
Darwazai Charpani ..	Lat. 30° 50′ N.,	Long. 72° 12′E.	43 c/

Darwazai ..	.. Lat. 30° 49′ N.,	Long. 72° 14′E.	43 c/1
Dakhner Fort ..	.. Lat. 33° 51′ N.,	Long. 72° 17′E.	43 c/5
Dag ..	.. Lat. 33° 51′ N.,	Long. 71° 49′E.	38 o/13
Hissartang ..	.. Lat. 30° 50′ N.,	Long. 72° 10′E.	43 c/1
Jabba Khattak ..	.. Lat. 33° 54′ N.,	Long. 71° 48′E.	38 o/13
Jallozai ..	.. Lat. 33° 55′ N.,	Long. 71° 51′E.	38 o/13
Jalala Sar ..	.. Lat. 33° 52′ 30″ N.,	Long. 71° 51′E	38 o/13
Kund ..	.. Lat. 33° 56′ N.,	Long. 72° 14′E.	43 c/1
Manki ..	.. Lat. 33° 57′ N.,	Long. 71° 58′E.	38 o/13
Mir Kalan ..	.. Lat. 33° 49′ N.,	Long. 71° 57′E.	38 o/13
Nizampur ..	.. Lat. 33° 47′ N.,	Long. 72° 2′E.	43 c/1
Palosai ..	.. Lat. 33° 53′ N.,	Long. 71° 57′E.	38 o/13
Qamar Mela ..	.. Lat. 33° 47′ N.,	Long. 71° 49′E.	38 o/13
Raja Hodi Tunnel	.. Lat. 33° 53′ N.,	Long. 72° 13′E.	43 o/1
Rumia ..	.. Lat. 33° 52′ 30″ N.,	Long. 72° 17′E.	43 c/5
Sangrobi Ghundai	.. Lat. 33° 55′ 30″ N.,	Long. 71° 50′E.	38 o/13
Shahkotbala ..	.. Lat. 33° 51′ N.,	Long. 71° 52′E.	38 o/13
Spin Khak ..	.. Lat. 33° 52′ N.,	Long. 72° E.	
Shakhai ..	.. Lat. 33° 53′ N.,	Long. 71° 55′E.	38 o/13
Tangaru ..	.. Lat. 38° 55′ N.,	Long. 72° 8′E.	43 o/1
Uch Khattak ..	.. Lat. 33° 54′ N.,	Long. 71° 48′E.	38 o/13
Ziarat Kaka Sahib	.. Lat. 33° 56′ N.,	Long. 72° 2′ 30″E.	43 c/1

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Fig. 1. Ripple Marks in Manki Slate in Piran Nala.

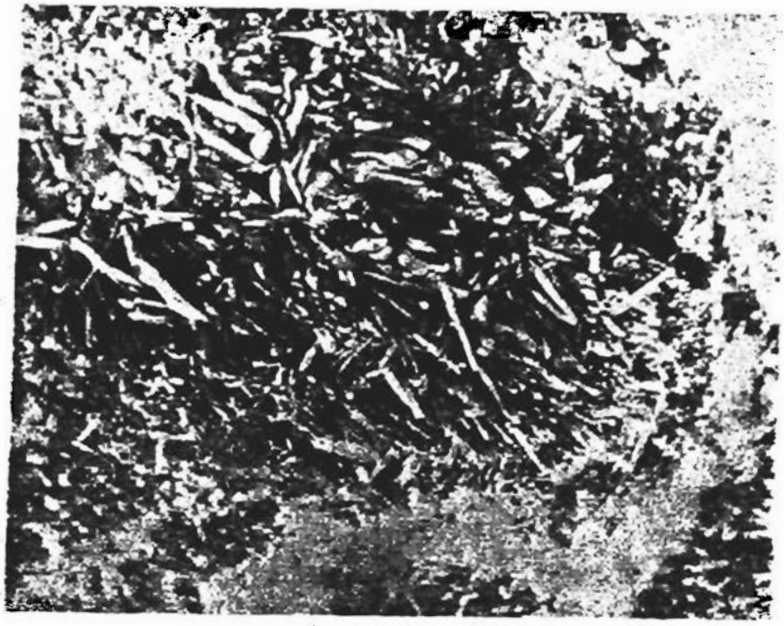

Fig. 2. The weathering product of the Attock shale.

Fig. 3. Khattak Limestone in a section about 2 miles northwest of Khairabad village.

Fig. 4. A compressed pitching fold in Khattak Limestone near Raja Hodi Tunnel about a mile southwest of Khairabad

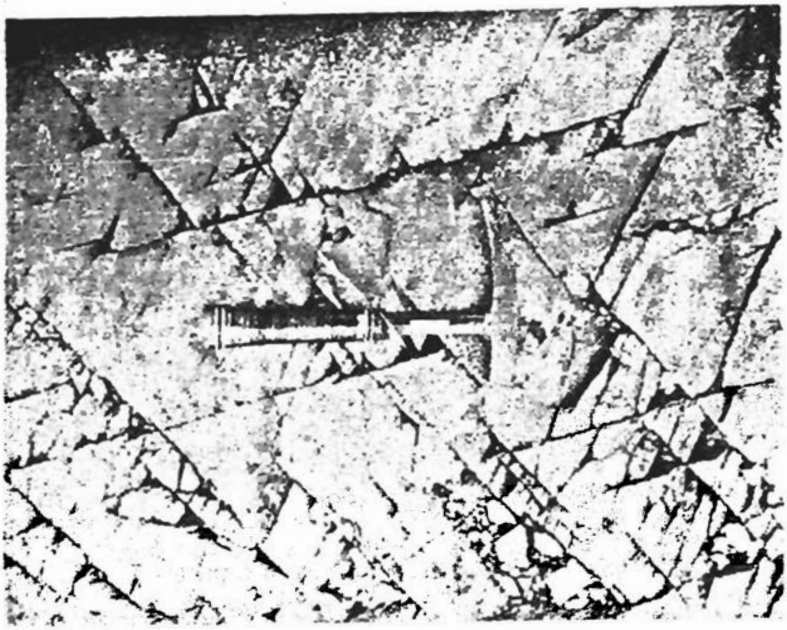

Fig. 5. Jointing pattern in the Attock Shale near Attock Fort.

Fig. 6. Folding in the Attock Shale near Shakhai village.

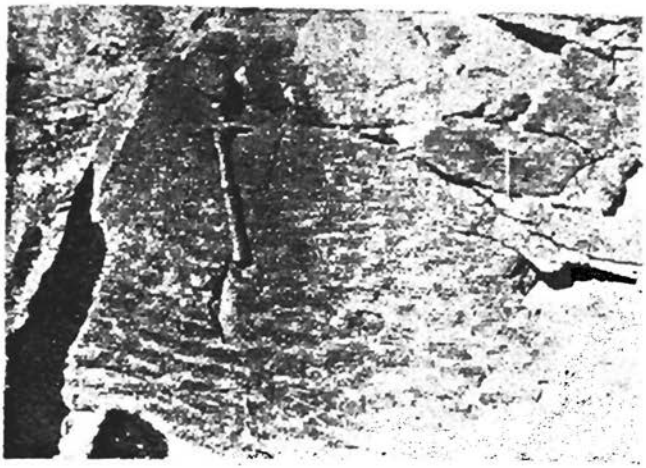

Fig. 7. Ripple marks in the Attock Shale near Palosai village.

Fig. 8. Nodular texture in Khattak Llimestone.

Bull. Univ. Peshawar, Vol. 5, 1970, pp. 1-26

THE GEOLOGY OF THE ATTOCK-CHERAT RANGE, WEST PAKISTAN

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ABSTRACT

The Attock-Cherat Range is exposed in an area of about 50 square miles in Attock ct and 360 square miles in the Peshawar district, on both the sides of the Indus River. nd Attock the relief is low; the elevations range from 1300 to 2079 feet which on ther side of the Indus culminate to 4546 and 5033 feet at Cherat and Jalala Sar ctively, which are the commanding heights in the Peshawar Plain. Between :k and Mir Kalan village, the general trend of the range is east-west which coincides the strike of the rocks. Beyond this point, the range swings to the south-west ltimately merges into the Nizampur-Kohat mountains in Darra Adam Khel tribal ory. In the Attock plain the slates are lost beneath the alluvium beyond Kamra :k till they crop out again in southern Hazara. In the west, the last slate outcrop ed is exposed near Dag village, beyond which the slates are covered by thick ium till they crop out in the Khyber mountains.

Two types of lithological elements, with a tectonic contact, are exposed in the :k-Cherat Range. One comprises the Palaeozoic metasediments (phyllite, itic slate, slate and crystalline limestone) forming the northern face of the range. are correlated with the rocks of Khyber in the west, Hazara in the east and Swabi- r Swat in the north. The dominantly sedimentary rocks belonging to the Meso- Tertiary eras, developed along the southern face of the Attock-Cherat Range, be correlated with the rocks of Samana Range, Kala Chitta hill, Salt Range Hazara.

The pelites of the Attock-Cherat Range are divided into two parts on the basis of evidences. The older, Manki Slate, is of Lower Silurian age and the younger, :k Shale, has been placed in the Middle Jurassic-Cretaceous. Altogether, thirteen able lithological units have been distinguished in the Attock-Cherat Range. Of four have been placed in the Palaeozoic, four in the Mesozoic and five in the ary. The Shahkotbala Formation is the oldest lithological unit exposed in this and is (?) Upper Ordovician to Lower Silurian in age. No Precambrian rocks been recorded in the Attock-Cherat Range.