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## IMPLICATION OF EARLY CARBONIFEROUS (LATE TOURNAISIAN) CONODONTS FROM THE TABAI FORMATION, SOUTH KHYBER REGION, NORTH PAKISTAN.

**Fazli-Rabbi Khan<sup>1</sup>, Sahaddat-ur-Rehman<sup>1</sup>, Ruth Mawson<sup>2</sup>  
Mohammad Ihsan Afridi<sup>1</sup>, M.Irfan Khan<sup>1</sup>**

<sup>1</sup> National Centre of Excellence in Geology, University of Peshawar NWFP Pakistan.

<sup>2</sup> Centre of Ecostratigraphy and Palaeobiology, Macquarie University 2109, Sidney, Australia.

cpandb@hotmai.com, geomenco@yahoo.co.uk, irfank78@hotmail.com and Geoscientist78@yahoo.com,

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### ABSTRACT

Apart from information on a traverse of the Bazar Valley–Tirah region by [11] and observations on igneous rocks of the Spinkai area of Tirah by [3], very little published data have been available on the geology of the Bazar Valley–Tirah area of the southern Khyber region of northwest Pakistan since a traverse by [2] in which he noted the occurrence of an unexpected and interesting Permian sequence from which he collected fossils identified with well-known forms from the Salt Range.

The bedrock of the Khyber region was formerly thought by [8,9,10] to be largely Ordovician (Landikotal Slates), by analogy with Ordovician clastics reported from farther west in Afghanistan, Silurian (Shagai Limestone), or Carboniferous (Khyber Limestone) because of an unpublished report of arenaceous foraminifers. On the basis of extensive mapping, Aslam and Ashraf of the Geological Survey of Pakistan have concluded these units are Precambrian and that all prior reports of fossils from them should be discounted. This opinion coincides with the results of acid-leaching numerous samples of all three of the above units from outcrops along and near the Khyber Highway [6] though, admittedly, not from the substantial areas of these units north and south of the Khyber Highway.

Unequivocal Devonian–Early Carboniferous (Tournaisian) sequences, unconformable upon the above Precambrian units and structurally preserved, nevertheless occur in limited areas, for example west of Tauda Mela [6,8,9] and in the vicinity of Ghundai

Sar [1] from which a single sample from the superb sequence there has produced Famennian Conodonts [7].

Silurian–Triassic sequences, identified from conodont data, are known from the northeast margin of the Peshawar Basin and from the Nowshera region [6], though [4] report of Early Carboniferous rocks at Nowshera does not accord with the Silurian–Early Devonian (Emsian) conodont data from that particular area [6,7]. Unsuspected Ordovician–Triassic sequences have recently become known from many areas of northernmost Pakistan, especially in Chitral [5,12].

Conodonts recently discovered in the Tabai Formation (new stratigraphic name) in the Bazar Valley–Tirah region of the South Khyber region indicate the presence of an Early Carboniferous (Tournaisian) sedimentary interval (chronologically controlled by the zonally

Important Conodonts genus *Gnathodus*) within the largely Proterozoic bedrock (Landikotal Slate, Khyber Limestone, Shagai Limestone) of the southern Khyber region of northwest Pakistan.

The discovery is important because it, and recent discoveries of Early Carboniferous sequences (with limestones) in the eastern Khyber region, in the Turikho and uppermost Yarkhun regions (Chitral), in the upper Hunza valley (Gilgit) and, though metamorphosed, among the metamorphics of the northwestern margin of the Peshawar Basin, provide evidence of a formerly widespread marine Early Carboniferous sedimentary wedge extending over much of northwestern Pakistan

(Indo-Pak and Karakorum Blocks). Such sediments, and the generally associated latest Silurian–Devonian sequence (Nowshera, “Ali Masjid” and Kûrugh Formations or their equivalents) extending southwestwards beneath the Mesozoic–Cenozoic blanket, may have been source rocks for petroleum. What is sobering in this regard is that rocks of similar age are widespread in central and southern Afghanistan and central Iran. In central and eastern Iran, Color Alteration Indices (CAI) of Devonian-Permian Conodonts fall within the oil and gas windows.

## INTRODUCTION

Khyber Agency is named after the world’s famous Khyber Pass, the most vital and important Pass connecting the Indo-Pak subcontinent with Central Asia via Afghanistan.

Khyber is unique in its geography, location, climate to and inhabitants. It lies at 34°20' north and 71°27' east. It is bounded on the north by the Kabul River, on the east by Peshawar District, on the south by Kohat District and Aurakzai Agency and on the northwest by Afghanistan, Mohmand Agency lies in the north and northeast. Fig. 1 & Fig.2.

The Khyber area comprises a mountainous terrain bounding the Peshawar plain on its west. Elsewhere in North Pakistan, the metamorphic rocks of Lower Swat and Mohmand Agency are separated from low grade states of the Attock-Cherat Ranges and unmetamorphosed Mesozoic Carbonates of Kalachitta Range by alluvium of Peshawar plain with those to the south of it. Khyber area is therefore unique in the sense where outcrops are continuous northward with the rocks of internal zone of Himalaya all the way to the Main Mantle Thrust and to the south with the rocks of Samana Range all the way to Main Boundary thrust. This area is therefore a useful link in the determining the structural and stratigraphic changes from the internal zone to external zone.

Bazaar Zakhakhel the project area is a part of Tirah Belt Khyber Agency. Due to its in-accessible Tribal Status, lack of communication, lack of administrative control, the area remained unexplored and inaccessible to systematic Geological Study in spite of its geological importance. Bazar Zakhakhel is a part of Tirah area Khyber Agency. It starts from a few kilometers south of Landi-Kotal and extends upto Jarobi in west and Bara River in south. It is located on survey of Pakistan top sheet Nos, 38 0/1, 38 N/4 and 38K/13 and roughly bounded by co-ordinates 1179000N-1200000N and 3300000E-3328000E. in Yards.

[2] Made traverses in Tirah and Bazar valleys and reported for the first time Paleozoic rocks in the area. He collected fossils from china of Bazar valley. [11] Made a geological traverse through the northern part of Tirah and described rock units in eastern parts of Chora valley and Rajgal area of Tirah valley. They found Palaeozoic sequences in Mughalbagh and Rajgal area of Tirah Region.

[6] Documented Devonian Conodonts faunas from southeastern part of the Khyber Agency at Mesrikhel area

## GEOLOGICAL & TECTONIC SETTING

Tectonically Bazar Zakhakhel lies at junction of two major tectonic zones of northern Pakistan (i) Northwest Himalayan fold and thrust belt (ii) Himalayan Crystalline Nappe and Thrust Belt.

### Northwest Himalayan Fold and Thrust Belt

This belt is 250 Km wide and about 560 Km long, irregularly shaped mountainous region stretching from Afghan border near Parachinar upto Kashmir Basin. A major thrust fault that is Panjal Khairabad fault divides the NW Himalayan sequence in to (i) Deformed southern zone, often referred to as the external or Foreland Zone and (ii) A Deformed and Metamorphosed Northern Zone, as the Hinterland Zone. Fig.3. The Foreland Zone is comprised of Hazara-Kashmir Syntaxes, Salt Range and Kohat, Potwar Fold Belt and Kurram-Cherat-Margalla Thrust Belt. The Hinterland Zone comprises the Himalayan Crystalline Nappe and Thrust Belt. Fig.3

### Himalayan Crystalline Nappe and Thrust Belt:

This 100 Km wide, intensely tectonized zone forms the northwestern margin of the Indo-Pakistan crustal plate and lies between the Khairabad-Panjal Thrust and Main Mantle Thrust. It extends westward from Nanga Parbat-Harmosh Massif up to the Sarobi Fault on Afghanistan at a distance of over 450 Km. Its southern part is largely covered by Quaternary deposits of Peshawar and Haripur Basins. North of Khairabad Panjal Thrust, low hill ranges comprised of Precambrian metasediments and a near complete sequence of fossiliferous Paleozoic and early Mesozoic rocks surround these basins. In the southern part, this sedimentary sequence, has been affected by low grade metamorphism, northwards near the MMT zone, the tecto-metamorphic setting changes from an essential sedimentary fold and thrust belt to a metamorphic and magmatic terrain which is characterized by thick stacks of nappies, thrust sheets and mylonitized shear zones. In this complex fold and thrust belt three major structural zones are evident.

From north to south these include (i) The Crystalline Nappe Zone, (ii) Khyber Lower Hazara Metasedimentary Fold and Thrust Belt, (iii) Peshawar Basin.

## REGIONAL GEOLOGY

The structure of NW Himalayan fold and thrust belt shows that the faults in the southern part bring strongly deformed Mesozoic and early tertiary rocks to the surface, while those in the north bring up Precambrian and Paleozoic sequences. Stratigraphic, tectonic, isotopic and paleomagnetic data indicates that NW Himalayan fold and Thrust Belt along with Kurram –Cherat-Margalla Fold and Thrust belt went through at least six periods of deformation. i.e during Precambrian, Permo-Triassic, Late Cretaceous, Pre Pliocene, Pliocene and Quaternary. In the belt Precambrian to Triassic strata are intruded by basic dykes and sills that however, do not cut the Mesozoic sequence and represent a Pre-Mesozoic Magmatic event.

Bazar Zakhakhel is the part of the Khyber Lower Hazara Metasedimentary Fold And Thrust. This Metasedimentary Fold and Thrust Belt lies to the north of Kairabad-Panjtal Thrust and extends eastward from Khyber Pass region to Garhi Habibullah. The Khyber-Hazara Metasedimentary Belt is largely composed of Precambrian to early Mesozoic Sediments. The Precambrian sequence is mainly comprised of slates and phylites with subordinate quartzite and marbles, which crop out in the southern part of the belt. In Khyber region a series of slates, phylites with limestones are intruded by Mafic Dykes is known as Landikotal Formation [8] and is considered to be Precambrian [7], Tab.No1. A fossiliferous (Conodonts Bearing) Paleozoic rocks occur in the hills, east of Peshawar Basin near Nowshera, in Sherwan Syncline of Hazara Area, and in the Khyber Pass Region [7]. The Paleozoic sequence mainly comprises thick beds of argillites, marbles and Dolomites. A widespread Amphibolite Horizon occurs in the upper part of this sequence and has been named as Karapa Green Schist [7]. Conodonts in the overlying and underlying formations indicate late carboniferous to late Triassic age for this unit. Geochemical analyses indicate that this Green Schist is Tholiitic Basalt.

The Khyber-Hazara Metasedimentary fold and thrust belt has been intruded by mafic dykes, sills and granitic rocks of which the extensive Ambela pluton and Warsak granite are conspicuous. These intrusive rocks range in age from Late Paleozoic to Early Mesozoic. This Metasedimentary Belt is characterized by tight, asymmetrical or isoclinal folds imbricated by several

thrust faults.

## GEOLOGY OF BAZAR ZAKHAKHEL AREA.

Bazar Zekhakhel is situated at transitional zone between Kurram-Chirat Fold and Thrust Belt in the southwest and Himalayan fold and thrust belt in the northeast and is situated at central part of Khyber Agency Fig 2. The stratigraphic sequence of the area is given in Geological map of Bazar Zakhakhel Area of Khyber Agency Fig 5. The Stratigraphic Overview is as follows:

### Shagai Formation

It is the oldest formation of the area and composed of black grey shale and slate found as in liar in shape of circular bodies and lenses. It contains dolerite dykes and sills at places its lower contact is not exposed, upper contact is with Khyber limestone, no fossils have been found from this formation and its age is thought to be Devonian to Silurian. [9].

### Khyber Limestone

It is most prominent sequence of the area forms thick & steep mountains, generally running in east west direction. It is composed of monotonous sequence of thick to medium bedded and thin-bedded brownish gray to dark gray laminated limestone-containing stromatolite at places on small-scale level form a series of reclined recumbent folds. It contains dolerite dykes and sills at Zairi Kandao area and small lenses of barite at Landi Khana, Zir Sar and Parpanry Sar Areas. Its thought to be Carboniferous – Permian. [9].

### Tabai Section Overview

At Tabai area thick sequence of heterogeneous lithologies starting from a small layer of shale at base overlain by quartzite bed both having no fossils are underline by three main successions of limestone. Fig. 4.

Dark radish maroon to buff limestone, having petted with black imbedded shells. It contained fossils like **Corals Crinoids, Brachiopods**. It also contained micro fossils like **Conodonts, Bryozoans, Ostrocodes**. At the centre of the bottom layer the strata is siliceous limestone having rhythmic layers total thickness is about 30 meters. The middle layer is pale yellow limestone having fossils like **Corals** and **Crinoids** comparative more thick bedded containing intercalations of gritty calcareous shale.

The top unit is medium to thin bedded fine grained, dark gray limestone having comparatively less fossils extending for beyond upto the bottom of the section Fig.4 .

The middle layer of limestone yielded Early Carboniferous (Tournaisian) zonally important Conodont Genus **Gnathodus**, (Fig. 6 a & b). This discovery is important because it and recent discoveries of early carboniferous sequences in the eastern Khyber Region, in the Turikho and uppermost Yarkhun Regions (Chitral), in the Hunza Valley (Gilgit) and though metamorphosed, among the metamorphics of the northwestern margin of the Peshawar basin, provide evidence of a formerly widespread marine early carboniferous sedimentary wedge extending over much of northwestern Pakistan (Indo-Pak and Karakorum Blocks).

Such sediments, and the generally associated latest Silurian Devonian sequence (Nowshera, Ali Masjid and Kuragh Formations or their equivalents) extending southwestwards beneath the Mesozoic-Cenozoic blanket, may have been source rocks for Petroleum. Rocks of similar age are widespread in central and Southern Afghanistan and Central Iran.

## CONCLUSIONS

It was as a result of preliminary geological investigations and research work in part of Khyber in the Bazar Zakhakhel area to find rich Fauna of Conodonts, Bryozones and Ostrocodes.

On the bases of discovery of Conodonts; it is important to conduct detailed studies of entire stratigraphic sequence in the immediate surroundings of the area for precise definition of the stratigraphic succession of the area.

The occurrence of Genus **Gnathodus** representing index fossil for the definition of Carboniferous boundary which to be investigated for Color Alteration Indices (CAI) because the (CAI) of Devonian-Permian Conodonts fall within the Oil and Gas Windows. What is sobering in this regard is that the seepage of oil and gas from well water and surface have been reported from Landikotal, Inzari Kandao (north of Landikotal) and Azakhel Area (south of Peshawar) as reported by locals at different times. Though the seepages has been stopped now.

Further investigations are thus desirable of all limestones for conodonts (CAI) coupled with elite crystallinity studies (as proxy for CAI) of associated mudstones and

shales (other than unequivocal Landikotal Slates or obvious metamorphic) occurring in the NWFP westwards from Peshawar to the Afghan border and immediately north of the great Mesozoic Cenozoic sedimentary complex on which so much of Pakistan's Petroleum Exploration has focus until now.

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**Table-1 : Modified after [9] showing the Stratigraphic Sequence of Eastern Khyber Agency.**

<b>Formation</b>	<b>Lithology</b>	<b>Age</b>
<b>Quaternary deposits</b>	<b>Gravel bed</b>	<b>Pleistocene to Recent</b>
<b>Murree Formation</b>	<b>Shale, sandstone, conglomerate etc</b>	<b>Miocene</b>
<b>Khyber Limestone</b>	<b>Predominantly limestone with shale and sandstone</b>	<b>Premain Carboniferous</b>
<b>Ali Masjid Formation</b>	<b>Limestone (reefoid in places) quartzite and shale</b>	<b>Devonian</b>
<b>Shagai Limestone</b>	<b>Limestone and dolomite</b>	<b>Devonian Silurian</b>
<b>Landi Kotal Formation</b>	<b>States Phyllites, limestone, quartzite and some igneous rocks</b>	<b>Silurian Ordovician to Cambrian</b>

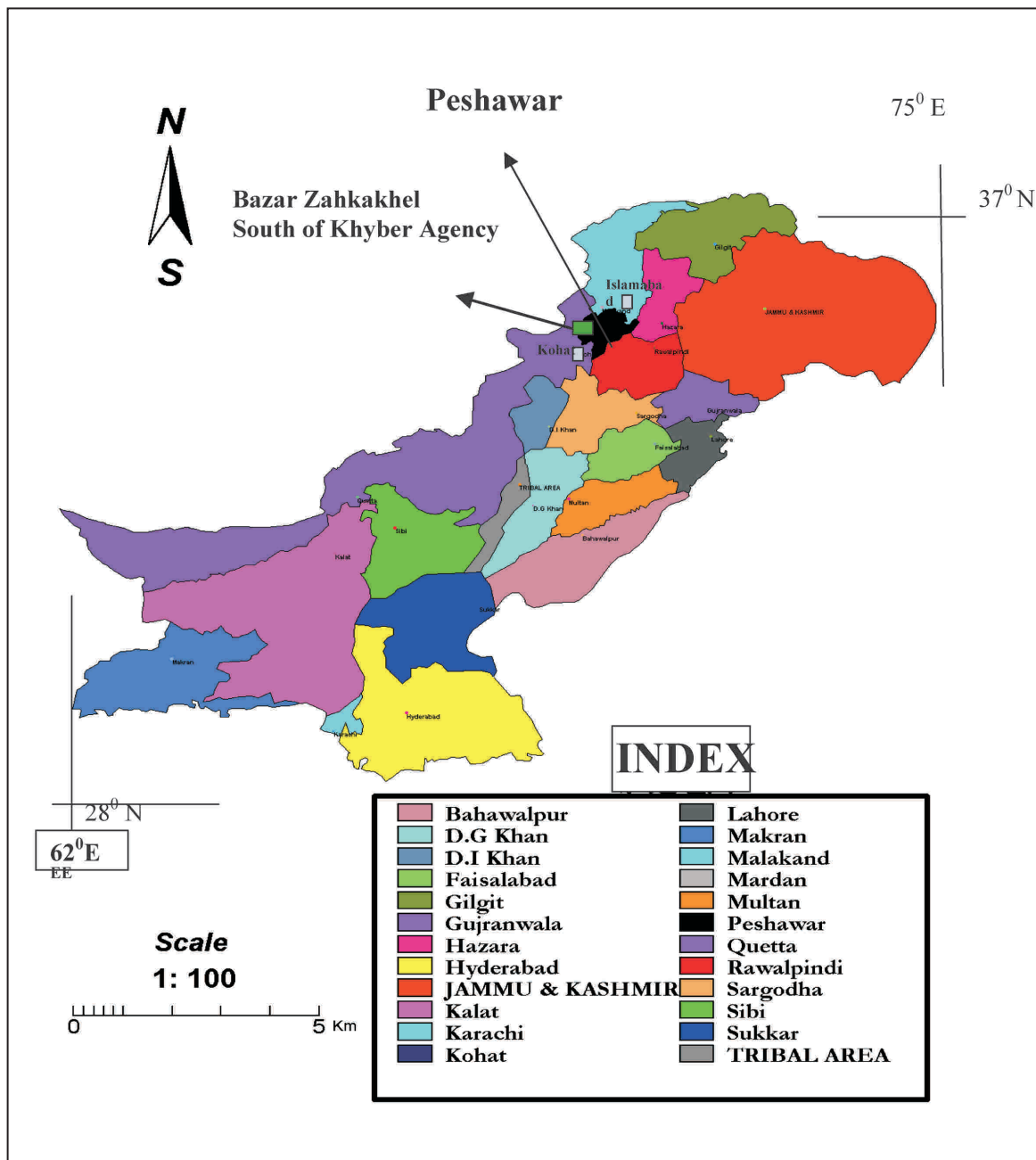


Fig. 1 - Index Map and Division Map of Pakistan, Showing the location of Bazar Zahkakhel Area, South Khyber Agency, North Pakistan.

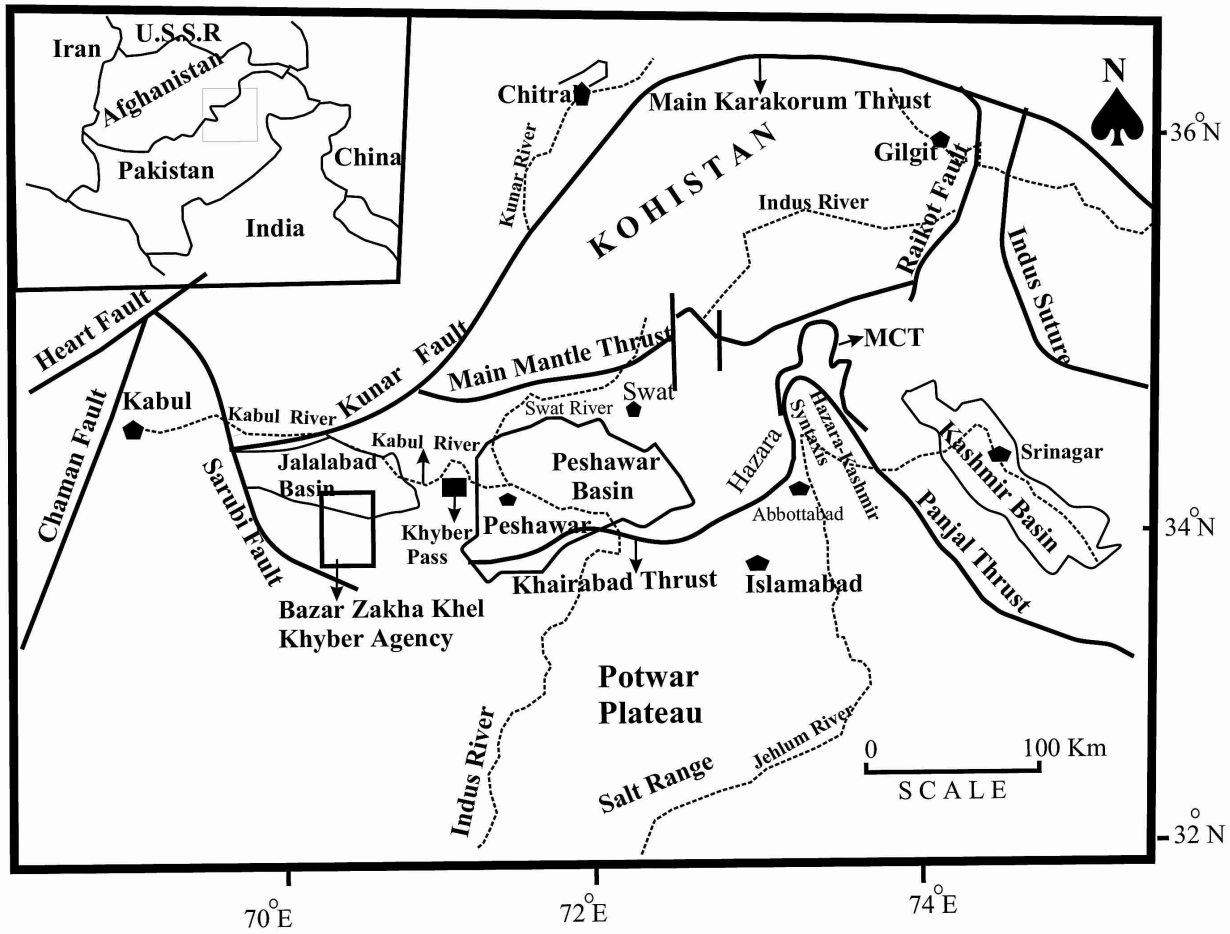


Fig. 2 - Index map of the Jalalabad Basin, showing the location of Bazar Zakha Khel and selected major Himalayan Faults modified after [ 7].

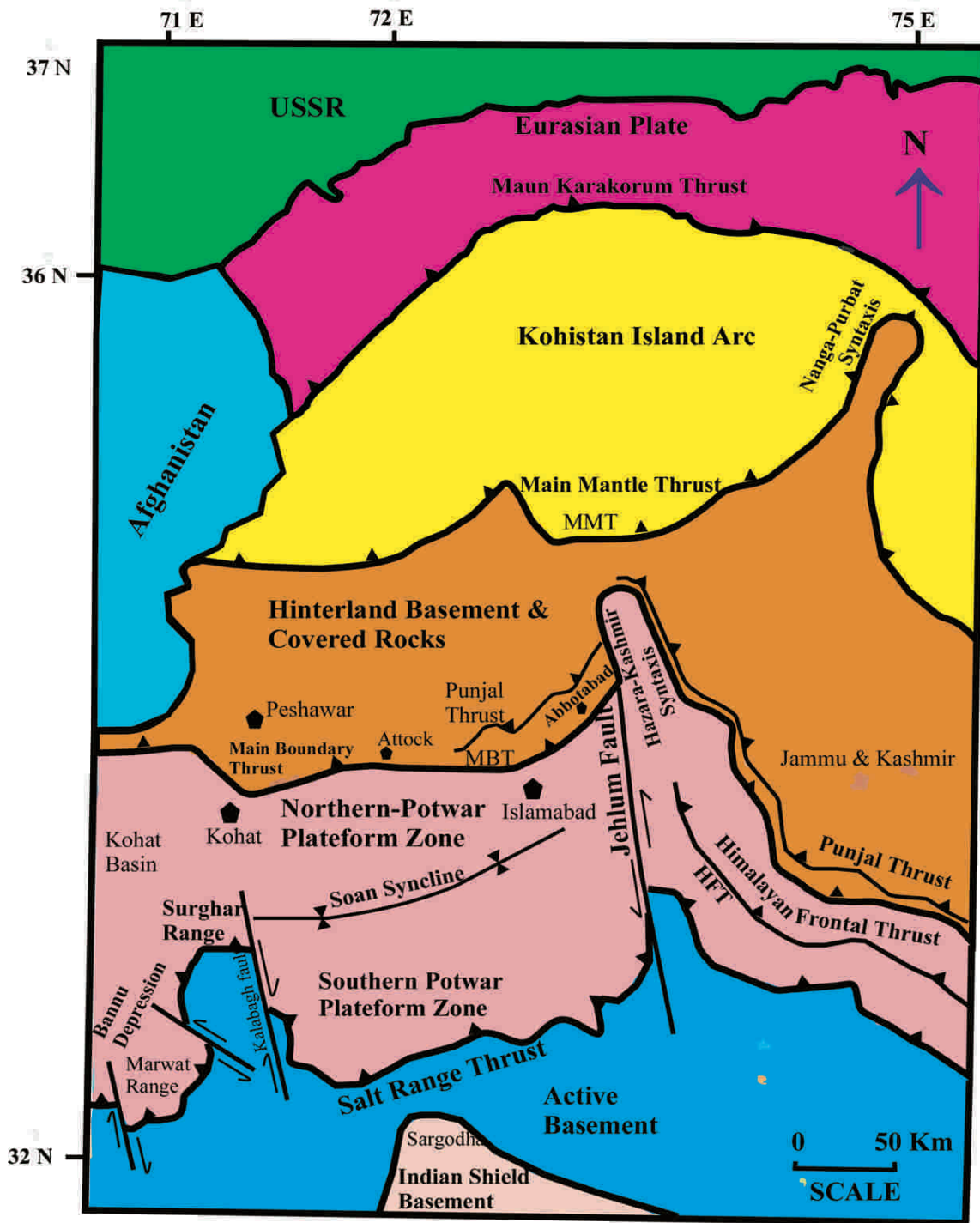


Fig. 3 - Regional Tectonic Map of Northwest Himalayas of Pakistan.

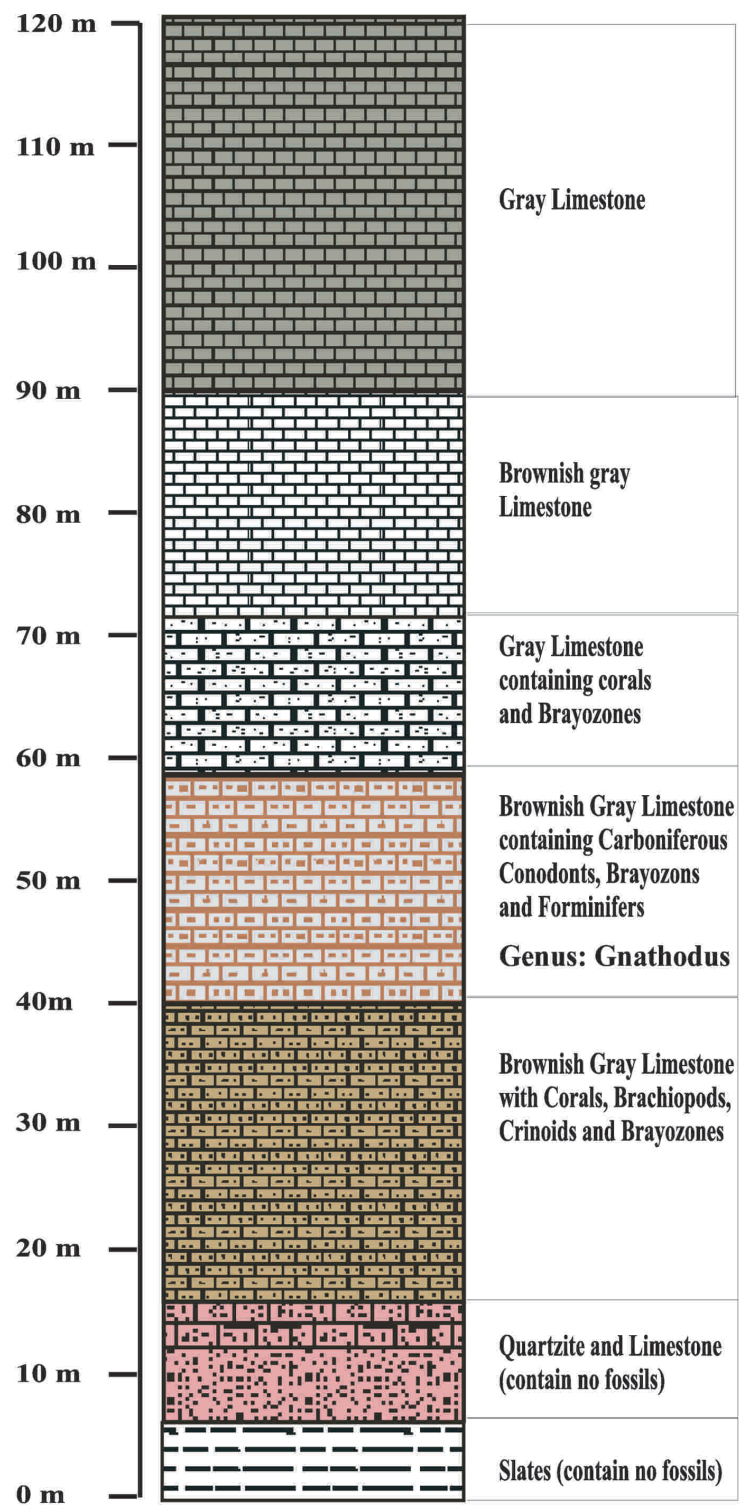


Fig. 4 -Vertical & Lithological Section of Tabai Formation at Tabai Section South of Khyber Agency, North Pakistan.

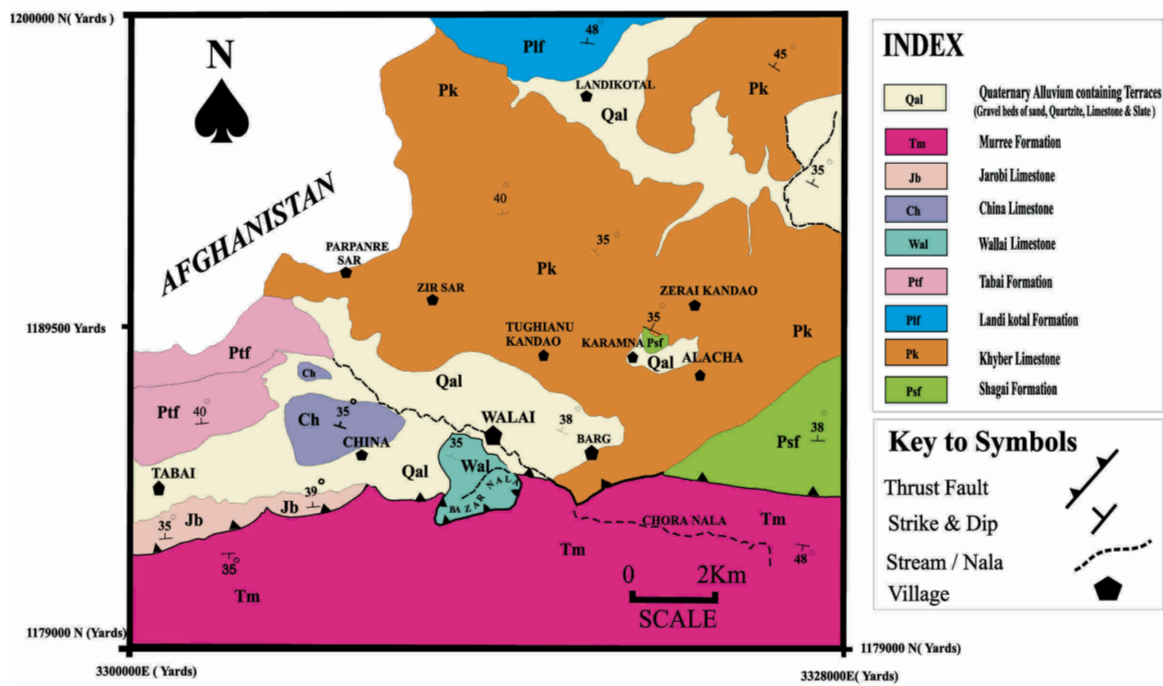


Fig. 5 - Geological Map Of Bazar Zakhakhel And Tabai Area, South of Khyber Agency, North Pakistan.

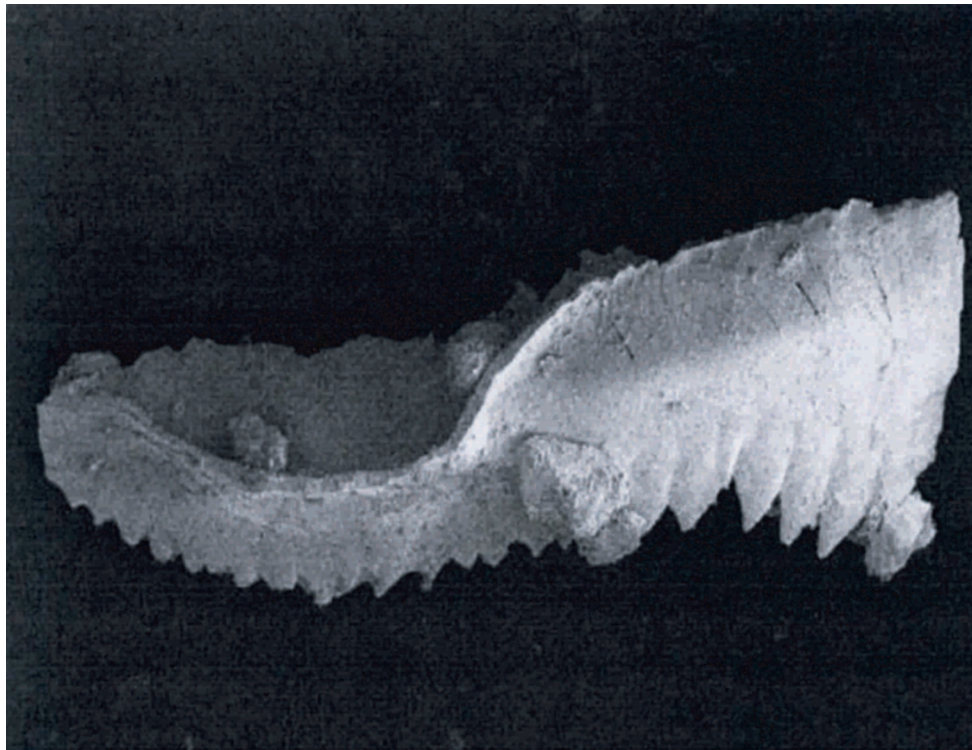
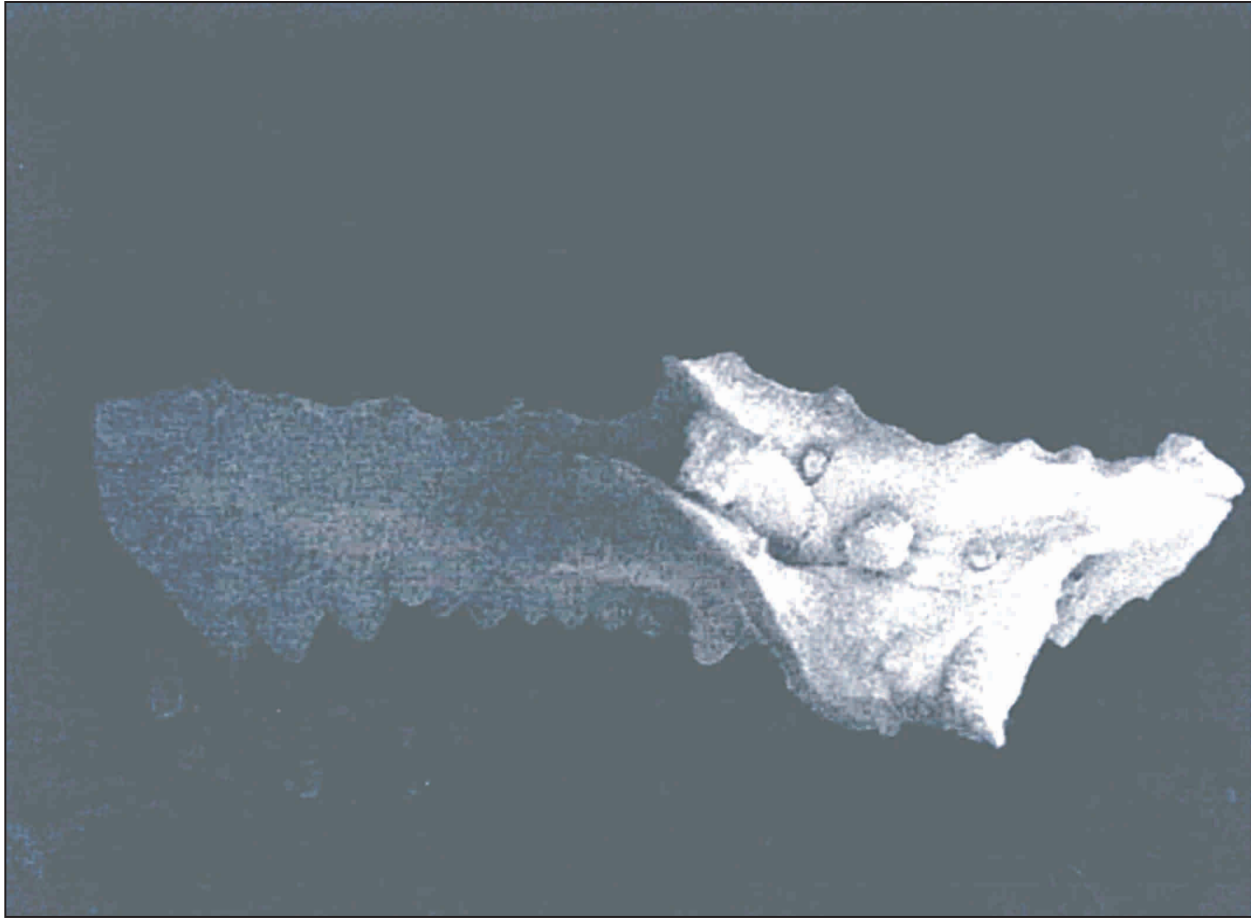


Fig. 6a - "Gnathodus Species" of Conodont Micro Fauna, reported Tabai Formation at Bazar Zakha Khel, Khyber Agency, N.W.F.P. North Pakistan.



**Fig. 6b - "Gnathodus Species" of Conodont Micro Fauna, reported Tabai Formation at Bazar Zakha Khel, Khyber Agency, N.W.F.P. North Pakistan.**

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## ABOUT THE AUTHOR

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### **Dr. Fazli rabbi khan**

*Dr. Fazli rabbi khan completed Ph.D in micro-paleontology from U.C.B Lyon 1, France 1993, and French language course, CAVALAM, VICHY, FRANCE 1990. M.Sc in sedimentology from Department of geology University of Peshawar, 1977. And attended following short courses, short course on the hydrochemistry laboratory exercise and field work, NCE Geology university of peshawar, 1988, three month training on Micro-Fauna at Royal Institute of Natural History, 1991, Concept of Sequence Stratigraphy course at the National Institute of Oceanography, Karachi Pakistan, 1998, Short course on the Geochemical Exploration for Oil and Gas Assumptions, Applications and Recent Advances at Hotel Holiday Inn, Islamabad Pakistan, 2003. Professional experience, 1979–till todate NCE in Geology, U.O.P. Peshawar, N.W.F.P. Teaching, Graduate and Post Graduate and higher level studies and research. Curator for Development and maintenance of the museum of Department of Geology, University of Peshawar. 1982–1984 Mecca, Medina and Jadda Highway project; Ministry of Communications Saudi Arabia. (EM, IP and Gravity) for copper and base metals in the Ophiolite environment. Supervised the Geodata Computer Lab of FATADC for managing the Mineral Data and processing of Copper project data for preparation of pre-feasibility and evaluation on mining and marketing parameters. Currently working on Kurrum Tangi Dam Project, N.W.F.P.*



### **Muhammad Irfan Khan.**

*M. Irfan Khan is currently enrolled for Ph.D. Programme in National Centre of Excellence in Geology, University of Peshawar. He acquired B.Sc Hon's and M.Sc degree with specialization in Petroleum and Structural Geology from Department of Geology, University of Peshawar in 2002. He got distinction at Master level. He worked with Premier & Kufpec Pakistan B.V. in various disciplines including formation evaluation, prospect evaluation and digitization of Kirthar, Benir, Khambu, Dumber structures. Irfan's field of interest is Structural Geology, Petroleum Geology and Geophysics. He also attended workshops on Petroleum Exploration organized by H.D.I.P. and Petroleum Symposium 2003. His long cherish goal is to become an active part of the Petroleum Industry in the field of Exploration .*



### **Mohammad Ihsan Afridi**

*Mohammad Ihsan Afridi Completed my elementary education from my home town in the Khyber; Qualified my post graduate degree in Geology from the University of Peshawar in 1982. My main area of research is the Igneous /Metamorphic Petrology, Petrography and Mineralogy. Also conducted research in the Plate Tectonics and remote sensing, worked as an exploration geologist for base and precious metals projects in the western fold belt and Ophiolites terrains along the Pak-Afghan boarder areas of FATA. Conducted Diamond Core Drilling and Ground Geophysics. Detailed mapping, survey and grid sampling for various Copper Prospects in the Waziristan area. Worked in the Federally Administered Tribal Areas Development Corporation (FATADC) as Geologist from September 1982 till September 2001. During my professional carrier, I Worked in different capacities in the field and Laboratory for conducting survey and exploration research on minerals in the Tribal Belt of Pakistan. Supervised Petrographic Laboratory for rock and mineral research studies. Supervised field research for reconnaissance survey and geological mapping of part of the unmapped areas of FATA. Supervised Diamond Core drilling and logging work. Supervised and interpreted the Geophysical survey (EM, IP and Gravity) for copper and base metals in the Ophiolite environment. Supervised the Geodata Computer Lab of FATADC for managing the Mineral Data and processing of Copper project data for preparation of pre-feasibility and evaluation on mining and marketing parameters. Currently working on Kurrum Tangi Dam Project, N.W.F.P.*

