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THE GEOLOGICAL, STRATIGRAPHICAL AND HYDROGEOLOGICAL STUDIES AROUND SINDH UNIVERSITY, ALLAMA I. I. KAZI CAMPUS, JAMSHORO.

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Abstract

The investigated area belongs to Kirthar Province, lower Indus basin and Laki Range lying on the Hyderabad arch. This paper mainly describes the Stratigraphical, Lithological, Hydrogeological and Geological setup around the Sindh University. Besides this the structure and tectonics of the area is also discussed. In order to get the controlled composite columnar section, three sections from different localities were measured. The rocks in the studied area are of clastic and nonclastic of marine origin. The clastic rocks are mainly Shales and Marls with subordinate Sandstones while the non clastics are Limestones.

The oldest rock in the area belongs to upper Ranikot group of Paleocene (Lakhra formation) whereas the youngest rocks belong to lower Eocene (Laki Limestone). A forty two meters thick water bearing zone of marginal to fine quality is suggested in the subsurface of the studied area .

Keywords:- Geological, Hydrogeological, Stratigraphical studies, Sindh University, Jamshoro.

Introduction

Jamshoro is virtually the gateway of the Indus valley and situated on the junction of the Super Highway and the Indus Highway. Th e studied area belongs to district Dadu, about 16 km in the west of Hyderabad, 150 km towards the north of Karachi and about 4km on the right bank of river Indus (Fig. 1). Jamshoro is hilly area striking north south with gentle dip upto five degree and the northward continuation of the same hilly track joins the Laki range, merging with Kirthar northwards. The studied areas lies in Toposheet No. 40 C/3 in between Latitude 25° 15′ 25″ – 25° 30′ 00″ N and Longitude 68° 07′ 43″ – 68° 15′ 00″ E (Figs.2-4).

The main purpose of the paper is to describe the lithological, hydrogeological and stratigraphical studies around the Sindh University, Jamshoro. Geological mapping on 1:50,000 scale of Toposheet No. 40 C/3 was also carried out. The lithological studies of different exposed rocks are done from various places, in order to provide the lateral and vertical facies changes and to get environmental control. For establishing a complete stratigraphic section, three locations were chosen to make a composite section from Lakhra (Paleocene) to Laki Limestone (Eocene) Fig. 5. The geological map was prepared to achieve the structural and tectonic controls. The map provides the basic geological information, which can be used in different disciplines, like civil Engineering, soil investigation, Planning and Development, Mineral resources investigation and correlation.

Material and Methods

The mapping of the area was carried out on the Survey of Pakistan Toposheet, having scale 1:50,000 and is reduced to the present form according to the format of the page. Since the outcrops of the investigated area have low dips ranging from 2-5 degress. Therefore, the section measurements for the thickness of the formations were done by measuring slope distance, angle of slope and using the formula of sine & cosine of the angles. To investigate the subsurface hydrogeological conditions, geophysical resistivity survey was used.

Geological Setup

The studied area is the part of Laki range, Kirthar Province and lower Indus basin, which is one of the major sedimentary and structural basin of Pakistan, The studied area consists of both clastic (Shale) and non-clastic (Limestone) rocks of sedimentary origin. The limestone of the studied area is argillaceous and partly arenaceous. Geological setup of the area is as under.

Laki limestone
Conformity
Meting shale
Conformity
Meting limestone
Conformity
Sohnari bed
Disconformity
Lakhra formation

Stratigraphic Description

The studied area is the part of lower Indus basin, which plays an important role in the stratigraphy of Pakistan and the stratigraphic sequence exposed in the different studied areas in the ascending order is discussed as under

Lakhra formation

Blanford (1876) suggested the name "Ranikot group" for Lakhra formation. But finally Ahmed and Ghani (1971) proposed the name Lakhra formation, after Lakhra, in Laki range, for (upper Ranikot Limestone) of Vredenburg (1906) and (upper Ranikot) of later workers.

It is well exposed at the core of anticline near Lakhra village in the North West of Jamshoro Thermal Power Plant. (Latitude 25° 40' 15'' N, Longitude 68° 15' 20'' E) 40 miles North West of Hyderabad. Type section is at Lakhra Bholari section, southern flank of Lakhra anticline Laki range. The Lakhra formation is mainly composed of Limestone with sub-ordinate Shale and Sandstone. In the studied area Lakhra formation is exposed three kilometers to the west of Federal Hostel in the core of plunging anticline. The lower part of it mainly consists of Limestone which is mostly yellowish grey to dark grey with yellowish patches, in places it displays variegated colours and weathers in yellow, buff to brown and dirty brown or orange to pinkish in colour. The limestone is massive to thick bedded. It is hard, compact and having a very rough weathered surface showing cavities of chemical weathering. It breaks into fragments of very sharp edges. It is arenaceous and shows sugary and brecciated texture.

The upper part of the Lakhra formation is inter bedded with layers of about 2-3 cm Shale of reddish brown, Clay and Sandstone. The Shale and Clays are mostly gypsiferous and calcareous. Whereas the Sandstone shows sugary texture and is fine to medium grained.

The Lakhra formation in this area is about 35 meters thick. Its lower contact is not exposed whereas its upper contact is disconformable with Sohnari beds of Laki formation. It contains poorly preserved fossils of Bivalves, Brachiopods, Gastropods, Nautilus and larger Forams in the studied area. On the basis of faunal study of larger Foraminifera and mega fauna, Hunting Survey Corporation hereafter HSC (1960) has assigned late Paleocene age to

Lakhra formation. The important forams reported by HSC are *Nummulites nuttalli, N. thalicus, N. globulus, N. sindensis, Assilina ranikoti, Miscellanea miscella, M. stampi, Lokhartia haimei, Lepidocyclina (Polylepidina) punjabensis* and *discocylina ranikotensis*. In the present study the *Nummulites nuttali, Assilina ranikoti* have also been reported which also confirms Lakhra formation to be the late Paleocene in age.

Laki formation

Blanford (1876) proposed as "Lower part" of his "Kirthar series". Noetling (1903) named it as "Laki series" and separated from Kirthar on Palaentological basis. HSC (1961) redefined unit as (Laki formation). Type section is at Mari Nai (Latitude 26° 6' 00'' N, Longitude 67° 51' 00'' E) southwest of Bara Nai. The subdivisions of the Laki series northern Laki range were made by Vredenburg (1906) and Nuttall (1925). Nuttall (1925) gave the following subdivisions which are widely accepted and are named in the ascending order as under

Cheema et al, (1977).

Laki limestone

Meting shale

Meting limestone

Sohnari / Basal Laki laterite

Sohnari member

The Sohnari member is very well developed around the Meting Jhampir area in the Thatta District. But in the studied area

Sohnari member is exposed at the base of most of cuestas or as scattered outcrops and in the forms of pockets of Limonite / Ochre covering the Lakhra formation. It consists of highly ferruginous Clay and Shale of variegated colours with subordinate rusty brown Sandstone.The Shale ranges from yellowish orange, red, maroon, rusty brown, liver red, and brick red. It is soft, and loose. It contains thin layers (about 2-3 cm) of Gypsum and red Claystone. The mega fossil occurrence in this member is either nil or rare. It overlies the Lakhra formation disconformably while it underlies the Meting Limestone conformably. It is 4 meters thick and early Eocene age is assigned to it.

Meting limestone and Meting shale member

The name Meting limestone has been derived from the lower Sindh, where this limestone is exposed near Jherak. In the studied area Meting limestone is mostly present in the southeast and southwest. Its colour is white, creamy white, brownish yellow. Weathers to grayish brown, and yellowish white. It is massive, medium hard and nodular. The nodules are angular to sub-rounded and are full of larger Forams mostly *Alveolina* spp. In some places the Limestone becomes *coquinoidal*. The Mollusks are also commonly found. It's upper and lower contacts are conformable with underlying Sohnari beds and overlying Meting shale. In the studied area the Meting shale member is exposed to the South of Habib Bank and is commonly found to the further South and along the Super Highway road cuttings.

On the occurrence of its characteristic fauna *Alveolina oblonga, Flosculina globosa* the early Eocene age is assigned to it by HSC (1960).

Laki limestone

Outcrops of Laki limestone member are widely distributed in the studied area. Sindh University , Allama I. I Kazi Campus

Jamshoro is situated on the hillock of this member. Mainly it contains Limestone but partings of interbedded Shale are present. This member can also be further subdivided into two units. The lower unit is white, nodular, weathers yellowish orange and is hard, massive and fossiliferous. The upper unit of this limestone is white, cream and chalky in which the fossil occurrence is abundant which include larger Forams, *Gastropods, Echinoderms* and *Bivolves* with full of solution cavities. It is medium to thick bedded and forms small ridges in the investigated area. The total thickness in this area is about fifteen meters. The good collection of fossils of Laki limestone member together with other members of Laki formation were reported by HSC (1960) and Iqbal (1973). Among these the typical forms are *Assilinia granulosa, A. pustulosa, lockhartia hunti var. pustulosa, Flosculina globosa, F. oblonga, Linderina brugesi, Dictyoconoides vredenburgi, Gisortia murchisoni, Velates perversus* and *Blagravvia sindensis*. Some well preserved fossils of the form of *Assilina* sp. and *Assilina granulosa* are also reported presently. The above fossils indicate an early Eocene (Ypresian) age.

Discussion

The studied area lies in lower Indus basin, Kirthar Province, Laki range. The area is covered by highly folded belts on the North-West and South West. It is going to be plain on the East and South East. Main structural feature in the North West of studied area is double plunging Lakhra anticline, having two western and eastern flanks. Studied area is lying on the eastern flank. HSC (1960) reported the axial length of Lakhra anticline is 65 km and width 24 km.

Eastern flank is dipping gently in South East direction with value from 1°- 3°. The area has North East strike direction with little variation. The thickness of Lakhra formations is reducing towards North East & South East where it is overlain by laki formation.

There is a minor fault, generally parallel to anticlinal axis having Norh South trends. There is an unconformity (disconformity) between Lakhra and Laki formation. Tectonically Indus basin can be divided into four parts.

1. Indian Shelf
2. Sloping Shelf
3. Foredeep
4. The borderland.

The studied area lies in the western part of Hyderabad arch, (dominant positive feature in the sloping shelf). Hyderabad arch is a simple, broad anticlinal feature, developed approximately during late Creataceous. But the crest became first emergent during late Paoleocene or early Eocene.

During the origin of Himalayan orogeny, compressional forces affected the area, which are still affecting and in the result uplifting of the area has taken place then on further compression folds and faults developed in the area.

The rocks of (Lakhra and Laki formation) exposed in the studied area were deposited under marine to fluvial environmental conditions. As indicated by the nature of exposed rock units. Rocks are mainly non-clastic (limestone) with subordinate clastic (shale) and at places partly arenaceous.

The presence of fossils indicates that deposition of rocks has taken place in two different time periods. At first deposition of Lakhra formation took place under shallow marine conditions, during Paleocene period

when main transgression occurred, spreading from west to north east contained manly gastropods. Later on water became clear then foraminifers also appeared. Climate was arid, as indicated by the presence of gypsum beds.

After the deposition of Lakhra formation, the sea regressed westward as indicated by the lateritic bed of Laki formation at Lakhra. The laterite bed/Sohnari indicates disconformity between Lakhra and Laki formation. The regression of sea brought fluvial environment, depositing lagoon Sohnari/Laterite member of Laki formation. The presence of highly oxidized lateritic bands confirm its fluvial origin.

Second time, during the deposition of Laki formation sea transgressed from west to north during early Eocene. The Laki formation, which is mainly composed of non-clastic sediments accumulated on the shelf, in an open shallow marine conditions as indicated by the presence of reefoid growth of foraminifera and shallow water fauna. (Haque, 1962). The climate was tropical to sub-tropical throughout the deposition of Laki formation. Economically the studied area is not so valuable but some non economic minerals like Gypsum and Ferruginous material are available. Limestone of Lakhra formation can be used as a building material. Some crushing plants are already in progress to the north of this area. Laki Limestone being a nodular and loose is easily transported for the construction material.

The occurrence of red and maroon Clay with Laterite indicates that the depositional conditions were shallow marine where enough oxidation took place. Meanwhile the presence of Gypsum in the Laterite shows that sea was so shallow where vaporization took place giving rise to the gypsum interbeded in Clay.

Hydrogeology

The studied area is a part of lower Indus basin and on the right bank of river Indus. The hydrogeological conditions in and around Jamshoro are characterized by low rainfall, non-perennial streams and long periods of drought. Rain usually falls only during the monsoon and in the short bursts. Because the hard and rocky surface, the large areas of bare rock with slopes creates higher runoff rates when there are short periods of rainfall. This further leads to provide lesser opportunity for infiltration of water downward and the water rapidly funnels through numerous streams into major waterways.

The climate of the studied area is broadly classed as hot and arid. The area is characterized by hot summers, mild winters and scanty rainfalls. The average annual precipitation ranges from 5-10 inches (Soomro et al, 1997) and the area is included in the arid zones of Pakistan. In the summer the temperature ranges from 35°-45°C and in the winter temperature ranges from 10°-20°C. The ideal time for the field work in the mapped area is from November to March. Vegetation is very thin due to lack of adequate soil cover and scanty rainfall. The cultivation at some places is done by rain water.

The surface Geophysical Resistivity Survey was conducted in the investigated area to ascertain the subsurface hydrogeological conditions for delineation of the quality and thickness of groundwater body in the subsurface. The Electrical Conductivity of groundwater sample at one site is successfully correlated with the surface resistivity of water bearing layer. The zone

about 42m thick Sandstone / fractured Limestone (aquifer) is suggested behind boys hostels in a valley with groundwater of marginal to fine quality and can be utilized for drinking & agricultural purpose.

Layer No.	*Resistivity (ohm.m)*	*Thickness (m)*
1	32.8	3.0
2	5.4	1.5
3	40.8	2.0
4	960.0	5.8
5	25.0	42.5
6	2.0	-

Table showing the geophysical resistivity data of the subsurface (After Soomro, S.A, 1997).

The resistivity data of layer No.4 with resistivity 960 ohm.m in the middle shows that there is a hard and compact rock of Limestone. Then there is late falling data of layer No.5 with resistivity 25 ohm.m and thickness 42.5m which is most probably due to the water bearing zone of sandstone or fractured Limestone (aquifer) in the area (Soomro, et al, 1997).

Acknowledgement

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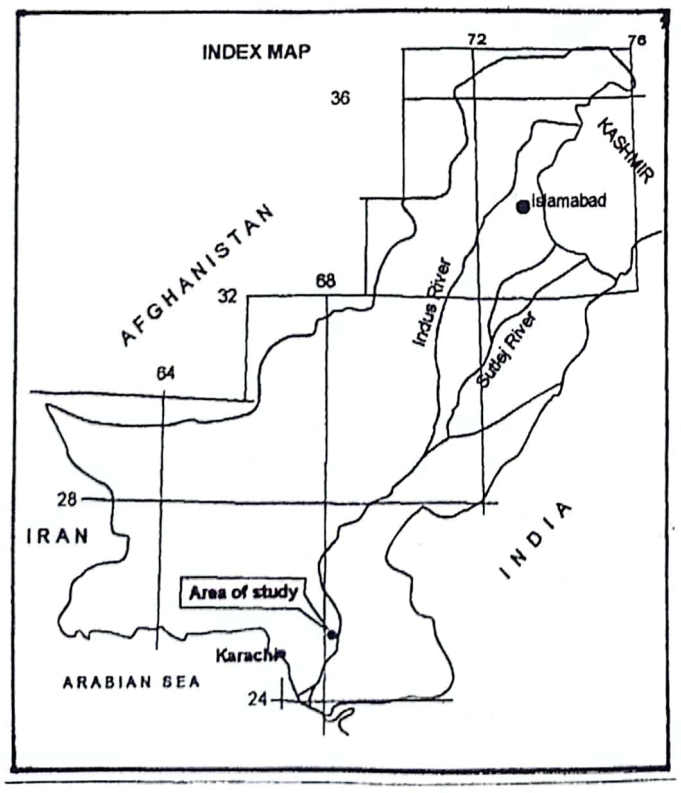


Fig. No.1: Index map of Pakistan showing the area of Investigation.



Fig. No.2: Geological Map of the area

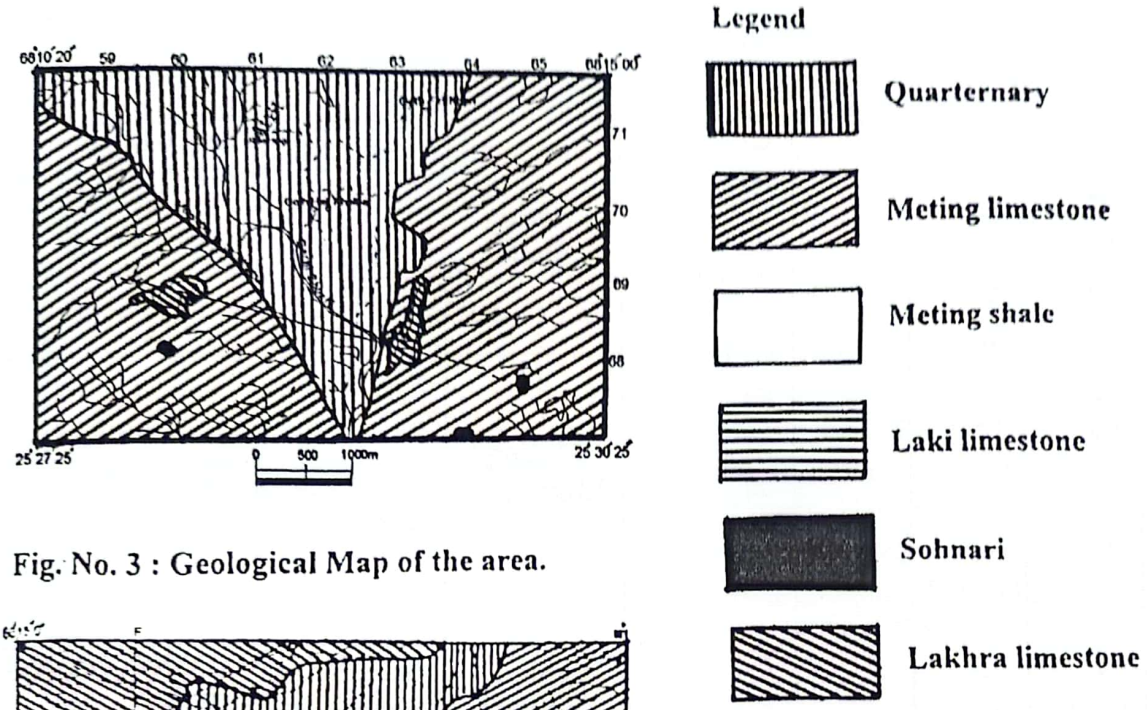


Fig. No. 3 : Geological Map of the area.

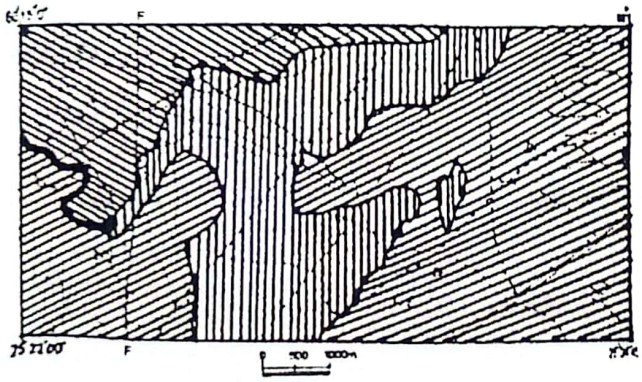


Fig. No.4: Geological Map of the area

Era	Period	Epoch	Group	Formation	Member	Lithology	Lithologic description.
CENOZOIC	EARLY TERTIARY	EOCENE		LAKI FORMATION	Laki Limestone		Limestone, white, chalky, pale orange weathers to light pale yellowish orange, thick, massive, sandy, argillaceous and highly fossiliferous.
					Meting Shale		Brown, olive brown, weathers to dirty olive brown, soft loose, calcarious and gypsiferous.
					Meting Limestone		White nodular, hard, massive, fossiliferous.
					Sohnari		Red, rusty brown, gray and maroon ferrogeneous, highly oxidized, soft, gypsiferous.
		PALEOCENE	RANI KOT	LAKHRA FORMATION	Lakhra		Mainly Limestone interbedded with thin layers of shale, clay and gypsum of varied colors and is fossiliferous.

Composite section of Paleocene & Eocene rocks

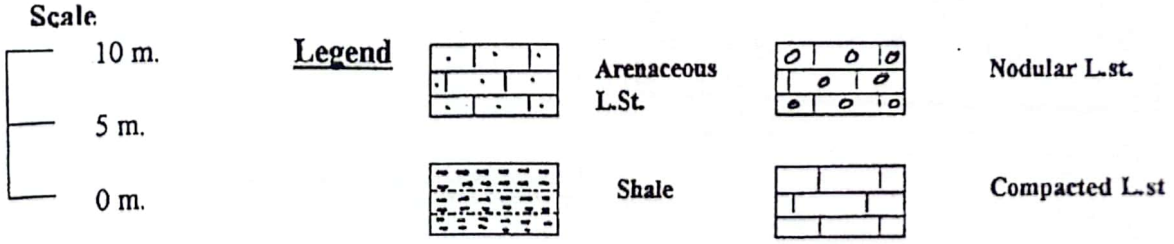


Fig. No. 5 : Composite section of Paleocene and Eocene rocks.

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