

GEOLOGICAL STUDY OF THE WESTERN FLANK OF SURJAN ANTICLINE, THANO BULA KHAN, SINDH, PAKISTAN

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ABSTRACT

Detailed geological mapping of the western flank of Surjan Anticline was carried out in order to gain better understanding of geology of the area in general, and economic potential in particular.

The rocks in the area range in age from Early Eocene to Oligocene. Early Eocene rocks predominantly are composed of limestone of the Laki Formation, where-as Middle Eocene comprise mostly of shales and marl beds of Tiyon Formation. Oligocene is characterised by fossiliferous limestone and sandstone of Nari Formation. **Fig.3.**

Structurally, the western flank of the anticline has gentle dips in comparison to very steep dips on the eastern flank. A major fault which runs through Surjan Anticline to Sumbak is known as Surjan Sumbak Fault. Huge deposits of chalky limestone. Fuller's earth and celestite which can be of great economic importance, have been observed in the studied area.

INTRODUCTION

The purpose of this paper is to publish the findings of the detailed geological mapping of the Western Flank of the Surjan Anticline and also the economic potential of the area.

a) LOCATION AND ACCESSIBILITY

The area under present study can be located on the toposheet No.35 0/15 lies in between the Latitude 25 30' 45" to 25 34' 35" and Longitude 67 25' 15" to 67 29' 20".

Fig.1.

The mapped area is accessible by a metalled road which is running between Super Highway and Thano Bula Khan. The area starts from well-known Chohar Pass at a distance of about 6 km. westwards, leading to Thano Bula Khan. Fig.2.

b) TECHNIQUES OF STUDY

The mapping was carried out by traverse method. Traverses were conducted across the structures. Stations were chosen mainly at the Formation contacts. The contacts then were followed on either side and marked on the map. The section was measured along the line A-B on the map. The mapping was carried out on 1:50,000 scale.

GENERAL STRATIGRAPHIC SUCCESSION

The rocks exposed in Surjan range are of sedimentary origin which range in age from Early Eocene to Pleistocene together with the recent and subrecent deposits. Within mapped area Kirthar Formation is missing, therefore the contact between underlying Tiyon and overlying Nari Formation is unconformable. Following table gives the arrangement of established stratigraphic units.

PERIOD	AGE	FORMATION	LITHOLOGIC DESCRIPTION	THICKNESS
Q U A T E R N A R Y	Late Pleistocene	Dada Conglomerate Sub-Recent	Consolidated silt, sand, pebbles, cobbles & boulders.	20 Meters
	Unconformity			
T E R T I A R Y	Oligocene	Nari Formation	Alteration of sandstone, clay & limestone. Sandstone is multicoloured, fine to coarse grained, thick bedded. Clay is grey, light brown, yellowish brown, crumbly and gypsiferous. Limestone is yellowish brown, light grey and pale orange, hard & fossiliferous.	08 Meters
	Middle Eocene	Tiyon Formation	Intercolation of limestone, clay, moderately hard, nodular, thin to thick bedded and fossiliferous clay is dark grey, greenish grey, soft and crumbly and gypsiferous. Marl is creamy and chalky white, and fossiliferous.	70 Meters
	Early Eocene	Laki Formation	Limestone with few bands of Marl. Lime stone is light grey, creamy and white, hard, nodular, medium to thick bedded, chalky, highly fossiliferous. Marl creamy and yellowish, moderately soft and fossiliferous.	134 Meters

LAKI FORMATION

The Laki Formation in the studied area consists of the following members:

- i) Laki limestone
- ii) Mering shale member
- iii) Mering limestone member
- iv) Sorhary member

Within the mapped area, only the Laki limestone is exposed. The Laki Formation mostly consists of limestone, marly limestone and marl. Limestone is grey, chalky white, yellowish and creamy in colour and weathers to grey. It is hard compact, thin to thick bedded, highly fossiliferous but the lower beds contain less fossils. The marly limestone is soft and thin bedded, light yellow to green in colour and it weathers to pale orange. The marl is yellowish brown and cream coloured, soft and fossiliferous. Fig.3.

On the basis of lithological variations, the Laki Formation has been divided from base to top into the following three members:

1. Nodular Limestone
2. Chalky Limestone
3. Massive Limestone

The complete section of Laki limestone is exposed in the ridge of SURJAN Anticline. The limestone is beautifully exposed in the flat topped hills of almost horizontal strat. Limestone in this area has been measured by the present workers as 134 M thick. The Laki Formation lies unconformably over the Paleocene rocks at most of the places, probably due to development of the Hyderabad High.

The Laki Formation has conformable contact with the Tiyon Formation. Foraminifera area is the abundant

fossils of Laki limestone. They include *Alveolina Globosa*, *Alveolina Oblanga*, *Discocyclina*, *Lapidocyclina* and *Nummulites* among *Gastropods*, *Natica*, *Certhium* and *Conus* which are commonly found. Others fossils include *Echinoids* and *Lamlibranchia*.⁹

TIYON FORMATION

The Tiyon Formation consists of soft nodular limestone interbedded with clay and marl. The limestone is brownish yellow, light grey, cream coloured, marly, and is highly fossiliferous. The clay is dark brown, yellowish brown, gypsiferous, calcareous and fossiliferous. Fig.3.

Tiyon Formation is mainly exposed on the western and eastern flanks of the Surjan range. The contact of Tiyon Formation is conformable with the underlying Laki Formation and it is unconformable with the overlying Nari Formation. The Formation was deposited in shallow marine environment probably in the shelf area.²

Foraminifera are abundant in Tiyon Formation. They include *Alveolina Oblanga*, *Assilina exponus*, *Camerina* and *Texturina*. Other less abundant fossils include *Lamlibranchia* and *Gastropods*.⁸ The amount of Dip is about 5° and the Strike is about N 85° W. Total thickness measured by the present workers is 70 Meters.

NARI FORMATION

The Nari Formation is mainly composed of sandstone, shale and limestone. The sandstone is calcareous and compact. Some portion of sandstone is friable. The sandstone is unfossiliferous. The formation is divided into two parts on the basis of fauna and lithology:

a) LOWER NARI FORMATION

It consists predominantly of light grey, brown,

yellowish brown, greenish grey and reddish brown sandstone. It weathers to grey and brownish grey. The limestone is in minor amount. It is grey, yellowish brown and weathers to dark grey and dark brown. Limestone is highly fossiliferous. The basal part of this unit consists of limestone interbedded with conglomerate.

b) UPPER NARI FORMATION

This part consists of skeletal limestone, calcareous sand, and soft shale. Some beds of limestone are full of fossils. Shale is greenish grey, yellowish brown and the weathered surface remains unchanged. It is gypsiferous, loose and at places interbedded with clay, sandstone and lateritic bands. Most part of the Upper Nari Formation consists of shale with thin beds of sandstone.

The lower Nari is of marine and the upper Nari is of fluvial origin.³ The formation shows unconformable relation with the underlying Kirthar Formation throughout this region. The contact with overlying Gaj Formation is also dis-conformable at Thana Bula Khan. In this formation foraminifera fossils are abundant. Some species of oligocene age are Alveolina, Calcarina, Camerina, Lapidocyclina and Numulites. Foraminifera of Eocene age are Antinocyclina, Alveolina, Assilina, Cardita Beaumonti and Gypsina.⁴ The dip of this area is 4° and the STRIKE N 82° W. The total thickness measured by the present workers is about 8 meters.

SUB RECENT DEPOSITS (DADA CONGLOMERATES)

Dada conglomerates in Sindh consist of poorly sorted pebbles, cobbles and boulders with calcareous sandy matrix. They are thick-bedded and can be seen on the eastern side in the foot of Surjan Anticline as well as on the western side.

Most of the boulders are composed of marl, limestone and sandstone, derived from the Tertiary and older rocks. The conglomerates usually form hillocks and vertical walls as cliffs. They are mostly covered. The Sub-recent deposits are about 20 meters thick.

ECONOMIC GEOLOGY

Minerals and rocks of economic significance, encountered in the area, are given below:

a) FULLER'S EARTH DEPOSITS

Fuller's earth deposits are found within the Tiyon Formation which is located at three miles east of Thano Bula Khan and a mile south of Chohar Pass at Wahi, and 10 miles north of Thano Bula Khan. The Fuller's earth is at all places underlain and overlain by flat thin-bedded shales of the Tiyon Formation. The exposed thickness of Fuller's earth deposits in the quarries is 1'-2' thick.

b) LIME STONE DEPOSITS

Limestone occurs extensively in almost all the major hill ranges. It can be placed in categories of Laki limestone, Limestone of Tiyon Formation and Kirthar limestone. The Laki limestone is hard, and compact. It is locally used for construction purposes and chalky limestone of Laki is used as a source of lime.

c) CELESTITE DEPOSITS (Sr.SO₄)

Celestite is a mineral of industrial use. It occurs naturally in the form of disseminated crystal and grainular masses.

In the vicinity of Thano Bula Khan, Celestite deposits occur along the Surjan Sumbak Fault plane. Celestite is found in veins and varies in thickness from

few inches to six feet.

d) SILICA SAND DEPOSITS

Silica sand deposits consist of sand sized particles of SiO_2 . Sand grains are angular to sub-rounded and are found in Gaj Formation of the Oligocene age.

Silica sand measuring about 60 feet long and 12 feet thick deposits are located about 2 miles south of Darwat Pass along the northern edge of the Surjan range.

The white sand occurs in patches capping one of the hillocks in that area. Silica sand occurs as a natural commodity. Silica has a wide variety of industrial uses. Silica sand quarry is under the supervision of Pakistan Mineral Development Corporation (P.M.D.C.).

CONCLUSIONS

1. Three lithological units i.e. Laki limestone, Tiyon shale and Marl and Nari sandstone, have been encountered in the area, ranging in the age from Eocene to Oligocene period. The oldest Formation is Laki, whereas Nari Formation is the youngest one.

2. The thickness of Laki and Tiyon Formation measured in the area is 134 and 70 meters respectively, whereas the Nari Formation is thin (8) and can be seen in patches only at few places.

3. Surjan Anticline is an Assymtrical Anticline, flanking towards East and West. The Eastern flank has a steep dip of about 75° and the Western flank is gentle and has a maximum dip of about 30° .

4. The Surjan Sumbak Fault is on the western flank

of the Surjan Anticline, it runs parallel to the axis of the anticline.

5. Surjan Anticline attains a maximum height of 1294 feet.

6. The streams in the studied area originate from hills and flow in the North-South and East-West directions. Due to arid climatic conditions, the streams remain dry for most part of the year.

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FIG. 1

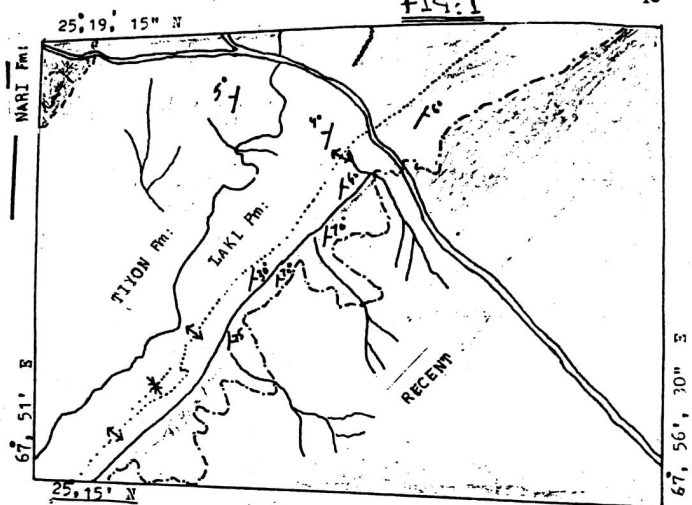













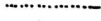




FIG. 1 GEOLOGICAL MAP OF THE SURJAN ANTICLINE, A PART OF TOPO SHEET No. 35 0/15.

L E G E N D.

- | | | | |
|---|--|---|------------------------|
|  | |  | METALLED ROAD |
| RECENT | |  | DRAINAGE |
|  | |  | STRIKE, DIP |
| NARI Fm.: | |  | FAULT |
|  | |  | ANTICLINE |
| TIYON Fm.: | |  | SYNCLINE |
|  | |  | CONFIRMABLE CONTACT |
| LAKI Fm.: | |  | UN CONFIRMABLE CONTACT |
| | |  | COVERED CONTACT |
| | |  | AXIS |

PAKISTAN.

LEGEND

- INTERNATIONAL BOUNDARY - - - - -
- PROVINCIAL BOUNDARY - - - - -
- RIVERS 
- STUDIED AREA. 

SCALE 1:7500,000

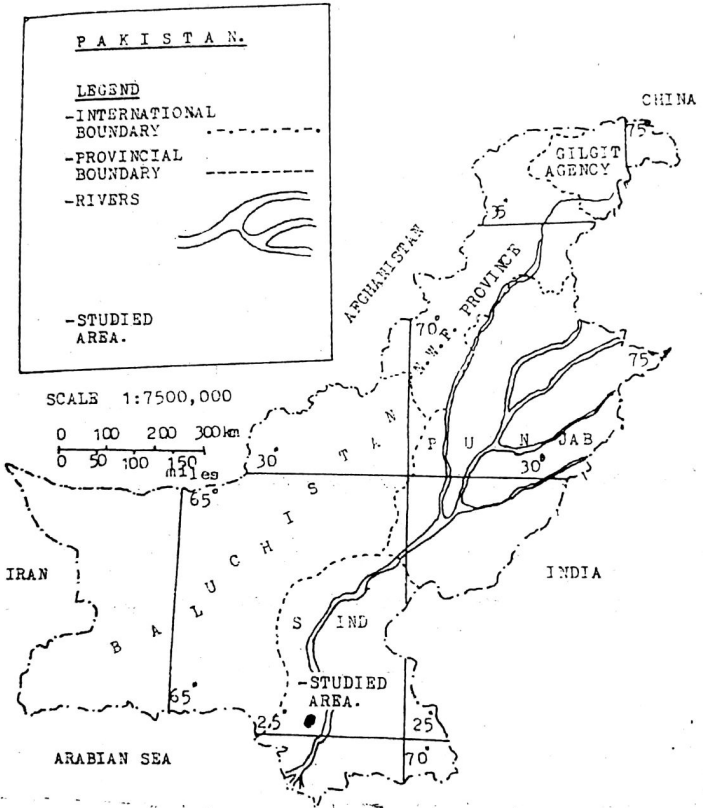
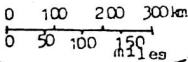


FIG: 2 INDEX MAP OF PAKISTAN SHOWING THE STUDIED AREA.

OF THE TROPICAL AREA.

C E N T R O I C											ERA
T E R T I A R Y											PERIOD
EARLY EOCENE					MIDDLE TO EARLY EOCENE						EPOCH
L A R I F O R M A T I O N					T E R C O N F O						FORMATION
L O W E R		M I D D L E			U P P E R		L O W E R		U P P E R		MEMBER
1	2	3	4	5	6	7	8	9	10	11	12
29	12	32	8	31	15	7	7.5	7	5	21	8
LITHOLOGICAL DESCRIPTION											
<p>Reddish gray weathers to dark gray, modular, hard, thin concretions. Noduloid is found, Gastropods and bivalves.</p> <p>Dark brown weathers to yellowish brown, loose, interbedded lime stone, sticky when wet. Gymsae, veins are present, full of larger forams and crinoid stems.</p> <p>Yellowish orange, weathers to yellowish brown, modular highly porous, crushed, shaly and gastropods are found.</p> <p>Gray white weathers to light gray, thick bedded, soft to medium hard, highly calcareous, fossiliferous. Alveoline, Obolus, Gastropods are found.</p> <p>Light gray weathers to light gray, thick bedded, very fine compact, massive highly calcareous, fossiliferous. Alveoline Obolus are found.</p>											

Fig-3

L E G E N D

- Reddish Gray Weathers to Dark Gray, Modular, Hard, Thin Concretions, Noduloid is found, Gastropods and bivalves.
 - Dark Brown Weathers to Yellowish Brown, Loose, Interbedded Lime Stone, Sticky when Wet, Gymsae, Veins are Present, Full of Larger Forams and Crinoid Stems.
 - Yellowish Orange, Weathers to Yellowish Brown, Modular, Highly Porous, Crushed, Shaly and Gastropods are Found.
 - Gray White Weathers to Light Gray, Thick Bedded, Soft to Medium Hard, Highly Calcareous, Fossiliferous, Alveoline, Obolus, Gastropods are Found.
 - Light Gray Weathers to Light Gray, Thick Bedded, Very Fine Compact, Massive, Highly Calcareous, Fossiliferous, Alveoline, Obolus are Found.
 - Modular Limestone.
 - Chalky Limestone.
 - Massive Limestone.
- Scale: 0 1/4 1/2 3/4 1 mile