

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

Preliminary report on coal characteristics in the  
Salt Range area of north-central Pakistan

by

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This report is preliminary and has not been reviewed for conformity with  
U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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PRELIMINARY REPORT ON COAL DEPOSITS OF  
THE SALT RANGE AREA, NORTH-CENTRAL PAKISTAN

by

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EXECUTIVE SUMMARY

As part of a cooperative program between the Geological Survey of Pakistan (GSP) and the U. S. Geological Survey (USGS), sponsored by the Government of Pakistan and the U. S. Agency for International Development (USAID), a preliminary evaluation of Tertiary coal deposits was undertaken for the Salt Range area, Punjab Province, north-central Pakistan. This report, the first to consider the entire Salt Range area, shows that the coal beds in the eastern and central Salt Range are generally thin (average thickness 0.43 m, range 0 - 2.13 m), and high in ash yield (average = 24.02 percent, as received or a.r.) and sulfur content (average = 5.71 percent, a.r.). Average calorific value is 9843 Btu/lb and rank is high volatile C to B bituminous. Tertiary coal beds are not present in the western part of the Salt Range. A preliminary estimate of the total tonnage for the Salt Range area is 235 million metric tons, not including carbonaceous shale deposits.



Permian coal deposits in the western Salt Range are generally thin (<1 m thick) and poor quality, however in the Punjab Plains, cuttings from an oil test hole indicates the possibility exists for the discovery of deep (1000+ m) Permian coal beds in that area.

The following is list of recommendations for further coal exploration work in the Salt Range and Punjab Plains area:

1. Approximately 100 additional coal exploratory boreholes are needed in the Salt Range to test for coal thickness, quality and coal bed extent.
2. Coal and carbonaceous shale bed sampling programs should be continued to complete the characterization of the quality and trace-element variations in the Salt Range coal field.
3. All future private and government coal exploratory boreholes in the Salt Range area should be geophysically logged.
4. After additional boreholes in the Salt Range are completed, a detailed coal resource estimate should be made.
5. Additional topographic base and structural field maps are needed in the Salt Range where coal mining is planned.
6. Structure contour, overburden isopach, and quality and chemical composition isopleth maps should be made for the Salt Range coal field.
7. Additional field work is needed in the Salt Range and Trans-Indus Range to establish a regional depositional framework for the Tertiary and Permian coal bearing intervals. This

work would be helpful in coal exploration in other areas.

8. Additional drilling (2-3 holes to about 1500 m each) is needed in the Punjab Plains to test for the existence of deep Permian coal beds.

## ABSTRACT

A preliminary evaluation of the coal deposits of the Salt Range area indicates that the average thickness for Tertiary coal beds in the Salt Range is 0.43 m (range 0 - 2.13 m). Average major chemical characteristics of coal samples from this area are as follows (all as received, a.r.): moisture, 5.85 percent; ash, 29.57 percent; volatile matter, 31.31 percent; fixed carbon, 33.56 percent; sulfur, 5.27 percent; and calorific value, 9843 Btu/lb. Rank has been reported to be high volatile C to B bituminous. A preliminary estimate of the total tonnage for the Salt Range area is 235 million metric tons (not including carbonaceous shale). Additional drilling and field work are needed to delineate further the Tertiary coal resources of the Salt Range coal field.

Permian coal deposits in the western Salt Range are generally discontinuous and of poor quality. Similar or better quality Permian coal beds may be possibly discovered in the Punjab Plains area by coal exploratory drilling or by hydrocarbon test holes. The depth to the coal-bearing zone is expected to be more than 1000 m.

## INTRODUCTION

As part of a cooperative program between the Geological Survey of Pakistan (GSP) and the U. S. Geological Survey (USGS), sponsored by the Government of Pakistan and the U. S. Agency for International Development (USAID), a preliminary evaluation of coal deposits was undertaken for the Salt Range and Punjab Plains areas, Punjab Province, north-central Pakistan. Previous geologic reports on these deposits have been limited to parts of the area, or contain only brief and general descriptions of the coal characteristics (Ahmad et al, 1986; Alam et al, in press; Bhatti, 1967; Gee, 1938; Ghaznavi, 1988; LaTouche, 1894; Khan, 1949; Shah, 1980; Simpson, 1904; Wynne, 1878). This report contains (1) a review of the geology of the Salt Range, Potwar Plateau, and Punjab Plains; (2) a discussion of the characteristics of Salt Range coal and carbonaceous shale beds; (3) thickness maps of coal and carbonaceous shale beds in the Salt Range Tertiary coal field; (4) chemical analyses of Salt-Range area coal samples; (5) a preliminary estimate of coal resources for the Salt Range; and (6) recommendations for future coal exploration in the Salt Range and Punjab Plains areas.

## ACKNOWLEDGMENTS

This work could not have been possible without the generous support and guidance of various organizations. These include the Punjab Directorate of Industries and Mineral Development, Punjab Mineral Development Corporation, Pakistan Mineowners Association, and Pakistan Mineral Development Corporation. We would like to thank the many individual mining companies throughout the Salt Range for providing coal thickness data and access to their mines for coal sampling. We also thank the Punjab Mineral Development Corporation and various GSP geologists (see contents) for the release of stratigraphic data reproduced in the Appendices.

## LOCATION

The Salt Range is an east-northeasterly trending mountain front in the northern part of Punjab Province, Pakistan (fig. 1). West of the Salt Range is the Trans-Indus Range and the Makarwal coal field described by Danilchik and Shah (1987). The southern margin of the Salt Range forms an escarpment which rises abruptly from the Punjab Plains, which are covered by alluvium from the Jhelum, Chenab, Ravi, and Sutlej Rivers. The Potwar Plateau extends north from the Salt Range to Islamabad and the Margala Hills. Coal mining, exploratory drilling, and related activities in the Salt Range have been concentrated on the escarpment and limestone covered plateaus of the eastern and central part of the range (fig. 2). Another area of interest for coal exploration is the Punjab Plains where coal exploratory drilling has been done near the town of Jhang about 150 km south of the Salt Range (fig. 1 this report, and Alam et al, 1987).

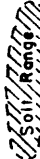



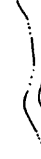

## METHODS

Field and office work took place during the 1987-88 field season. Sections through the coal-bearing units of the Salt Range were measured along the escarpment and canyons cut into the Salt Range plateaus. The sections and field observations containing coal-thickness data are presented in Appendix I. Thirty-four coal and carbonaceous shale samples for chemical analyses were collected from drill core and working mines. Mine samples were collected by channeling the working face. Rock partings greater than 2 cm were excluded from all samples. Analyses are not complete at this time. Stratigraphic and coal thickness data were posted on 1:50,000 scale maps using Gee's (1980) geologic maps as a base (Paleocene data location maps, Appendix III). This data includes (1) measured sections and observations collected during this field season, (2) previously published data from geologic reports on the area, and (3) unpublished reports, measured sections and borehole logs from GSP, Punjab Mineral Corporation (PUNJMIN), and private mining companies. Unpublished stratigraphic and coal-thickness data that were used in this report are presented in Appendix II. Cumulative thickness maps for Tertiary coal and carbonaceous shale deposits were then prepared by hand (Appendix IV, Paleocene coal and carbonaceous shale thickness maps). Salt Range coal analytical data and their sources are tabulated and presented in table 1.

A preliminary rough estimate of coal resources for the Salt Range was determined for the coal areas shown on the four coal-thickness maps in Appendix IV, and the results are tabulated in table 2. To calculate the tonnage, the median coal-bed thickness for each of the coal-thickness categories mapped in 1-ft (0.3 m) intervals shown on the maps in Appendix IV were multiplied by the average weight of unbroken bituminous coal per acre foot or 1,633 metric tons per acre foot (Wood et al, 1983). This sum was then multiplied by the area in acres for each of the coal-thickness categories shown on the four thickness maps in Appendix IV (table 2). The area for each coal-thickness category was estimated, using the graph-paper method. This method of coal resource calculation differs slightly from that described by Wood et al (1983, p. 36), which suggested that coal-thickness intervals should be 14 to 28 inches, 28 to 42 inches, etc., rather than the 1-foot intervals used for convenience in this report. Carbonaceous shale beds were not included in this calculation. Mined-out areas were not deleted from the total because the mined areas are relatively small compared to the total coal-bearing area of the Salt Range.

Figure 1. Index map of northern Pakistan showing some cultural and topographic features mentioned in this report. The contours shown in the Punjab Plains are depth to basement in feet. The stars indicate: (1) a hydrocarbon well which penetrated a Permian coal bed at 2704 m (Sarai Sidhu), and (2) a Permian coal exploration hole drilled by GSP (Ashaba). Map adapted from Bakr and Jackson (1964) and Kazmi and Rana (1982).

# EXPLANATION

	Boundary of physiographic feature
	Locality
	Drill hole
	Road
	Water features
	Contours showing depth to the basement (in ft)

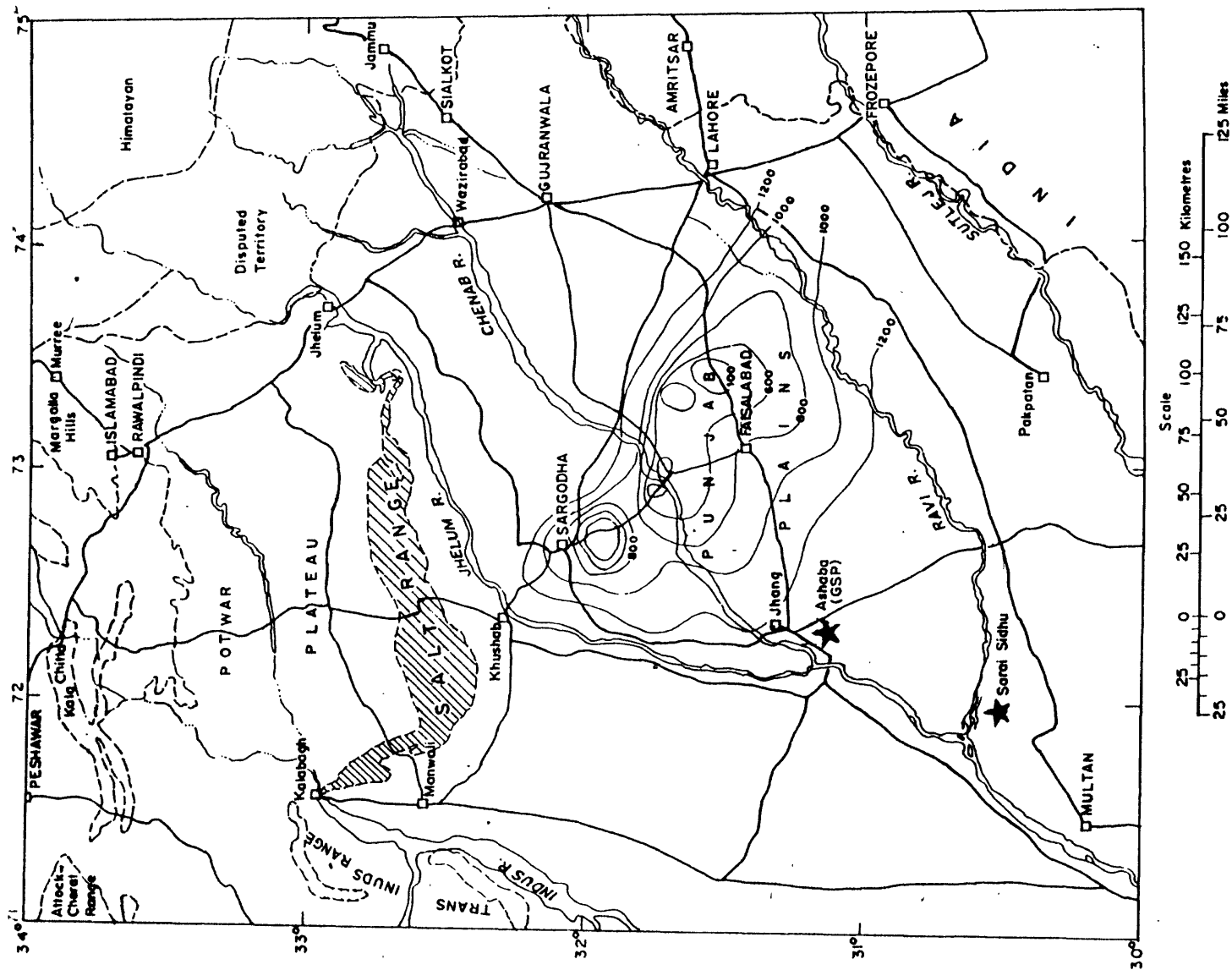


Figure 2. Generalized north - south cross section through the Salt Range. A detailed stratigraphic column for the Salt Range area is given in Appendix I.



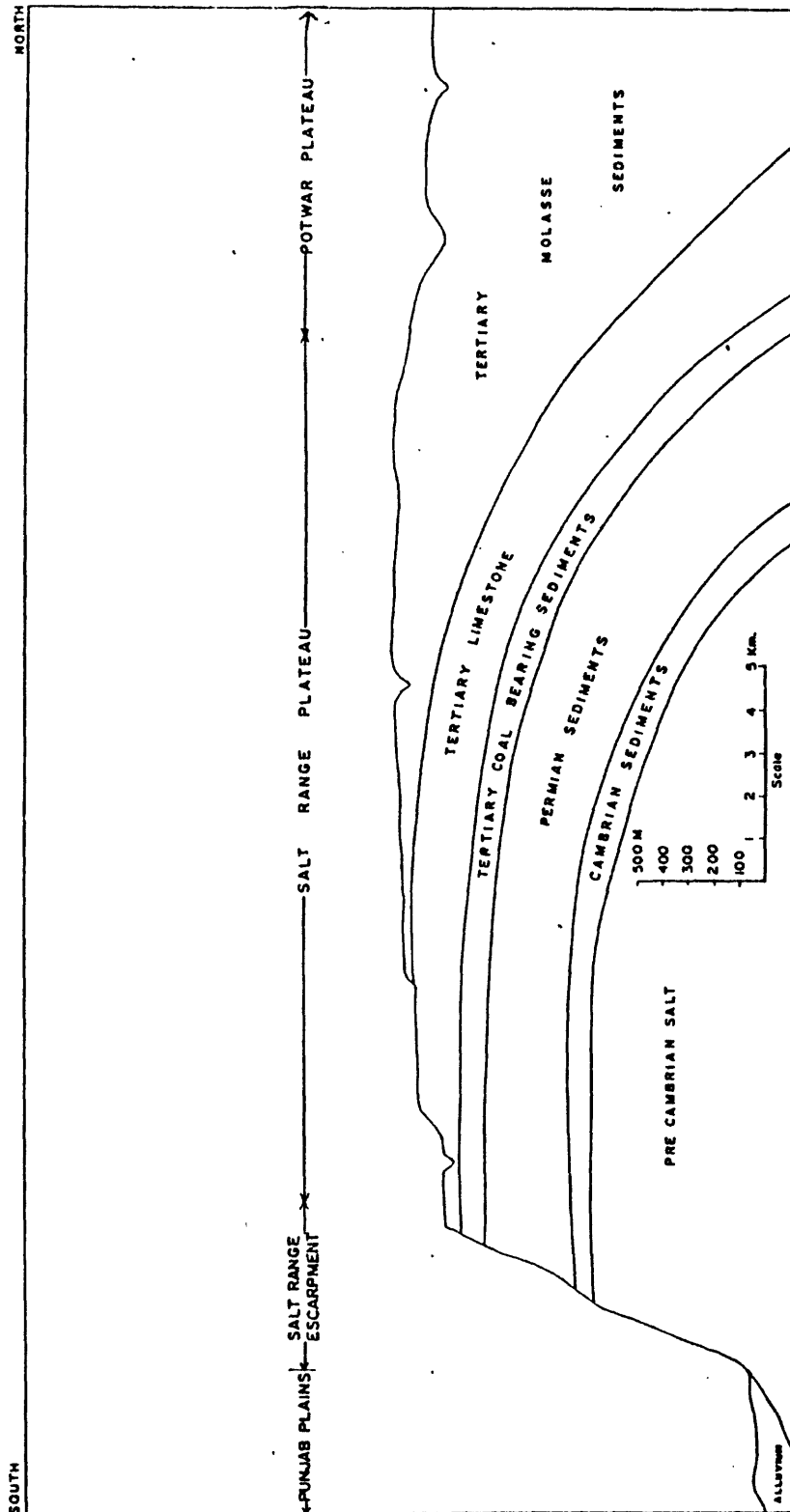


Table 1. Salt Range coal analytical data, all values as received.

Sample No.	Mois.	Ash	V. M.	F. C.	H.	C.	N.	S.	O.	BTU	S.S.	P.S	O.S.	FSI	EQ	M	SP	HCI	ID	ST	FT	HT
A. TCP-1-87L	5.03	43.04	26.70	25.23	---	---	---	6.86	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TCP-1-87U	3.31	39.32	31.04	26.33	---	---	---	2.77	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TCP-2-87	6.50	26.51	32.44	34.55	---	---	---	10.47	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TCP-6-87	5.62	41.27	26.32	26.79	---	---	---	4.36	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TCP-8-87	4.93	19.02	28.34	47.71	---	---	---	6.52	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-3-87	5.61	25.45	32.16	36.78	---	---	---	3.58	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-4(1)-87	4.62	32.70	25.45	37.13	---	---	---	11.67	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-8-87	4.77	17.80	20.05	48.38	---	---	---	9.53	---	---	---	---	---	---	---	---	---	---	---	---	---	---
B. TSM-1(2)-87	4.93	19.07	37.62	38.00	---	---	---	2.69	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-7-87	4.66	34.58	32.25	28.51	---	---	---	3.79	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-9-87	5.55	22.61	37.48	34.85	---	---	---	3.18	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-11-87	4.48	23.33	37.39	34.80	---	---	---	4.04	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-12-87	4.38	33.99	28.36	33.27	---	---	---	3.42	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-13-87	5.00	47.63	27.02	20.27	---	---	---	2.93	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-14-87	5.41	22.26	37.48	34.85	---	---	---	7.05	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-15-87	6.34	33.03	29.94	30.69	---	---	---	8.30	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TSM-16-87	3.93	33.87	33.07	29.13	---	---	---	3.53	---	---	---	---	---	---	---	---	---	---	---	---	---	---
C. G-A	7.23	25.17	36.26	31.04	---	---	---	5.16	---	9020	---	---	---	---	---	---	---	---	---	---	---	---
G-B	5.10	8.99	42.00	43.91	---	---	---	---	---	11797	---	---	---	---	---	---	---	---	---	---	---	---
G-C	5.15	11.20	41.90	41.75	---	---	---	---	---	11489	---	---	---	---	---	---	---	---	---	---	---	---
G-D	5.87	12.44	43.65	38.04	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
G-E	2.60	6.00	43.98	46.52	---	---	---	---	---	---	---	---	---	---	---	---	1.36	---	---	---	---	---
G-F	4.44	16.48	40.38	38.70	---	---	---	---	---	---	---	---	---	---	---	---	1.44	---	---	---	---	---
D. 86-TGM-9	7.51	46.70	21.49	24.30	3.32	34.37	0.45	2.16	13.00	5977	0.09	0.72	1.35	---	7.57	---	---	---	2800+	2800+	2800+	---
86-TGM-1	9.01	29.67	30.62	30.70	4.60	44.04	0.71	3.63	17.35	8080	0.12	2.89	0.62	---	9.01	---	---	---	2600	2700	2730	---
E. 85-SDT-001	11.44	13.84	35.36	39.36	5.47	57.19	0.95	2.71	19.84	10279	0.05	1.67	0.99	0.5	---	---	1.51	46	2160	2200	2500	2270
85-SPR-002	9.23	18.48	35.03	37.26	4.90	51.66	1.01	8.62	15.33	9880	0.15	7.21	1.26	1.0	---	---	1.44	50	2120	2160	2370	2190
85-SKA-003	14.46	13.63	32.06	39.85	5.37	52.71	0.95	7.02	20.32	9574	0.20	5.67	1.15	0.5	---	---	1.42	53	2120	2160	2520	2190
F. D-91610	10.8	21.6	31.6	36.0	4.8	47.7	0.8	8.5	16.6	8900	---	---	---	---	---	---	---	52	---	---	---	---
G. PDTS-A	7.6	20.0	34.1	38.3	3.7	50.7	1.0	10.7	6.3	9800	---	---	---	---	---	---	---	---	---	---	---	---
PDTS-B	5.2	12.3	37.7	44.8	4.5	61.1	1.0	5.0	10.9	10900	---	---	---	---	---	---	---	---	---	---	---	---
PDTS-C	5.3	14.0	37.5	43.1	4.5	59.3	1.1	5.7	10.0	10800	---	---	---	---	---	---	---	---	---	---	---	---
H. SHAH-A	7.56	14.87	37.84	39.73	---	---	---	4.01	---	10370	---	---	---	---	---	---	---	---	---	---	---	---
SHAH-B	8.45	16.30	32.45	42.80	---	---	---	7.70	---	9900	---	---	---	---	---	---	---	---	---	---	---	---
AVERAGE:	6.21	24.02	33.44	35.98	4.57	50.97	0.88	5.71	14.39	9843	0.13	3.63	0.94	0.6	8.28	1.43	50	2359	2403	2583	2216	---

Table 1 Continued. The abbreviations used on Table 1 are as follows: Mois. = moisture, V. M. = volatile matter, F. C. = fixed carbon, H. = hydrogen, C. = carbon, N. = nitrogen, S. = sulfur, O. = oxygen, BTU = British Thermal Unit, S.S. = sulfate sulfur, P.S. = pyritic sulfur, O.S. = organic sulfur, FSI = free swelling index, EQ M = equilibrium moisture, SP = specific gravity, HGI = Hargrove Grindability Index, for ash-fusion temperatures (C), ID = initial deformation, ST = softening temperature, FT = fluid temperature, and HT = hemispherical temperature.

The following is a list of sample thickness, location and source for the analytical data listed on Table 1.

- A. These samples are from boreholes in the eastern Salt Range described by Alam et al (in press). The borehole locations are shown on Sheet 5 of the data point location maps in Appendix III. Samples were analyzed by GSP coal laboratory in Karachi.

SAMPLE NO.	THICKNESS (Ft)	LOCATION
TCP-1-87L	0.29 coaly shale	GSP-6
TCP-1-87U	0.46 coaly shale	GSP-6
TCP-2-87	1.16 coal	GSP-6
TCP-6-87	1.0 coal	GSP-5
TCP-8-87	0.75 coal	GSP-12

- B. These samples are from mines in the eastern Salt Range described by Alam et al (in press). Samples were analyzed by GSP students at the Southern Illinois University coal laboratory, Carbondale, Illinois.

SAMPLE NO.	THICKNES (Ft)	LOCATION
TSM-3-87	1.00 coal	Dost Sons Mine No. 4
TSM-4(1)-87	0.83 coal	Dost Sons Mine No. 2
TSM-8-87	0.83 coal	Marhaba Mineral Co. Ltd. Mine No. 2
TSM-11-87	0.5 coal	Hyderia Mineral Co. Mine No. 1B
TSM-13-87	1.25 coaly sh.	M/S Hafeezullah Khan and Co. Mine No. 1b
TSM-16-87	3.33 coal	M/S Iqbal Mineral Co. Majid Mine
TSM-15-87	1.0 coal	Aftab Coal Co. New Khara Kangar Colliery
TSM-1(2)-87	0.42 coal	Dost Sons Ltd. Mine No. 1
TSM-9-87	1.83 coal	Marhaba Mineral Co. Mine No. 4
TSM-14-87	3.33 coal	M/S Hafeezullah Khan and Co. Mine No. 5
TSM-7-87	0.42 coal	Dost Mohammad and Sons Mine No. 6
TSM-12-87	1.16 coal	Aftab Coal Co. old Zatar Mine

- C. These analyses were reported by Gee (1938). All are mine samples of unknown thickness from the Dandot area in the Eastern salt Range.

Sample No.	Location
G-A	Lat. 33/39/00N, Long. 72/58/00E
G-B	Near Dandot
G-C	Near Dandot
G-D	Near Dandot
G-E	Lat. 32/40/00N, Long. 72/59/00E
G-F	Lat. 32/41/00N, Long. 72/59/00N

- D. These Eastern Salt Range mine samples were collected by GSP and were analyzed in 1986 by Geochemical Testing Laboratories, Somerset, Pennsylvania.

SAMPLE NO.	THICKNESS (FT)	LOCATION
86-TGM-9	-----	Lat. 32/44/18N, Long. 73/11/58E
86-TGM-1	1.25 coal	Lat. 32/44/32N, Long. 72/59/07E

- E. These mine sample analyses were reported by Ghaznavi (1988). Coal bed thickness was not reported. Analyses were done by Geochemical Testing, Somerset, Pennsylvania.

SAMPLE NO.	LOCATION
85-SDT-001	West central Salt Range
85-SPR-002	Central Salt Range
85-SkA-003	Eastern Salt Range

- F. Analytical results from this mine sample were reported by Landis et al (1971). Analyses were done by the U. S. Bureau of Mines.

SAMPLE NO.	THICKNESS (FT)	LOCATION
D-91610	2.16	Mine No. 4, East Chambal, central Salt Range

- G. Analytical results from these mine samples were reported by Powell and Duffryn Technical Services (1949). Coal bed thicknesses was not reported.

Sample No.	Location
PDTS-A	Chamil, central Salt Range
PDTS-B	Katha, central Salt Range
PDTS-C	Shah Bihot, central Salt Range

- H. Analytical results from these central Salt Range mine samples were reported by Shah (1980). Coal bed thickness was not reported.

Sample No.	Location
Shah-A	Katha Colliers Mine No. 4
Shah-B	Katha Colliers Mine No.

Table 2. Preliminary estimate of coal resources for the Salt Range coal field. Carbonaceous shale beds are not included in this estimate.

MILLIONS OF METRIC TONS OF COAL  
BY COAL BED THICKNESS IN FEET

		+	0-1	1-2	2-3	3-4	4-5	5-6	6-7	+TOTALS
MAP		-----	-----	-----	-----	-----	-----	-----	-----	-----
	Sheet 3	+	8.91	38.53	9.17	1.72	-----	-----	-----	+ 53.33
SHEETS		+								+
	Sheet 4	+	37.22	24.37	11.79	3.41	0.80	-----	-----	+ 77.59
IN		+								+
	Sheet 5	+	22.01	48.36	11.64	2.75	-----	-----	-----	+ 84.75
APPENDIX		+								+
	Sheet 6	+	4.71	3.93	2.46	1.05	0.74	0.72	0.21	+ 14.14
IV		-----	-----	-----	-----	-----	-----	-----	-----	-----
	TOTALS	+	72.85	115.19	35.06	9.25	1.53	0.72	0.21	+234.82
		+								+

TOTAL APPROXIMATE RESOURCES 234.82 MILLION METRIC TONS

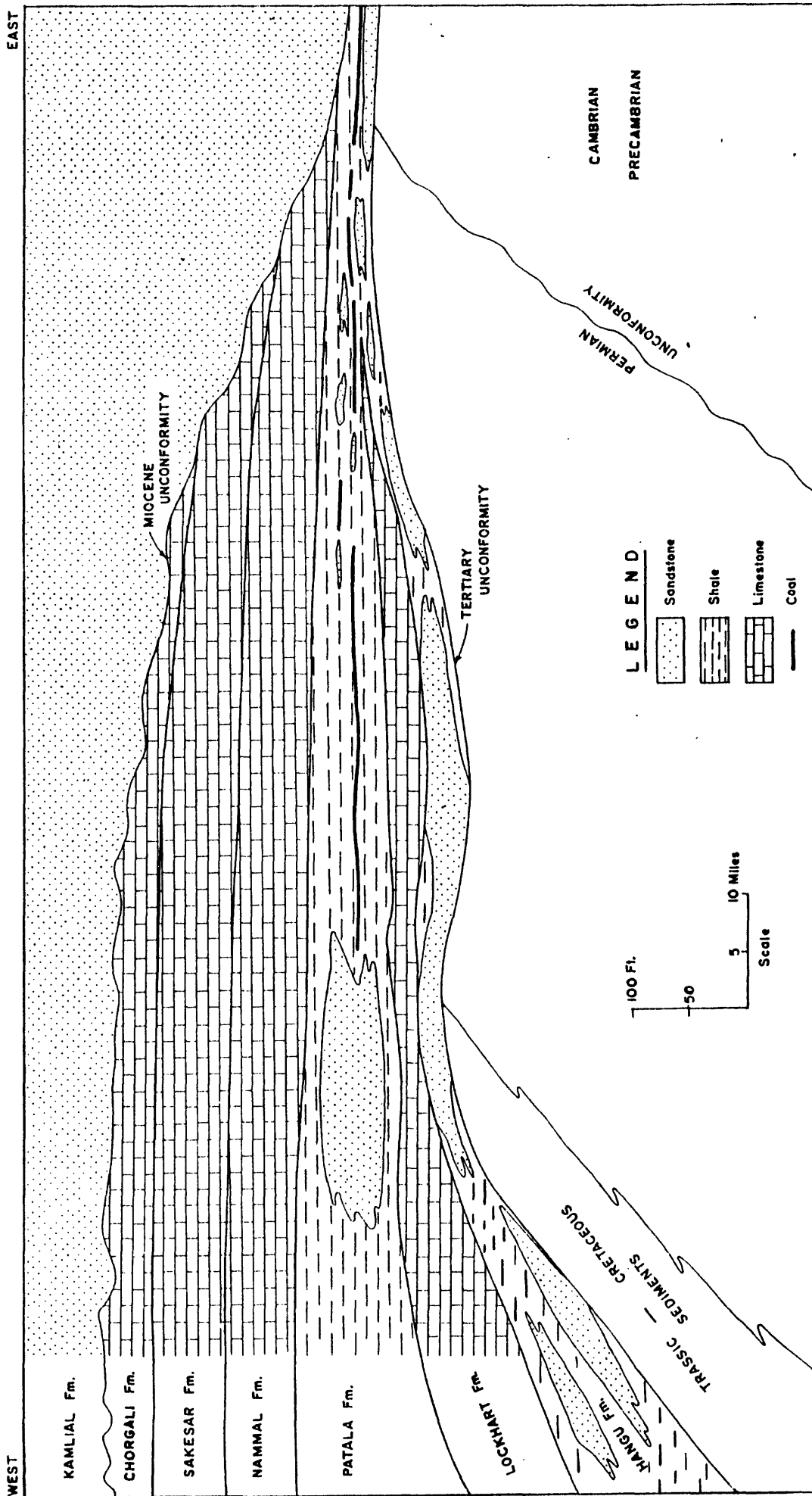
## REGIONAL GEOLOGY OF THE SALT RANGE AREA

The Salt Range and Potwar Plateau are part of the active foreland fold-and-thrust belt of the Himalaya of northern Pakistan (Jaume and Lillie, 1988). The Salt Range is an east-northeast-trending (175 km long) thrust front that rises abruptly from the Punjab Plains (figs. 1 and 2). The western end of the range bends northward and is characterized by a major strike-slip fault that extends to the town of Kalabagh and the Indus River (Baker et al, 1988). The eastern end of the range is characterized by complex thrusting that gives way to the northeast-trending Pabbi Hills anticline. To the north, the Salt Range merges with the Potwar Plateau which is a low relief upland except where dissected by the Soan River and its major tributaries (Yeats et al, 1984).

Salt Range structure is characterized as a narrow zone of localized strong folding, faulting and uplift, and contrasts with the open folds of low structural relief in the Potwar Plateau and lack of deformation in the immediately adjacent Punjab Plains (Yeats et al, 1984). The Salt Range uplift brings to the surface strata containing evaporites of late Precambrian or early Cambrian age (Gee, 1980). These ductile evaporites underlie the Potwar Plateau and form a zone of decollement for regional thrusting (Butler et al, 1987; Jaume and Lillie, 1988). Overlying the Salt Range evaporites is an unusually well exposed sedimentary sequence that includes Cambrian through Neogene strata (figs. 2 and 3, and Appendix I, this paper; and Gee, 1980; Yeats et al, 1984). The absence of Ordovician-through-Carboniferous, late Cretaceous and Oligocene rocks marks some of the major unconformities in the area (Shah, 1980). Exploratory drilling immediately south of the Salt Range has shown that pre-Miocene erosion has removed Cambrian-to-Eocene sediments in that area (Baker et al, 1988). Farther south, the Paleozoic through Cenozoic sequence exposed in the Salt Range underlies the alluvial cover of the Punjab Plains (Yeats and Lawrence, 1984; Alam et al, 1987). This sedimentary sequence is truncated by a basement ridge which is a part of the Indian Shield that reaches the surface near Sargodha and Chinot (Farah et al, 1977) (fig. 1). Alam (1987) has described these Precambrian shield rocks as consisting of quartzites, slates, phyllites and metavolcanics.

The Potwar Plateau is an active oil and gas exploration and production area. Recent studies have combined seismic reflection profiles, petroleum exploration well logs, Bouguer gravity anomaly maps and surface geology to construct regional structural cross sections that detail the thrust-related tectonics of the area (Jaume and Lillie, 1988; Baker et al, 1988; Butler et al, 1987; Leathers, 1987). Rocks exposed in the Potwar Plateau area consist of Miocene-to-Quaternary molasse sediments. These deposits have been the subject of recent paleomagnetic,

Figure 3. Generalized east - west cross section through the entire the Salt Range. Dip of pre-Tertiary units and coal bed thickness are exaggerated.





paleontological, and sedimentological studies (as reviewed by Johnson et al, 1985, Johnson et al, 1986; Behrensmeyer, 1987,; and Behrensmeyer and Tauxe, 1982).

## COAL GEOLOGY

Most coal and carbonaceous shale deposits in the Salt Range area are contained within the Paleocene Patala Formation, with limited occurrence in the Permian Tobra Formation (Gee, 1938; Bhatti, 1967; Shah, 1980; Alam et al, in press). Previous workers have also reported coal beds in the Datta Formation (Jurassic), Lumshiwal Formation (Cretaceous), Hangu Formation (Paleocene) and Siwalik Group (Miocene - Pleistocene), but these coal beds are thin (<0.25 m), irregular, generally consist of carbonaceous shale, and are considered to be noneconomical (Simpson, 1904; Gee, 1938; Faruqi pers. comm., 1987). Only Permian and Paleocene coal deposits are currently being mined in the Salt Range so only these deposits are considered in this report.

### Permian Coal Deposits

Descriptions of cuttings from hydrocarbon exploratory drilling in the Punjab Plains has indicated that thin (<1 m thick) Jurassic, Cretaceous and Tertiary coal beds occur at depths greater than 1000 m. A borehole log from north of Multan (Lat. 30/32/00N, Long. 71/54/00E; Ashaba, fig. 1) also has indicated that coal cuttings were collected from a 3 m interval near the Permian-Cambrian contact at a depth of 2704 m. The possibility of deep Permian coal deposits in the Punjab Plains has prompted exploratory drilling in this area (fig. 1, this report, and Alam et al, 1987).

Permian coal is currently being mined near the town of Buri Khel, near Mianwali, in the western Salt Range (fig. 1). At this location (Lat. 32/41/00N, Long. 71/38/00E), a single, discontinuous coal bed occurs within the faulted and folded transition zone between the Tobra Formation (conglomeratic tillites and diamictites) and Warchha Formation (cross bedded, pebbly sandstone). Two measured sections from the mining area are presented in Appendix I (Sections 32 and 33). Bhatti (1967) reported that the coal bed at Buri Khel has a very irregular thickness, with maximum thickness of 1.62 m and average thickness of 0.62 m. Analyses of one coal sample indicated the following results (Bhatti, 1967): moisture, 1.94 percent; volatile matter, 20.92 percent; ash, 42.30 percent; and fixed carbon, 34.84 percent. Other observations by Bhatti (1967), Shah (1980) and the present authors indicate that the Permian coal deposit has a very limited lateral extent and that coal beds are only found in a few canyons in the area. In a canyon locally known as "Sarin Nala" (Lat. 70/49/00N, Long. 32/37/00E), a 1 m-thick coal bed laterally thins to less than 0.1 m in a few hundred meters. In

other nalas near Buri Khel, the coal horizon is represented as thin (0.1 m thick) bands of carbonaceous shale interbedded with sandstone (Bhatti, 1967). The coal-bearing interval of the Tobra and Warchha Formations that is exposed in the Buri Khel area also is exposed throughout most of the Salt Range and Trans-Indus Range. But in these areas, no coal or carbonaceous shale beds are present, which probably indicates that the coal occurrence at Buri Khel is unique for the Salt Range.

During 1984 to 1985, GSP drilled a Permian coal exploratory hole near the town of Jhang (fig. 1) on the hypothesis that (1) the Permian coal bed penetrated by the hydrocarbon test hole near Multan would be shallower near the Sargodha basement ridge and (2) the Permian coal zone at Buri Khel extends southward into the Punjab Plains subsurface (Alam et al, 1987). Drilling was completed to the Sardhi Formation (Permian) at a depth of 738.5 m. The Warchha and Tobra Formations underlie the Sardhi Formation and were not penetrated. After analysis of available seismic, gravity and stratigraphic data, GSP has proposed further coal exploratory drilling south of the Sargodha Ridge.

### Tertiary Coal Deposits

The Patala Formation (5-90 m thick), which contains the major coal deposits in the Salt Range area, is comprised of dark grey, fossiliferous shale interbedded with white quartzose sandstone, siltstone, marl, and limestone. In the eastern and central Salt Range, coal and carbonaceous shale deposits (<1 m thick) generally occur as a single bed (<1 m thick) that is often split by dark grey shale or thin (<0.25 m thick) bands of quartzose sandstone. These laterally discontinuous coal and carbonaceous shale beds overlie and are laterally associated with northeasterly trending, elongate, quartzose sandstone bodies (1-20 m thick) and are interpreted to have been deposited in back-barrier and near marine environments (fig. 3 this paper; Alam et al, in press; Warwick and Shakoor, in press). No Tertiary coal beds are present in the western Salt Range.

In the eastern and central Salt Range, the Patala Formation grades laterally towards the west into the Lockhart Limestone and Hangu Formation (fig. 3). The Lockhart Limestone (5-70 m thick) consists of dusky yellow, marly, nodular and fossiliferous limestone and the Hangu Formation (5-90 m thick) consists of burrowed, slightly calcareous, fine-to-medium grained, light grey sandstone that is interbedded with siltstone, dark grey shale and minor amounts of carbonaceous shale. The Patala Formation is conformably overlain by thick (>100 m) Eocene limestones which consist of the Nammal Formation (shaley, marly nodular limestone), Sakesar Limestone (nodular to massive bedded, cherty limestone), and Chor Gali Formation (interbedded marl and shaley limestone) (Shah, 1980).

Tertiary coal beds in the Salt Range are laterally and vertically gradational with carbonaceous shale. Megascopically, the coal beds are generally thinly banded (bands <3 cm thick) with bright bands usually isolated in a matrix dominated by dull, resinous organic material. The number of bright bands decreases as the coal bed grades into carbonaceous shale. Thin (<1 cm thick) fusain beds are present, but not common. Nodules of pyrite (up to 5 cm diameter) are often dispersed throughout the coal bed. These tend to form in abandoned burrows which are more common in the upper part of the bed. Thin (<0.5 cm thick) gypsum veins are common and tend to occur along the general vertical fracture pattern of the coal bed. Ghaznavi (1988) has described the petrology of three Salt Range coal samples to consist of the following percentages of each major maceral group: 79.1 percent vitrinite, 11.2 percent inertinite, and 9.7 percent liptinite.

The thickest coal and carbonaceous beds (up to 2.13 m) generally form discontinuous, northeasterly trending, elongate bodies that are roughly 2 to 3 km long and 1 km wide. These shapes are illustrated on the cumulative coal and carbonaceous shale thickness maps in Appendix IV. The bodies grade laterally into thin (<0.25 m) coal and carbonaceous shale beds or dark grey shales. Average cumulative coal thickness for the entire Salt Range coal-bearing area is 0.43 m (range 0 - 2.13 m). Average cumulative coal and carbonaceous shale thickness for this area is 0.46 m (range 0 - 2.13). These averages are based on 345 borehole, outcrop and mine-thickness data points (Appendix IV). There is little variation in average thickness of coal and carbonaceous shale beds from the eastern to central Salt Range areas. In the eastern Salt Range, however, near the town of Ara, anomalously thick coal beds (up to 2.13 m) were described by LaTouche (1894). These areas of thick coal have a very limited lateral extent and have generally been mined out. In areas where mining from the escarpment has been active for a number of years, the coal bed has generally been removed for up to 600 m from the hill side. Limited borehole data indicates that coal and carbonaceous shale bed thickness decreases northwesterly toward a northeast trending no-coal area in the central Salt Range (see thickness maps Appendix IV).

In the plateau areas, which are usually covered by Eocene limestone, exploratory drilling has indicated that the average depth to the coal-bearing zone is about 130 m (range from 87.4 to 272.5 m; N = 67 boreholes). The northern limit of the coal field, shown on the coal and carbonaceous shale bed thickness maps (Appendix IV), is a line showing the approximate aerial extent of the Eocene limestones (fig. 2). This line represents depths to the coal bearing zone that range from 200 to more than 400 m and marks the approximate limit of coal mineability. North of the line, the depth to the coal bearing Patana Formation rapidly increases resulting from the general northward dip of the strata. The thickness of the limestones increases in a westward

direction. Representative thicknesses and lithologic descriptions of overburden material are given in borehole logs in Appendix II and Alam et al (in press).

Relatively few coal samples from the Salt Range have been analyzed. The results of analyses of 34 samples collected by various workers are listed on table 1. For the 34 samples, average moisture content is 6.21 percent (a.r.); ash yield is 24.02 percent (a.r.); volatile matter is 33.44 percent; fixed carbon is 35.98 percent and total sulfur is 5.71 percent (a.r.). The average calorific value for the 12 samples with data is 9843 Btu (a.r.). Landis et al (1971) and Ghaznavi (1988) reported the rank of coal samples from the Salt Range to be high volatile C and B bituminous. According to Ghaznavi (1988) the Salt Range and the adjacent Makarwal coal fields produce the highest rank coal in Pakistan.

A preliminary calculation of coal resources for the Salt Range coal field is summarized on table 2. The approximate total resources for the entire Salt Range coal area is 235 million metric tons. This figure does not include carbonaceous shale deposits that are commonly associated with the coal bed. The areas that appear to have the greatest coal resources are near the towns of Choa Sidan Shah (Sheet 5, Appendix IV) and Pail (Sheet 4, Appendix IV). The amount of coal decreases west and east of these areas, with the least amount of coal found in the extreme eastern Salt Range (Sheet 6, table 2).

#### RECOMMENDATIONS FOR FURTHER COAL EXPLORATION IN THE SALT RANGE

Following is a list of recommendations that may be helpful for future coal exploration work in the Salt Range and Punjab Plains areas.

1. Approximately 100 additional coal exploratory bore holes are needed in the Salt Range area to test for coal thickness, quality and coal bed extent. Seven areas with little or no outcrop, mine, or borehole information are outlined on the data point location maps in Appendix III (Areas A - G). The area, number of bore holes, and the cumulative drilling depths are tabulated on table 3. These areas should be drilled at an average spacing of 5.0 kilometers for coal exploration. GSP plans in 1988-89 to drill 30 holes in the eastern Salt Range (Basharat - Ara, Areas E, F and G, and Kallar Kahar, Areas C and D, in Appendix III), but presently there are no plans to drill in the large plateau areas of the central Salt Range (Areas A and B in Appendix III). PUNJMIN has completed most of its coal exploratory drilling in the Salt Range and is not expected to drill more holes in the near future (Saleem, Project Manager PUNJMIN, pers. comm., 1988).

2. Coal and carbonaceous shale bed sampling programs should be continued to complete the characterization of the quality and trace-element variations in Salt Range coal field. This can be achieved through additional drilling and mine sampling.
3. All future private and government boreholes should be geophysically logged. Although core recovery has generally been good in Salt Range drilling, occasionally core loss does occur in the coal-bearing zone of the Patala Formation. Geophysical logging would prevent redrilling exploration holes in the event of core loss in the coal-bearing zone.
4. Once the additional drill holes in the Salt Range are completed, a detailed coal resource estimate should be made. This estimate would delineate the different categories such as measured, indicated, inferred, and hypothetical as described by Wood et al (1983).
5. Additional topographic base maps and structural field maps at a scale such as 1:10,000, are needed on the major coal-bearing plateaus in the Salt Range where mining is planned.
6. Additional maps of the Salt Range coal field need to be made. These maps include coal structure contour, isopach maps of overburden, and isopleths of quality and chemical composition.
7. Additional field work is needed to establish the facies relationship and depositional history of the Salt Range coal field and the Makarwal coal fields. Such an understanding would prove useful in further coal, oil, and gas exploration in the area.
8. Additional drilling (2-3 holes to about 1500 m) is needed in the Punjab Plains to test for the existence of deep Permian coal beds. Collaboration between government and private hydrocarbon exploration agencies is needed to make available Permian coal information that may be obtained through future holes planned by these agencies. A thorough review of all geophysical and stratigraphic data must be made before drilling is started in order to determine the best coal borehole locations.

Table 3. Summary of additional boreholes needed in the Salt Range.

Areas are indicated on data point location maps in Appendix III. Average spacing of boreholes is 5 km. Twenty percent of each area has been excluded due to unfavorable topography.

		AREA sq. Km	BOREHOLES NEEDED	AVERAGE DEPTH (130 m/borehole)
Sheet 3	Area A	230	35	4550
	Area B	90	15	1950
Sheet 4	Area C	200	30	3900
Sheet 5	Area D	25	5	650
	Area E	25	5	650
Sheet 6	Area F	25	5	650
	Area G	20	5	650
	TOTALS	630	100	13000

## CONCLUSIONS

A preliminary evaluation of the coal characteristics of the Salt Range and Punjab Plains area indicates that the average thickness for Tertiary coal beds in the Salt Range is 0.43 m (range 0 - 2.13 m) and that coal beds of similar quality may underlie the Punjab Plains. Average major chemical characteristics of Salt Range Tertiary coal samples are as follows (all values by weight a.r.): moisture, 6.21 percent; ash, 24.02 percent; volatile matter, 33.44 percent; fixed carbon, 35.98 percent; sulfur, 5.71 percent; and calorific value, 9843 Btu/lb. The rank has been reported to be high-volatile C to B bituminous. Areas of thickest, widespread coal beds are near the towns of Choa Sidan Shah in the eastern Salt Range (Sheet 5, Appendix III) and near Pail in the central Salt Range (Sheet 4, Appendix III). A preliminary estimate of the total tonnage for the Salt Range area is 235 million metric tons excluding carbonaceous rich shale deposits. Additional drilling and field work are needed to delineate further the coal resources of the Salt Range coal field.

Permian coal deposits in the western Salt Range are generally discontinuous and poor quality. Possibilities for the discovery of similar or better quality Permian coal beds in the Punjab Plains area may be provided by coal exploratory drilling or by hydrocarbon test holes. The depth to the coal-bearing zone is expected to be more than 1000 m.

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## **APPENDIX I**

### **MEASURED SECTIONS AND FIELD OBSERVATIONS FROM THE COAL-BEARING SECTION OF THE SALT RANGE**

**By**

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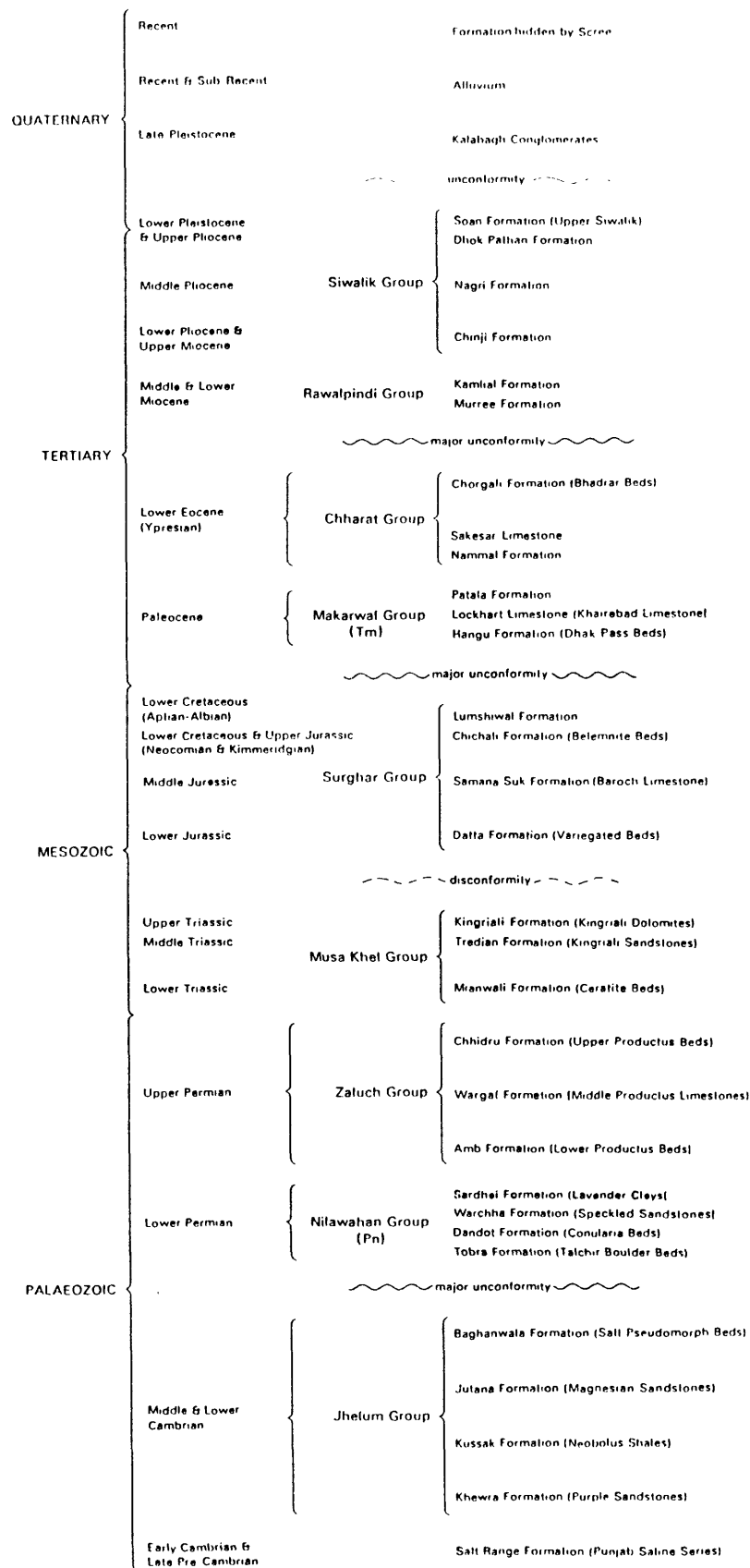
**and**

**Tariq Shakoor  
Geological Survey of Pakistan**

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<b>Measured sections.....</b>	<b>31</b>
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**Note: The rock code used in this report is after Ferm et al  
(1985). Sections were measured from the base upwards.**

# STRATIGRAPHIC COLUMN FOR THE SALT RANGE AREA (after Gee, 1980)



NOTE - Alternative formation names used in earlier reports are given in parentheses

## SECTION 1

Location: Lat. 32/43/29N  
 Long 73/17/45E

Date measured: 11 December, 1987

Mithachhoi area, Patala very thin, underlain by Tobra Formation, also very thin, underlain by Baghanwala Formation, strike of beds = N 17 NW, Baghanwala dip = 45 NW, Tobra dip = 33 NW, Patala dip = 30 NW; local change in dip, slight folding.

### Interval

Thkns (ft)	Rock code	Description
------------	-----------	-------------

Start of section in Baghanwala Formation

10.00	362	Siltstone, red
-------	-----	----------------

### Tobra Formation

8.0	745	Conglomerate, cobbles of mixed rock types, matrix is mudstone and sand, pebbles tend to be aligned, subangular to subrounded, clast mainly of quartzite, sedimentary rock fragments with chert, and black, basic igneous rocks, size is <3 inches.
-----	-----	--

6.0	745	Conglomerate, clast size near base is <2.0 ft, same lithology as below with large quartzite clasts, clast size decreases upwards.
-----	-----	---

### Patata Formation

1.25	333	Siltstone, white, almost very fine sandstone, occasional quartz grain scattered in a fine grained matrix, friable, top 2-3 inches rooted.
------	-----	---

0.5	327	Siltstone, with carbonaceous material, iron stained.
-----	-----	--

5.0	334 BUR	Siltstone, white, burrows stained with red iron, vertical and horizontal burrows, massive.
-----	---------	--

1.5	364 BUR	Siltstone, stained red, same burrows as below, massive.
-----	---------	---

1.5	363	Siltstone, interbedded with shaley stringers, less burrowing.
-----	-----	---

1.5	894	Shaley limestone, ostrea fossils in a marly limestone matrix.
Nammal Formation		
13.0	996	limestone, fossiliferous, nodular, marl between nodules, nodules 3-4 inches in diameter.
Kamlial Formation		
50.01	541	Sandstone, light grey, cross bedded, basal 2 feet has reworked Nammal fossils.

## Section 2

Location: lat - 32/43/45N  
long - 73/17/05E

Date measured: 12 December, 1987

Patala and Nammal formations are exposed in small nala in the Mithathhoi area. Patala Formation underlain by Baghanwala Formation, no Tobra Formation present. Baghanwala - strike = N 85 W, dip = 45 N; base of Nammal Formation strike = N 85 W, dip = 43 N.

### Interval

thkns (ft)	Rock code	Description
------------	-----------	-------------

-----  
Section starts in Baghanwala Formation

50.01	364	Siltstone, red, massive, interbedded with grey shale, bed thickness is 3-4 inches, burrows common.
1.0	364	Siltstone, red, mottled, lateritic, weathered at top.
Patala Formation		
2.0	134	Shale, light grey, massive, plant fragments, rooted.
1.2	137	Shale, light grey, rooted, plant fragments.

6.0	750	Conglomerate, quartzose, cross bedded, with coal stringers between bedding. Bed thickness 1 - 1.5 ft, with through cross beds, 3 ft across, 1 ft deep, pebbles at base up to 3 - 4 inches in diameter, most 1 inch in diameter, grain size decreases upwards, each bedding unit separated by a thin layer of silt and coaly material, unrotated trough cross bed measurements: S 70 W, N 90 W, S 65 W, S 72 W.
2.5	540	Sandstone, light grey, fine grained, friable, some plant material, mottled and churned, some rooting. Sample - SS-S2-1.
1.0	547	Sandstone, light grey, fine grained, rooted, with coaly stringers
2.0	540	Sandstone, light grey, friable, massive to churned, some plant material.
1.75	337	Siltstone, light grey, rooted, friable, becoming more carbonaceous upwards.
0.5	023	Coal, with sandy layers mostly covered, mostly wood 1 inch thick, 4 inches long making coaly layers, locally coaly carbonaceous shale above the coal, this contains woody stringers and shaley layers, and pyrite nodules.
4.0	232	Siltstone, light grey, with sandstone stringers, carbonaceous shale throughout, burrowed in upper part, up to 30% coaly material, this is being mined locally, Sample from nearby mine: SH-2-1.
0.75	429	Calcareous Siltstone, dark grey, fossiliferous.
0.75	134	Shale, light grey, massive.
Nammal Formation		
0.3	804	Shaley limestone, massive.
1.25	134	Shale, light grey, massive.
0.25	234	Calcareous Shale, light grey, massive.
0.25	994	Limestone, fossiliferous, massive.



0.5	234	Calcareous Shale, light grey, massive.
3.5	994	limestone, with Ostrea, massive.
5.0	994	Limestone, with forams, massive, very hard.
25.0	996	Limestone, with forams, nodular, marl between nodules, nodules 1 inch in diameter.
Kamlial Formation		
50.00	541	Sandstone, grey, cross bedded, scoured base.

### Section 3

Location: Lat - 73/15/05E  
Long - 32/43/55N

Date measured: 13 December, 1987

Section is east of Baghanwala Fort along Paleocene escarpment.  
Baghanwala strike = N 83 W, dip = 22 N, Patala strike = N 20 W,  
dip = 8 NE -- structural problems??

#### Interval

Thkns (ft)	Rock code	Description
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Start section in Baghanwala Formation

50.00	364	Siltstone, red, massive, interbedded with shale, burrowed, sandy at places, salt pseudomorphs.
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#### Tobra Formation

2.7	745	Conglomerate, sandy clay matrix, clast size <2 inches.
25.0	541	Sandstone, grey, cross bedded, medium to coarse grained, scoured at base, large cross beds 3 ft wide, 1.5 ft thick, top rippled and burrowed with carbonaceous stringers, upper part is lateritic at places, Permian channel sandstone.

#### Patala Formation

1.7	543	Sandstone, grey , with shaley layers, rippled, burrowed, carbonaceous stringers.
1.5	327	Siltstone, dark grey, rooted, with iron staining along root marks, carbonaceous material throughout, paleosol.
10.0	751	Conglomerate, quartzose, cross bedded, basal part with quartz pebbles, plant fragments, scour base, multiple scours within, stacked channels, fining upwards, small trough cross beds 2 ft wide, 1 ft thick near base, trough paleocurrents: N 82 W, N 85 W, top of body has abandoned channel 10 ft X 3 ft filled with burrowed siltstone and plant material.
2.0	323	Siltstone, dark grey, with sandstone stringers, carbonaceous material throughout, possible channel fill, no rooting, quartzose sand stringers.
1.0	032	Shaley coal, with sandstone stringers, varies in thickness, increases in thickness after local dip, may be due to channel fill.
1.5	348	Siltstone, greenish grey, burrowed, no rooting, plant material.
5.0	124	Shale, dark grey, massive, iron stained, coaly stringers - probably wood near top, no rooting.
3.0	433	Calcareous Siltstone, light grey, with sandstone stringers.
2.5	439	Calcareous Siltstone, light grey, ostrea fossils.
Nammal Formation		
22.0	990	Limestone, fossiliferous, mostly covered.
25.0	360	Siltstone, greenish red, mostly covered.
3.0	990	Limestone, with forams, mostly covered.
40.0	990	Limestone, fossiliferous, covered.
Kamlial Formation		
50.01	541	Sandstone, grey, cross bedded.

# Section 4

Location: Lat - 32/44/10N  
Long - 73/14/10E

Date measured: 13 December, 1987

Old mine workings near Baghanwala, described by LaTouche, section mostly covered except for Tertiary quartz pebble sandstone, no strikes and dips - too much cover.

## Interval

thkns (ft) Rock code Description

Sections starts in Baghanwala Formation

50.00 364 Siltstone, red, massive.

## Tobra Formation

1.0 745 Conglomerate, boulders on outcrop, mostly covered, thickness estimated.

1.0 100 Shale, covered.

## Patala Formation

6.0 750 Conglomerate, quartz pebbles, base coarse grained, fines upwards, top irregular, internal scours.

6.5 541 Sandstone, grey, cross bedded, quartz rich.

1.0 547 Sandstone, grey, rooted

0.5 022 Coal, with shaley layers

1.0 032 Shaley coal, with sandstone layers.

1.0 033 Shaley coal, with sandstone stringers, more shale than below.

0.6 323 Siltstone, dark grey, with sandstone and coaly stringers.

0.1 324 Siltstone, dark grey, massive,

5.0 001 Covered.

Nammal Formation - Limestone section mostly covered, may have missed shaley "Sidhandi member", thicknesses

		estimated.
45.0	990	limestone, ostrea fossils at base.
15.0	890	Shaley limestone.
10.0	990	limestone, fossiliferous.
5.0	160	Shale, red.
26.0	996	Limestone, fossiliferous, nodular, nodules 1 inch in diameter.

#### Kamlial Formation

50.0+	541	Sandstone, grey, cross bedded.
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#### Section 5

Location: Lat - 32/44/30N  
Long - 73/13/25E

Date measured: 12 January, 1988

Along escarpment just east of Ara Rest House, Baghanwala strike - N 8 W, dip = 5 NW.

#### Interval

thkns (ft)	Rock code	Description
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Section starts in Baghanwala Formation

50.0+	360-332	Siltstone, pale reddish brown, 10R 5/4, interbedded with fine sandstone.
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#### Tobra Formation

7.0	745	Conglomerate, silty matrix - pale olive, 10Y 6/2, boulders of pink granite and black mafic clasts - volcanics?, boulders up to 1 ft diameter, grain supported.
4.5	541	Sandstone, grey, cross bedded, conglomeratic, with same clast as below.
2.0	745	Conglomerate, boulder bed, clast up to 3 ft in diameter, rounded, clast composition same as below.

10.0	323	Siltstone, pale olive, occasional pebbles with angular shapes mixed in, clasts of mixed rock types, size up to 3 inches.
1.5	745	Conglomerate, with quartzite, black sandstones, siltstone and sedimentary rock fragments as clasts.
20.0	322/543	Siltstone, dark grey, with sandy layers, occasional pebbles in matrix, grades upwards into very muddy conglomeratic sandstone.
1.5	541	Sandstone, grey, cross bedded, fine to medium grained, scour based, Sample SS-S5-1.
15.0	322	Siltstone, greyish red, sandy, with pebbles of quartz and others, has greater iron content than siltstones below.

#### Patala Formation

13.5	541	Sandstone, clean quartz sand, medium grained, cross bedded to flat bedded, with conglomeratic lenses of quartz grains, some lenses up to 10 ft wide and 0.5 ft thick, flat bedded units up to 0.5 ft thick, scour based, multiply scoured.
2.0	547	Sandstone, clean quartz sand as below, rooted.
1.0	038	Coal, shaley, with sandstone stringers, locally mined, pyrite nodules 1 inch diameter, resin nodules up to 0.25 inch in diameter.
6.0	332	Siltstone, light grey, layered siltstone with sandy layers.

#### Nammal Formation

6.0	200	Marly clay, mostly covered.
38.0	896	Shaley limestone, light grey, fossiliferous, nodular, nodules <6 inches in diameter, marl between nodules.
6.0	200	Marly Clay, with limestone nodules, pale yellowish brown.
4.5	994	Limestone, fossiliferous, massive.

37.0	996	Limestone, fossiliferous, nodular, mostly covered.
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#### Kamlial Formation

50.0+	541	Sandstone, light olive grey, cross bedded, coarse grained.
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### Section 6

Location: Lat 32/44/25N  
Long 73/13/00E

Date measured: 12 January, 1988

Section on escarpment just below Ara Rest House, Baghanwala  
strike = N 63 W, dip = 14 NE

Interval thkns (ft)	Rock code	Description
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Section starts in Baghanwala Formation

50.00	322	Siltstone, grayish red, interbedded with rippled, very fine sandstone.
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#### Tobra Formation

3.0	745	Conglomerate, sandstone matrix, boulders of granite and mafic rocks, up to 1 ft long axis, scoured base, with basal lag of channel.
28.0	541	Sandstone, grey, cross bedded, large trough cross beds with pebbles on bedding planes, multiply scoured, pebbles consist of quartz and mafic rock fragments, Sample SS-S6-1.
10.0	323	Siltstone, light olive grey, massive, with sandstone streaks.
7.0	360	Siltstone, grayish red, silty shales, iron stained, partly lateritic, Sample SH-6-3.

#### Patala Formation

6.0	543	Sandstone, white, very fine grained, shaley,
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silty, grain size coarsens upwards.

1.5	745	Conglomerate, mostly quartz pebbles, pebbles up to 2 inches in diameter.
6.0	541	Sandstone, white, quartz rich, iron stained, Sample from middle - SS-S6-2.
1.0	547	Sandstone, rooted.
0.6	037	Coal, shaley, with shale layers and streaks.
0.9	123	Carbonaceous Shale.
5.5	124	Shale, dark greenish grey, massive, slightly silty.

#### Nammal Formation

3.0	434	Calcareous Siltstone, light grey, with limestone nodules 2 ft in diameter.
1.2	439	Calcareous Siltstone, light grey, filled with ostrea shells.
60.0	894	Shaley Limestone, fossiliferous, slightly nodular bedded.
5.0	360	Siltstone, red, mostly covered.
27.0	996	Limestone, fossiliferous, nodular.

#### Kamlial Formation

10.0+	541	Sandstone, grey, cross bedded.
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#### Section 7

Location: Lat 32/44/40N  
Long 73/11/50E

Date measured: 13 January, 1988

Section in gorge with spring southwest of Ara. Baghanwala strike = N 58 W, dip = 10 NE.

Interval

thkns (ft)	Rock code	Description
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Section starts in Baghanwala Formation

20.0+	362	Siltstone, pale red to darker reds, interbedded with fine grained sandstone.
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Tobra Formation

26.0	360	Siltstone with boulders, mudstone with coarse sandstone matrix, grayish red, granite and mafic boulders scattered throughout, boulders have up to 1 ft long axis, pebbles and boulders rounded, no orientation.
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1.0	332	Siltstone, light grey, sandy.
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2.2	360	Siltstone with pebbles, moderate pink, pebbles highly weathered, rounded, consists mostly of granite.
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1.0	333	Siltstone, light bluish grey, with sandstone stringers, small (<2 mm) pebbles of weathered granite.
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Patala Formation

36.0	541	Sandstone, quartzose, white to light grey, cross bedded, coarse grained with quartz pebbles, scoured base, upper part has 0.5 ft thick silty partings, burrows on some bedding planes, partings with some carbonaceous material throughout, lower part has contoured bedding, upper part flat bedded with ripples and burrows, small scale cross beds near base, generally coarsening upwards in grain size.
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2.0	027	Coal with shale layers, measured in nearby mine, bright stringers consist of logs 6 to 10 inches long, 1 to 2 inches thick in a dull matrix, resin and pyrite throughout. In old mine works, coal was reported to be 5 ft thick, and thickened after a slight dip. In an adjacent adit about 300 ft west, the coal bed is split by 1.5 ft sandstone (splay type and rooted), upper coal is 2 ft thick, lower part is carbonaceous shale 1 ft thick.
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5.0	114	Shale, black, massive.
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5.0      300      Siltstone, mostly covered.

Nammal Formation

50.0+      894      Shaley Limestone, fossiliferous, massive,  
mostly covered.

Section 8

Location: Lat 32/43/35N  
          long 73/11/25E

Date measured: 15 January, 1988

Above the town of Rawal, on the isolated hill with Patala and  
Tertiary deposits, Baghanwala strike = N 65 W, dip = 7 NE.

Interval

thkns (ft)    Rock code    Description

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Section Starts in Baghanwala Formation

50.0+      360      Siltstone, with shales interbedded, red.

Tobra Formation

30.0      320/745      Siltstone with boulders, light olive grey,  
mixed shales, sands and muds, boulder size  
varies, up to 2 ft diameter in lower part,  
smaller in middle and large at the top,  
boulders consist of granite, black quartzites  
and mafic rocks, also schistose and phyllitic  
rock fragments.

17.0      330      Siltstone with boulders, light bluish grey,  
highly weathered, boulders 0.5 to 1.0 ft long  
axis.

15.0      332/745      Siltstone with boulders and sandy layers,

weathered white, highly weathered, fractured and jointed, arkosic sand with bits of granitic rock fragments, feldspars weathered to kaolinite.

#### Patala Formation

5.0	541	Sandstone, very pale orange, quartz rich, cross bedded, with rip clasts of underlying material incorporated, red stained at base, burrowed, upper 1 ft rooted.
5.0	137	Shale, light brownish grey, slightly silty, rooted.
2.0	030 *	Shaley Coal.
15.0	332	Shale, light grey, with quartz-rich sandy layers, layers up to 3 inches thick, upper part rooted, lenses grade laterally into small channels 1.0 ft thick.
0.3	123	Carbonaceous Shale.
5.0	322	Siltstone, light olive grey, sandy layers, calcareous with limestone nodules.
10.0	001	Covered.

#### Nammal Formation

25.0	996	Limestone, fossiliferous, nodular.
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#### Section 9

Location: Lat 32/44/30N  
Long 73/09/05E

Date measured: 18 January, 1988

Section along road NE of Sidhandi, location Jabrian, north of cement factory, Baghanwala strike = N 55 E, dip = 16 SE.

Interval  
thkns (ft) Rock code Description

Section starts in Baghanwala Formation

50.0+	360	Siltstone, red, interbedded with shales.
Tobra Formation		
24.0	360/745	Siltstone with boulders, lower part olive green, upper part pale blue, pebbles highly weathered at top, pebbles and cobbles of granite, quartzite and mafic rock fragments.
Patata Formation		
5.2	541/750	Sandstone, light grey, quartzose, coarse grained with quartz pebbles, flat bedded, with ripples and small tabular cross beds, shale clasts of 1 inch long diameter mixed in near base, poorly sorted, matrix supported, top burrowed.
1.0	547	Sandstone, light grey, rooted, fine to medium grained.
11.0	323/123	Siltstone, carbonaceous, plant material on bedding planes, lower part slightly rooted, upper part not rooted.
17.0	543	Sandstone, light grey, with very thin shaley beds, rippled, fine grained at base, coarsening upwards to medium grain size, sand is quartzose, burrowed throughout.
1.6	332/123	Siltstone, carbonaceous, does not appear to be rooted, weathered, iron staining along fractures.
9.0	541	Sandstone, light grey, coarse to medium grained, quartzose, cross bedded, gravel at base 2 inches in diameter, scoured base, small tabular cross beds sand pinches out laterally, grain size fines upwards.
7.0	123/022	Carbonaceous Shale, coaly horizons, highly weathered.
9.0	543	Sandstone and shale interbedded, light grey, sand rippled, sand units <2 ft thick, shale partings usually < 1 inch thick, burrowed sands through out, horizontal and vertical burrows.

Note: Upper part of section faulted and jumbled, the ostrea bed overlies this section but true thickness of faulted section

is unable to obtain.

## Section 10

Location: Lat 32/44/48N  
Long 73/08/08E

Date measured: 19 January, 1988

Section is east of Saloi at the top of the nala, north of cement factory, Baghanwala strike = N 5 E, dip = 8 NW.

Fl.	Rock code	Description
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Section starts in the Baghanwala Formation

50.01	360	Siltstone, red, with sandstone layers.
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Tobra Formation

25.0	360/745	Siltstone with boulders, lower part reddish grey, upper part pale blue, upper part becoming more sandy, with granite pebbles and cobbles.
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3.0	540	Sandstone, yellowish grey, fine to medium grained, scattered Tobra type pebbles.
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3.0	334	Siltstone, coarse sand scattered through out, with weathered flecks of feldspars that become kaolinite.
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3.5	541	Sandstone, grey, cross bedded, scattered Tobra pebbles in matrix, basal lag granite cobbles, small tabular cross beds, fractured, iron stained.
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4.5	332	Siltstone, light grey, mixed with very fine sandstone, scattered pebbles throughout, rippled to flat bedded, pebbles are mainly quartz.
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7.5	541	Sandstone, grey, cross bedded, fine to silt size, tabular cross beds, scattered pebbles and boulders of Tobra type throughout, also magnetite boulders.
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Patalla Formation

1.0	123	Carbonaceous shale, silty, burrowed.
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2.7	541	Sandstone, grey, fine grained, flat to ripple bedded, burrowed.
0.5	320	Siltstone, dark grey, carbonaceous, thickens and thins laterally.
3.2	543	Sandstone, grey, with shale interbeds, lower part coarse grained, flat bedded, burrowed.
12.0	541	Sandstone, grey, fine to medium grained, local trough cross bedding.
5.0	123	Carbonaceous shale, silty.
15.5	543	Sandstone, grey, fine grained, rippled, burrowed, interbedded with shale, layers about 1 inch thick, top part rooted.
5.0	123	Carbonaceous shale, silty throughout.
2.0	548	Sandstone, grey, very fine, heavily burrowed.
5.0	333	Siltstone, light grey, silty, mostly covered.
5.0	360	Siltstone, reddish grey, mostly covered.

#### Nammal Formation

10.0	996	Limestone, filled with forams, nodular.
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### Section 11

Location: Lat 32/47/50N  
Long 73/11/50E

Date measured: 22 January, 1998

Section is east of Siki on north side of main nala at big cliff cut by tributary of main nala, Baghanwala strike = N 58 W, dip = 10 NE.

#### Interval

thkns (ft) Rock code Description

Section starts in Baghanwala Formation

50.0+	360	Siltstone, red, with sandstone interbeds.
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0.4	540	Sandstone, yellowish grey, coarse grained, flat bedded to rippled.
2.0	360	Siltstone, red.
Tobra Formation		
2.0	745	Conglomerate, mixed rock type boulders, sand matrix, clast size up to 6 inches, poorly sorted, well rounded pebbles.
Patala Formation		
1.5	541	Sandstone, grayish yellow, cross bedded, in places conglomeratic, mostly quartz pebbles, some tabular cross beds scour base, thickens and thins laterally.
1.5	322	Siltstone, medium grey, sandy layers, fines upwards in grain size, quartz pebbles mixed throughout, pebbles 2-3 mm long axis.
1.0	070	Iron stone, dark reddish brown, sandstone - siltstone - pebble matrix.
4.5	129	Shale, olive grey, forams throughout, shaley limestone nodules.
1.0	439	Calcareous Siltstone, yellowish grey, marly, ostrea shells.
Nammal Formation (thicknesses estimated)		
10.0	896	Shaley limestone, forams, nodular.
10.0	994	Limestone, fossiliferous, massive.
30.0	230	Marl, light grey, with limestone nodules
35.0	994	Limestone, fossiliferous, massive.
Kamlial Formation		
30.0	541	Sandstone, grey, cross bedded.

## Section 12

Location: lat 32/47/08N

Long 73/10/10E

Date measured: 23 January, 1988

Just north of Siki mines, all mines in this area are abandoned, locals say mines were working up to 3 feet of coal, but now they have mined it out, Baghanwala strike: N 60 W, dip = 12 NE, Tobra strike = N 45 W, dip = 29 NE.

Interval

thkns (ft)	Rock code	Description
50.0 +	360	Siltstone, red, interbedded with fine burrowed sandstone, top 0.5 ft of Baghanwala is iron stained.

Tobra Formation

2.0	745	Conglomerate, with highly weathered granite and mixed rock types, sand and mud matrix, lateral 8 ft thick sandstone scours into conglomerate.
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Patala Formation

3.0	750	Conglomerate, predominately quartz clasts, matrix supported, grain size fines upwards, upper part clean, quartz rich sandstone.
1.5	038	Shaley Coal, with very thin (<1 mm) silty shale partings, weathered, lots of plant fossils, no apparent rooting below.
3.0	124	Shale, dark grey, silty in places, plant fragments throughout.
5.0	139	Shale, olive grey, forams.
10.0	896	Shaley limestone, fossiliferous, nodular, mostly covered.

Section 13

Location: Lat 32/44/10N  
Long 73/10/10E

Date measured: 24 January, 1988  
 Section is directly east, northeast of Sidhandi, Baghanwala  
 strike - N 50 W, dip - 8 E.

# Interval

thkns (ft) Rock code Description

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 Section starts in Baghanwala Formation

50.00	360	Siltstone, red, with silty shales interbedded.
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# Tobra Formation

1.0	332	Siltstone, shale and fine sand interbedded, light grey.
8.0	541	Sandstone, yellowish grey, cross bedded, medium to coarse grained, arkosic, scoured base, friable, grain size fines upward.
1.0	332	Siltstone, light grey, with sand interbedded.
8.0	300	Siltstone, light olive grey, with pebbles, pebbles of mixed rock type.
1.0	332	Siltstone, light grey, with sand interbedded.
1.0	541	Sandstone, grey, flat bedded.
100.0	300/745	Siltstone with boulders and pebbles, light olive grey, mixed rock types, upper part boulders of granite weathered and color changes to very pale orange, section mostly covered.

# Patana Formation

7.0	541	Sandstone, light grey, quartz rich, coarse to medium grained, quartz pebbles at base, scour base on top of Tobra, contains broad, low angle cross beds with internal dips of 3 degrees, upper part flat bedded and burrowed.
0.7	332	Siltstone, light grey, with shale and sandstone stringers, burrowed.
5.0	548	Sandstone, light grey, medium grained, generally flat bedded, burrowed.
1.5	750	Conglomerate, white, quartz pebbles, round, < 1 inch in long axis.



6.0	541	Sandstone, light grey, fine grained, upper part generally cleaner, flat bedded, with local small scale trough cross beds, burrowed throughout.
0.6	332	Siltstone, light grey, with shale and sandstone stringers, carbonaceous, burrowed, no apparent rooting.
12.0	541	Sandstone, light grey, generally flat bedded, burrowed, scour based, small tabular cross beds at base and ripple marks in upper part, multiply scoured, individual units about 5 ft thick before scoured again and overlain by the same sequence, pebble lag over scours.
0.5	332	Siltstone, light grey, interbedded with sandstone and shale, carbonaceous, burrowed.
0.8	541	Sandstone, grey, flat bedded to rippled, burrowed.
1.0	332	Siltstone, light grey, interbedded with sandstone and carbonaceous shale, burrowed.
0.4	541	Sandstone, grey, flat bedded, rippled, burrowed, plant material on bedding planes.
0.4	123	Carbonaceous Shale.
1.0	547	Sandstone, grey, fine to medium grained, rooted, quartz rich, flat bedded.
0.3	123	Carbonaceous Shale.
1.0	541	Sandstone, grey, rippled, trails along ripple tops.
20.0	000	Covered.
Nammal Formation		
20.0	996	Limestone, fossiliferous, nodular.

#### Section 14

Location: Lat 32/45/55N

Long 73/19/00E

Date measured: 28 January, 1988

Section is east of in isolated outcrop of Tertiary beds in NE flowing nala. Baghanwala strike = N18W, dip = 22NE.

Fl.	Rock code	Description
Section starts in Baghanwala Formation		
50.04	360	Siltstone, red sandstone and shale interbedded.
Tobra Formation		
57.0	745	Conglomerate, olive grey siltstone matrix, with 2 ft diameter mixed rock type boulders, matrix supported, top weathered to light green.
10.0	745	Conglomerate, very light grey coarse sandstone matrix, pebbles and cobbles of mixed rock type, matrix supported, cobbles angular to subrounded, cross bedded, small tabular cross beds N50W.
7.0	541	Sandstone, grey, medium to coarse grained, mixed rock types, with shale partings, Sample SS-S14-1.
Patala Formation		
5.0	543	Sandstone, quartz pebbles, with shaley beds, carbonaceous partings, rooted.
0.5	322	Siltstone, dark grey, carbonaceous, sandy.
2.6	544	Sandstone, quartz rich, medium grained, massive, rooted at top, preserved small scale dunes on top, Sample SS-S14-2.
2.0	038	Shaley Coal, with sandstone stringers, almost 50% sandstone, locally mined.
1.0	541	Sandstone, clean quartz sand with scattered quartz pebbles, cross bedded, coaly stringers at base.
4.0	124	Shale, dark grey, massive, scattered plant

material.

1.7	369	Siltstone, grayish red, forams, slightly calcareous.
3.5	139	Shale, light grey, slightly silty, forams, slightly calcareous.

#### Nammal Formation

2.8	894	Shaley limestone, with siltstone, light grey, massive, with ostrea fossils.
30.0	996	Limestone, fossiliferous, nodular.

#### Kamlial Formation

100.0+	541	Sandstone, grey, cross bedded.
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### Section 15

Location: Lat 32/51/18N  
Long 73/25/15E

Date measured: 5 February, 1988

Section is on northwest side of Jogi Tilla, north of Pohti,  
Baghanwala strike = N85E, dir = 50NW.

#### Interval

Thkns (ft)	Rock code	Description
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Section starts in the Baghanwala Formation

50.0+	360	Siltstone, red, interbedded with sandstone and shale, appears to be more sandy than that seen in previous sections.
10.0	330	Siltstone, weathered greenish yellow, interbedded with sandstone and shale.

#### Patala Formation

3.0	543	Sandstone, light grey, fine grained, flat bedded, bioturbated, mottled, filled with plant material and woody chips, coaly
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		stringers, iron stained along joints, small crevasse splay type sandstone, 30 ft wide.
2.0	038	Shaley Coal, with siltstone stringers, 50% ash, no apparent rooting below bed..
2.5	134	Shale, light grey, no rooting.
9.0	124	Shale, dark to medium grey, coaly stringers, lots of plant material, fissile.
1.5	123	Carbonaceous Shale.
13.0	332	Siltstone, light grey, interbedded with sandstone, burrowed, 3 zones of shale about 1.5 ft thick, equally spaced.
12.0	124	Shale, dark grey, massive.
1.0	224	Shale, dark grey, with limy nodules, massive.
1.0	804	Shaley Limestone, massive.
3.0	164	Shale, reddish grey, massive.
1.0	894	Shaley Limestone, ostrea fossils, massive.
Nammal Formation		
15.0	996	Limestone, fossiliferous, nodular.
Kamlial Formation		
50.0+	541	Sandstone, grey, cross bedded.

### Section 16

Location: Lat 32/50/05N  
Long 73/23/32E

Date measured: 6 February, 1988

Section is above Nara on south side of Jogi Tilla ant Malik Dhost  
Mohammad Mines, Baghanwala strike = N85E, dip = 12N

Interval  
thkns (ft) Rock code Description

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Section starts in Baghanwala Formation

50.0+      322/543      Siltstone, interbedded with sandstone, grey to dark grey.

Patala Formation

3.0      000      Covered contact of Tertiary and Baghanwala Formations.

3.0      030      Shaley Coal, base not exposed, plant material mixed throughout in dull matrix, like mixinite.

2.0      742      Sandstone, fine grained, with very rounded clay balls less than 1 inch in diameter, more silty than sand, this is a split in the coal bed, its thickness increases toward the NE, upper split of coal decreases toward the NE.

0.8      030      Shaley Coal, burrowed throughout.

1.7      742      Silty Sandstone, with shale balls, very rounded, same as below, lens shaped.

3.5      333      Siltstone, light grey, plant material throughout.

1.3      332      Siltstone, light grey, sandy stringers, plant material.

3.0      124      Shale, dark grey, massive.

0.5      804      Shaley limestone, silty dark grey.

1.8      124      Shale, dark grey, massive.

1.8      174      Shale, grayish red, massive.

Nammal Formation

1.5      439      Calcareous Siltstone, with ostrea fossils, light grey.

2.0      806      Shaley limestone, with nodules.

15.0      996      Limestone, forams, nodular.

Kamlial Formation

50.0+      541      Sandstone, grey, cross bedded.

### Section 17

Location: Lat 32/48/00N  
Long 73/06/00E

Date measured: 9 February, 1988

Section is southwest of Choa Gang Ali Shah, up mining road to southwest, Tobra making slope, Patala strike N62E, dip 30NW, Tobra is in contact with Jutana, no Baghanwala, may be faulted out.

#### Interval

thkns (ft) Rock code      Description

-----  
Section starts at base of Tobra Formation at contact (fault?) with Jutana Formation.

95.0	745	Conglomerate in siltstone matrix, matrix greenish grey, boulders of mixed rock type up to 1 ft in diameter, matrix supported, lots of pebbles and gravel sized material, no apparent bedding, upper part becomes flat bedded and mixed with sand, almost no rock boulders here, scattered pebbles.
10.0	541	Sandstone, grey, fine grained, flat bedded.
35.0	745	Conglomerate in siltstone and sandstone matrix, some gravel beds up to 3 ft thick, cross bedded mostly matrix supported, massive bedded.

#### Patala Formation

14.0	742	Conglomerate, quartz pebble conglomerate, clean quartz sandstone, pebbles up to 2 inches in diameter, mostly cross bedded, low angle cross bedding, some iron staining, sharp scour base on top of Tobra, top is more iron stained, fewer quartz pebbles toward the
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top, finer grained upwards.

1.0	337	Siltstone, light grey, mixed with fine sandstone, rooted throughout, upper part carbonaceous.
1.2	123	Carbonaceous Shale, lower half silty, locally mined, locally develops coaly stringers, around 10 working and abandoned adits on slope.
17.0	333	Siltstone and shale interbedded, plant material mixed along bedding planes, small, less than 1 inch depth, 2 mm wide burrows.
2.0	164	Shale, reddish grey, massive.
5.0	000	Covered.
Nammal Formation		
20.0	996	Limestone, fossiliferous, nodular.

#### Section 18

Location Lat. 32/45/15N  
Long. 73/06/00E

Date measured: 10 February, 1988

Section is on road 0.5 mile from Saloi, Permian is very thick and scours into Baghanwala, Baghanwala strike is approximately E-W, dip is 10S.

#### Interval

Thkns (ft)	Rock code	Description
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-----  
Section starts at the Baghanwala - Jutana contact

50.0	360	Siltstone, red, interbedded with shale, Baghanwala thin at this location.
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#### Tobra Formation

65.0	745	Conglomerate, sandstone matrix, boulders of mixed rock type up to 2 ft in diameter,
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		clasts of Baghanwala, multiple scours, becomes finer grained upwards into cross bedded sandstone.
10.0	320	Siltstone, with cobbles and boulders, grayish green.
8.0	745	Conglomerate with sandstone matrix, olive grey, pebbles and cobbles of mixed rock type, 3-4 inch long axis, massive.
12.0	745	Conglomerate with sandstone and siltstone interbedded, olive grey, sandstone in lenses up to 2 ft thick, cobbles and boulders throughout.
10.0	745	Conglomeratic Sandstone, cross bedded, upper part mostly sandstone.
38.0	745	Conglomerate with siltstone matrix, olive grey, matrix supported, with <1 ft thick sandstone layers, cobbles and boulders mixed throughout.
5.0	745	Conglomerate in sandstone matrix, with cobbles and boulders mixed throughout, scour based.
18.0	541	Sandstone, light grey, coarse grained, cross bedded, with lenses of clay, cliff former.
3.0	332	Siltstone, light grey, flat bedded.
8.0	541	Sandstone, grey, coarse grained, flat bedded, a few pebble lenses.
2.0	332	Siltstone, light grey, flat bedded.

Dandot Formation ?

12.0	541	Sandstone, grey, coarse grained, pebble lenses, light olive grey, arkosic, flat bedded, brachiopod fossils, limestone clasts up to 3 inches long.
40.0	332	Siltstone, light olive grey, with sandstone stringers less than 1 ft thick.
25.0	543	Sandstone, grey, interbedded with siltstone and shale, flat bedded rippled.
5.0	541	Sandstone, yellowish grey, medium grained,



flat bedded, rippled.

8.0        332        Siltstone, yellowish grey, upper part becoming sandy.

6.0        540        Sandstone, pale reddish brown, lateritic, fine to silt size, massive, fractured.

#### Patala Formation

10.0       548        Sandstone, grey, fine grained, quartz rich, rippled, burrowed, flat bedded.

10.0       134        Shale, light grey, massive, mostly covered.

2.0        548        Sandstone, grey, fine grained, flat bedded, burrowed.

5.0        124        shale, dark grey, massive.

#### Nammal Formation

20.0       000        Covered, Nammal float.

### Section 19

Location: Lat 32/43/55N  
          Long 72/43/25E

Date measured: 19 February, 1988

Section at the head of Sohail canyon on west side around corner from spring and mill house.

#### Interval

thkns (ft)	Rock code	Description
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Section starts in Sardhi Formation

20.0	000	Covered.
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#### Patala Formation

5.0	070	Laterite, pisolitic, base not exposed.
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0.5	124	Shale, carbonaceous, plant material on
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bedding planes.

5.0	322	Siltstone, dark to medium grey, calcareous, sandy stringers.
12.0	432	Marly Siltstone, with limestone nodules, forams and mollusk fossils in upper part.
Nammal Formation		
30.0	896	Shaley limestone, fossiliferous, nodular.

## Section 20

Location: Lat 32/38/40N  
Long 72/35/45E

Date measured: 2 March, 1988

Section is on northwest side of Nila Wahan, on the point on the north slope of big tributary to northwest, Tertiary Hangu Formation overlies Permian Sardhi Formation, beds have slight dip.

Interval  
thkns (ft) Rock code Description

-----  
Section starts in Sardhi Formation

50.0+	360	Siltstone, grayish green to brownish red, shale and sandstone interbedded, cherty and calcareous lenses.
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Hangu Formation

22.0	541	Sandstone, very pale orange, medium grained, generally clean but not quartzose as Patana basal sandstone, scoured base, tabular cross beds and ripples, individual beds up to 6 inches thick, becomes massive towards top, coarsening upwards grain size, upper part thick bedded and micaceous, Sample SS-S20-1.
3.0	323	Siltstone, medium grey, with some sandy lenses, carbonaceous material throughout.

5.0	541	Sandstone, grey, medium grain size, flat bedded with ripples, crevasse type sandstone.
2.0	323	Siltstone, dark grey, shaley at base, carbonaceous and sandy layers.
5.0	541	Sandstone, flat bedded, rippled, small cross beds, same as below.
5.5	332	Siltstone, grayish orange, flat bedded, micaceous, upper part becoming glauconitic, limy lenses up to 6 inches thick near the base.
7.0	541	Sandstone, dusky yellow, medium grained, glauconitic, micaceous, massive bedded, may be burrowed, Sample SS-S20-2.
10.0	543	Sandstone, greenish grey, with shale interbeds, flat bedded, micaceous material along bedding, glauconitic.
6.0	541	Sandstone, dusky yellow, medium to coarse grained, some small pebbles up to 2 inches thick, flat bedded.
3.0	543	Sandstone, grey, with shale interbeds, some iron stains on beds, micaceous.
3.0	323	Siltstone, greenish grey, micaceous, iron stains throughout, clay balls in matrix like those at Jogi Tilla, sandy lenses, some lateritic textures.
13.0	541	Sandstone, dusky yellow, calcareous, massive to flat bedded, some small cross beds, lower 1 ft has shale rip clasts, lower part iron stained, glauconitic, upper part burrowed.
Lockhart Limestone		
15.0	894	Shaley Limestone, grayish orange, mollusk and forams, generally massive but some nodules.
40.0	996	Limestone, grayish orange, forams and mollusk in upper 10 ft, nodular, marl between nodules, upper part becoming shaley.
4.0	994	Limestone, fragments of shell debris, cherty layers, iron nodules, massive, strike = N48E, dip = 34NW.

Patala Formation

30.0        0000        Covered shale.

Nammal Formation

50.0+        996        Limestone, fossiliferous, nodular.

Section 21

Location: Lat 32/37/45N  
          Long 72/31/00E

Date measured: 3 March, 1988

Section measured in incline of PUNJMIN PJ-PCP-1 mine near PAH,  
at this location Chor Gali Formation is 0-98 ft, Sakesar is 98-  
288 ft, Nammal is 288-398 ft, Patala is 398-474, Lockhart is 474-  
ft, the coal bed is at 467 ft below surface.

Interval

thkns (ft) Rock code    Description

-----  
Section starts just below coal bed in Patala Formation.

4.5+	124	Shale, dark grey, with limestone nodules up to 6 inches in long axis and 2 inches thick, friable and mottled, burrowed at places, lots of plant material, no rooting seen.
1.1	021	Coal, bright and dull bands, pyrite fills burrows in upper part of bed, at places coal is up to 2 ft thick and split by olive grey shale, this parting thickens toward the north, sandstone roof towards the south, Sample PJ-PCP-1.
3.2	332	Siltstone, with quartzite sandstone stringers mixed throughout, flat bedded.
3.0.	124	Shale, dark grey, massive, Sample SH-PJ-PCP-1.
2.0	323	Siltstone, dark grey, massive.
25.0	124	Shale, dark grey massive.

3.0	994	Limestone, fossiliferous, massive.
3.0	124	Shale, dark grey, massive
Nammal Formation		
30.0+	994	Limestone, fossiliferous, massive.

## Section 22

Location: Lat 32/38/15N  
Long 72/31/20E

Date measured: 3 March, 1988

Section in PUNJMIN's new mine, PJ-PCP-2, north of PJ-PCP-1, and is near drill hole PJ-16.

### Interval

thkns (ft)	Rock code	Description
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Section starts in the Patala Formation below the coal bed.

4.0	994	Limestone, forams, massive, top of Lockhart?
0.2	124	Shale, dark grey, massive.
4.0	994	Limestone, fossiliferous, massive.
5.0	894	Shaley Limestone, with forams, massive.
5.0	894	Shaley Limestone, with forams, massive, same as below but with more shale.
5.0	124	Shale, dark grey, massive, limestone nodules and bands toward base.
1.5	124	Shale, dark grey, massive.
1.9	037	Shaley Coal, with shale stringers, bright stringers up to 1 inch thick toward the top, Sample PJ-PCP-2A.
2.0	323	Siltstone, dark grey, with quartzite stringers less than 1 cm thick, burrowed,

		pyrite filling burrows, shaley towards top.
0.3	037	Shaley Coal, with bright stringers and bright bands 2-3 cm thick, Sample PJ-PCP-2B
0.5	027	Coal, with shale stringers less than 1 cm thick, burrowed, with pyrite filling burrows, Sample PJ-PCP-2B, sample combined with lower unit.
5.0	338	Siltstone, light grey, sandstone stringers becoming more common upwards burrowed throughout.
8.0	124	Shale, dark grey, massive.
3.0	234	Shale, calcareous, light grey, massive.
Nammal Formation		
10.04	894	Shaley limestone, fossiliferous, massive.

### Section 23

Location: Lat 32/37/25N  
Long 72/29/15E

Date measured: 4 March, 1988

Section is from outcrops just east of Pail.

Interval  
thkns (ft) Rock code Description

-----  
Section starts in Amb Formation.

35.0	549	Sandstone, calcareous, grayish orange, very fine grained, fossil fragments, brachiopods and bryozoans throughout, flat bedded to rippled, bed sets up to 1 ft thick, base more micaceous than top, weathered break in outcrop bar beginning of Tertiary, Sample SS-S23 1.
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Hangu Formation

36.0	541	Sandstone, grayish orange, fine to medium grained, slightly calcareous, generally flat bedded, upper part has large tabular cross beds, top is burrowed, friable, Sample SS-S23-2 taken from near base.
5.0	541	Sandstone, grayish orange, fine grained, with shale stringers, calcareous, flat bedded and rippled.
5.0	124	Shale, dusky yellow, massive.
2.0	070	Laterite, grayish pink, siltstone and claystone matrix, pisolitic, iron stains, fractured.
15.0	544	Sandstone, light olive grey, medium to coarse grained, quartz pebbles at base, plant fragments throughout, massive to flat bedded.
5.0	332	Siltstone, reddish grey, sandstone stringers, weathered.
5.0	124	Shale, dark grey, massive, partly covered.
Lockhart Limestone		
43.0	996	Limestone, fossiliferous, nodular.
Patala Formation		
15.0	000	Covered, shale, dark grey, mining activity in this part of slope.
18.0	124	Shale, dark grey, massive.
5.0	224	Marly Shale, dark grey, with limestone nodules.
Nammal Formation		
15.0+	994	Limestone, fossiliferous, massive bedded, partly covered.

## Section 24

Location: Lat 32/36/50N  
Long 72/35/55E

Date measured 5 March, 1988

Section is in first major side canyon to west out of Nilla Wahan near CSR-3, section partly covered.

### Interval

thkns (ft)	Rock code	Description
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Section starts in Sardhai Formation

25.0	160/333	Siltstone, pale orange, beds about 3 ft thick alternating with shale, shale very dusky red purple, up to 6 ft thick, mottled.
65.0	000	Covered. contact of Permian - Tertiary covered.

### Hangu Formation

10.0	541	Sandstone, very light grey, medium grained, moderately sorted, micaceous especially at shale breaks, tabular cross beds, shale and carbonaceous shale interbedded at breaks up to 4 ft apart, plant material throughout, from tabular cross beds - S15E - paleocurrent reading.
35.0	541	Sandstone, grey, medium to fine grained, flat bedded, burrowed throughout, upper part rippled.
5.0	332	Siltstone, light grey, rippled, flat bedded.
4.0	124	Shale, dark grey, silty, sandstone stringers, plant material throughout, massive.
9.0	541	Sandstone, grey, medium to fine grained, cross bedded, rippled, small tabular cross beds, top burrowed.
2.0	070	Laterite, red nodules.
1.0	123	carbonaceous Shale.
3.0	134	Shale, light grey, silty, plant material throughout.



16.0	541	Sandstone, moderate olive brown, coarse grained, pebbles of quartz and shale, cross bedded, iron stained throughout, pisolitic structures in zone up to 1 ft thick, probably shale rip clasts, finer grained upwards, sharp scoured base.
5.0	332	Siltstone, moderate olive brown, sandstone stringers

#### Lockhart Limestone and Palala Formation

50.0      000      Covered.

Above thicknesses estimated.

15.0	124	Shale, dark grey, plant material throughout.
5.0	234	Shale, light grey, with limestone lenses, massive.

#### Nammal Formation

20.0	894	Shaley limestone, fossiliferous, massive and flat bedded.
30.0	996	Limestone, fossiliferous, nodular.
50.0	994	Limestone, fossiliferous, massive.

#### Section 25

Location: Lat 32/35/40N  
Long 72/35/00E

Date measured: 6 March, 1988

Section is west of Nila Wahan along the south escarpment.

#### Interval

Thkns (ft)    Rock code    Description

Section starts in Amb Formation.

10.00	894	Arenaceous Limestone, yellowish grey, silty, bryozoans and brachiopods mixed throughout.
Bampi Formation		
17.0	641	Calcareous Sandstone, yellowish grey, medium to fine grained, fossiliferous, burrowed, small scale cross beds, top rippled, reworked Permian fragments ?.
40.0	541	Sandstone, very light grey, medium to fine grained, cross bedded throughout, multiple scours, tabular sets in lower 10-15 ft, grades upwards into ripples, then scoured again, with 20 ft of tabular cross beds and ripples at top followed by another scour and the same sequence, paleoflow measurements from tabular cross beds: S60W, N50W, S10W, S20W, S15W, S10W, S10W, S5W, S5E, S50W.
5.0	543	Sandstone, very light grey, silty layers, flat bedded.
3.0	124	Shale, dark grey, with plant material.
Lockhart Limestone and Patala Formation		
55.0	000	Covered, local mining into this slope.
Hammal Formation		
50.00	996	Limestone, fossiliferous, nodular.

## Section 26

Location: Lat 32/35/15N  
Long 72/28/10E

Date measured: 9 March, 1988

Section is east of Pail Kushab road in Katha Collieries area.

Interval  
 Thkns (ft) Rock code Description

Section starts in Amb Formation.

44.0	894/434	Calcareous Siltstone, grayish orange, flat bedded, small tabular cross beds at places, bryozoans in pieces at base, massive.
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Hangu Formation

2.0	544	Sandstone, dark reddish brown, iron stained, massive.
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0.8	334	Siltstone, very light grey, pisolitic, mottled, thickness varies up to 2 ft thick.
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2.6	544	Sandstone, dark reddish brown to pale pink, fine to medium grained, mottled to burrowed, massive.
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22.0	544	Sandstone, grayish orange, fine to medium grained, noncalcareous, rippled, burrowed, covered at places.
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14.0	541	Sandstone, very light grey, coarse to medium grained, very clean, quartzose, pebbles of quartz, calcareous, poorly sorted, with iron rich layers, burrowed in places, cross bedded, tabular forsets up to 2.5 ft thick which are laterally continuous for 5-10 ft, paleocurrent readings from tabular cross beds, S25W, S5E, S5W.
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37.0	548	Sandstone, light brownish grey, fine to medium grained, burrowed, silty clay matrix, noncalcareous, flat bedded.
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8.0	333	Siltstone, light brownish grey, flat bedded, with sandstone streaks.
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6.0	333	Siltstone, with lenses of massive, fossiliferous, shaley limestone up to 0.5 ft thick.
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Geckhart Limestone and Patala Formation

70.0	000	Covered, mines on slope.
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Hammal Formation

100.0	996	Limestone, fossiliferous, nodular.
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## Section 27

Location: Lat 32/34/45N  
 Long 72/28/50E

Date measured: 20 March, 1988

Section is from outcrops east of Pail - Kushab road, along Katha Collieries road toward the south end.

Interval

thkns (ft)	Rock code	Description
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Section starts in Amb Formation

78.0	894	Silty limestone, massive bedded, fossil fragments, brachiopods throughout, generally flat bedded, arenaceous.
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Hangu Formation

10.0	540	Sandstone, grayish orange, medium to coarse grained, iron stained, burrowed, partially covered.
34.0	541	Sandstone, grayish orange, medium to fine grained, poorly sorted, calcareous, generally flat bedded, with some small scale cross bedding, tabular cross beds <1 ft thick, friable.
3.0	333	Siltstone, grayish orange, calcareous sandstone stringers.

Lockhart Limestone

5.0	894	Silty Limestone, fossiliferous, massive with some limestone nodules, partly covered.
30.0	996	Limestone, fossiliferous with forams, nodular to massive.

Lockhart Limestone, Patala Formation, and Nammal Limestone

50.0	000	Covered.
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## Section 28

Location: Lat 32/35/50N  
Long 72/27/15E

Date measured: 21 March, 1988

Section is from outcrop of Hangu Formation along Pail to Kushab road, base of Hangu not exposed, see CSR section for total thickness, measurement starts from road level.

Interval

thkns (ft) Rock code Description

Section starts in Hangu Formation

14.0	541	Sandstone, grayish orange, fine grained, flat bedded, burrowed, massive, iron stains along joints, upper part contains sets of flat beds up to 6 inches thick.
5.5	543	Sandstone, grey, fine grained, interbedded with shale, burrowed, mottled, rippled, plant material, iron stained along fractures.
13.0	544	Sandstone, dusky yellow, fine grained, calcareous, mollusk shells, massive, becoming greenish towards the top.
2.0	543	Sandstone, dusky yellow green, with shale interbeds, becoming more shaley upwards.

Lockhart Limestone

30.0	896	Shaley limestone, turratella, ostrea, pelecypod fossils abundant, nodular.
76.0	996	Limestone, gastropods, pelecypods, partly shaley, nodular.

Lockhart Limestone, Patala Formation and Nammal Formation

100.0	000	Covered.
75.0	996	Limestone, fossiliferous, nodular.

## Section 29

Location: Lat 32/31/55N  
Long 72/23/35E

Date measured: 24 March, 1988

Section is south of Arara on SW side of landmass that divides Arara and Chambalwala Nalan, section is mostly covered due to talus.

### Interval

Thkns (ft)	Rock code	Description
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Section starts in Wargle Formation

50.01	994	Limestone, brachiopods, massive.
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### Hangu Formation

5.0	070	laterite, maroon red, pisolitic, fine grained matrix.
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43.0	541	Sandstone, dusky yellow, medium grained, matrix rich in clays, generally flat bedded, mottled, burrowed?, slightly calcareous, becoming greenish upwards, Sample SS-S29-1.
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### Lockhart Limestone

2.5	894	Limestone, dusky yellow, fossiliferous, sea urchin spines? up to 1.5 inch long and 0.5 cm diameter, other shell debris, massive, silty.
45.0	896	Shaley Limestone, dusky yellow, marly, fossiliferous, partly covered.

### Patala Formation

36.0	541	Sandstone, light grey, medium grained, quartz rich, cross bedded, Lower 10 ft has low angle - sub horizontal cross bedding, multidirectional, dip on cross beds 20 - 25 degrees, sets up to 2 ft thick, middle 10 ft has large low angle cross beds, tabular cross beds, sets up to 5 ft thick, scour bases, top is burrowed and rooted, paleocurrents from tabular cross beds: S65E, S0E, N80E, N85E, S35W, S35W.
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5.0	548	Sandstone, light grey, medium grained, quartzose, burrowed, partly covered, coal zone here?
15.0	000	Covered, Patata shale.
Nammal Limestone		
50.00	996	Limestone, fossiliferous, nodular.

### Section 30

Location: Lat 32/27/45N  
Long 72/11/25E

Date measured: 28 March, 1988

Section is SW of Kathwai on isolated outcrops of Tertiary west of the road.

Interval

Thkns (ft) Rock code Description

Section starts in Mianwali Formation. This is the first appearance of this formation in this area (moving westward), the section is very thick, (>100 ft), and is above Wargle Formation.

50.00	894	Shaley limestone and silty shale interbedded, dusky yellow, fossiliferous, full of amenities, pelecypods and crynoids, medium bedded.
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Hangu Formation

3.0	541	Sandstone, reddish brown, medium grained, lateritic at places, very heavily iron stained.
4.0	541	Sandstone, dusky yellow, fine grained, small scale tabular cross beds at places, massive to flat bedded, mostly burrowed.
6.0	124	Shale, dark grey, carbonaceous throughout, siltstone and sandstone stringers, ironstone nodules in layers, Sample SH-S30-1.
4.0	548	Sandstone, grey, fine grained, almost quartzose, burrowed throughout.

2.5	323	Siltstone, dark grey, shaley, carbonaceous, burrowed.
2.0	123	Carbonaceous Shale, with shaley stringers, weathered, gypsum veins.
1.0	332	Siltstone, light grey, with sandstone stringers, carbonaceous, burrowed.
12.0	123	Carbonaceous Shale, shaley beds in places, shale beds up to 1-2 inches thick.
4.5	323	Siltstone and Shale interbedded, siltstone has sandy layers up to 4 inches thick, shale is carbonaceous.
6.0	124	Shale, dark grey, carbonaceous, with silty stringers, massive.
1.0	323	Siltstone, dark grey, carbonaceous.
1.0	234	Shale with limestone nodules, light grey nodules up to 2 ft long axis, massive.
8.0	124	Shale, dark grey, plant material throughout, with occasional siltstone stringers.
2.0	234	Shale with limestone nodules, light grey, nodules up to 2 ft long axis.
6.0	124	Shale, dark grey, carbonaceous at places, massive.
6.0	333	Siltstone, light grey, sandstone stringers, lower 0.75 ft iron stained, fine carbonaceous material mixed throughout.
1.5	124	Shale, dark grey, carbonaceous, massive.
2.0	333	Siltstone, light grey, sandstone stringers, carbonaceous at places.

#### Lockhart Limestone?

5.0	806	Shaley limestone, nodular.
13.0	124	Shale, dark grey, massive.

#### Patala Formation

20.0	541	Sandstone, light grey, fine to medium
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		grained, quartzose, tabular bedding up to 2 ft thick, becoming flat bedded and burrowed upwards.
5.0	548	Sandstone, light grey, fine grained, quartzose, flat bedded, burrowed.
8.0	543	Sandstone, interbedded with silty shale, light grey, sandstone burrowed, sand is quartzose and fine grained, flat bedded.
3.0	332	Siltstone, light grey, interbedded with sandstone, sand is quartzose.
12.0	541	Sandstone, light grey, medium grained, quartzose, flat bedded to cross bedded at places, burrowed, in upper part, top is iron stained.
5.0	333	Siltstone, light grey, sandstone stringers, burrowed, more shaley upwards.
3.0	894	Shaley Limestone, massive to nodular, forams, gastropods, turratella fossils.
12.0	124	Shale, dark grey, carbonaceous at places, Sample SH 930-2.
10.0	124	Shale, dark grey, massive.
15.0	000	Covered.
Nammal Formation		
30.0	994	Limestone, full of forams, flat bedded.

### Section 31

Location: Lat 32/31/40N  
Long 72/03/26E

Date measured: 6 April, 1988

Section is along abandoned road from Kathwai to Kuralli about 2 km south of Uchali, measurement from south limb.

Interval

Thkns (ft)	Rock code	Description
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Section starts at laterite ant base of Hangu Formation, strata is tightly folded

15.0	070	laterite, maroon red, base not exposed, pisolitic, iron rich throughout.
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2.0	134	Shale, white, bauxite, massive.
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Lockhart. Limestone?

45.0	439	Calcareous Siltstone, dusky yellow, fossiliferous pelecypods, shaley at places, dip changes at this place due to fold, thickness may be affected.
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25.0	239	Calcareous Shale, dusky yellow, fossiliferous, with limy silty lenses up to 2 ft thick at places.
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Patala Formation

17.0	124	Shale, dark grey, massive, a few limy lenses, silty at places, burrowed, Lower shore face?
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23.0	543	Sandstone, interbedded with shale, grey, quartzose sandstone, burrowed, middle shore face?
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32.0	541	Sandstone, light grey, cross bedded to massive, upper shore face?
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3.0	548	Sandstone, grey, cross bedded, quartzose, lots of carbonaceous material, burrowed throughout, generally flat to small scale cross beds.
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8.0	124	Shale, dark grey, carbonaceous mater throughout, massive.
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1.0	548	Sandstone, light grey, quartzose, burrowed.
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8.0	124	Shale, greenish dark grey, massive.
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1.0	439	Calcareous siltstone, with limestone nodules, dusky yellow, forams and shell debris.
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33.0	124	Shale, dark grey to greenish olive, with 3 interbeds of thin silty limestone, limestone lenses up to 1 ft thick.
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3.0	439	Calcareous siltstone, dusky yellow, forams and shell debris, rippled to small scale cross beds, burrowed.
48.0	124	Shale, dark grey to greenish olive, with a few interbeds of limy siltstone.
Nammal Limestone		
3.0	896	Shaley limestone, fossiliferous, nodular.
50.0	996	Limestone, fossiliferous, nodular.

### Section 32

Location: Lat 32/44/45N  
Long 71/43/00E

Date measured: 12-13 April, 1988

Section is in nala N of Buri Khel at Mohammad Aslam Khan Belall Colliery, Mine No. 3

Interval

thkns (ft) Rock code Description

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Section starts in Saline Series

50.00	XXX	Salt/Gypsum, interbedded, fault contact with Tobra Formation.
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Tobra Formation

34.0	745	Conglomerate, pale red, mud matrix, boulders of granite and mixed rock types of chert, black quartzite, and MRFs up to 3 ft in long axis, mostly cobbles and pebbles, matrix supported, no bedding.
2.5	541	Sandstone, yellowish grey, coarse to medium grain size, flat to small tabular cross beds, conglomeratic towards top.
30.0	745	Conglomerate, pale red, mud matrix, cobble size granite and mixed rock types, matrix supported.
0.5	745	Conglomerate, sandstone matrix, yellowish

		grey, cobbles up to 4 inches in diameter, matrix supported.
1.5	543	Sandstone, yellowish grey, fine grained, with shale interbeds, rippled.
85.0	745	Conglomerate, mud matrix, pale red, boulders at base up to 3 ft in long axis, matrix supported, mostly cobble to pebble size mixed rock types, long axis of cobbles parallel to bedding.
3.4	745	Sandstone, yellowish grey, cross bedded, pebbles and cobbles mixed, fining upwards grain size, scour based, matrix supported.
4.9	745	Pebbly Sandstone, yellowish grey, pebble supported, sandstone matrix, pebbles with random orientation.
3.0	541	Sandstone, yellowish grey, fine to medium grained, shale interbeds, small scale cross beds.
27.0	745	Conglomerate, sandstone matrix, yellowish grey, pebbles and cobbles near base less than 5 inches in long axis, grain supported, upper part is sandstone, and matrix supported, pebbles in upper part, generally flat bedded.
31.0	745	Conglomerate, mud matrix, pale red, matrix supported, pebbles and cobbles mixed throughout.
2.5	541	Sandstone, yellowish grey, fine to medium grained, massive.
21.0	745	Conglomerate, mud matrix, pale red, matrix supported, pebbles to cobbles in matrix.
3.0	745	Conglomerate, sandstone matrix, yellowish grey, boulders, cobbles and pebbles, poorly sorted, grain supported at places.
34.0	745	Conglomerate, mud matrix, pale red, matrix supported, pebbles to cobbles mixed throughout.
8.5	541	Sandstone, yellowish grey, medium to coarse grained, pebbles at places, cross bedded, scour based, mostly flat bedded.

27.0	745	Conglomerate, mud matrix, medium grey, matrix supported, pebbles and cobbles mixed throughout, some volcanic pebbles and cobbles.
3.0	745	Conglomerate, sandstone matrix, cobbles and pebbles.
22.0	124	Shale, dark grey, carbonate lenses up to 1 inch thick, become silty upwards.
2.0	541	Sandstone, grey, medium to fine grained, rippled to small scale cross bedded.
36.0	124	Shale, dark grey, silty stringers.
60.0	745	Conglomerate, sandstone supported, matrix supported with cobbles and boulders mixed throughout, at places becomes flat bedded to rippled sandstone, sandstone coarse grained, upper 10 ft with boulders up to 3 ft in diameter.
24.0	745	Conglomerate, mud matrix, matrix supported, medium grey, pebbles and cobbles mixed throughout.
8.0	541	Sandstone, grey, medium to fine grained, shale interbeds up to 3 inches thick, generally flat bedded.
23.0	745	Conglomerate, mud supported, medium grey, cobbles and pebbles.
3.0	020	Coal, dull, shaley, highly fractured, thickness varies, up to 6 ft at places, squeezed and faulted, hard to get true thickness, in mine Sample: BK-MAK-1.
1.0	745	Conglomerate, mud matrix, medium grey, grain supported.

#### Warehha Formation

40.0	745/541	Sandstone, conglomeratic at places, yellowish grey, coarse grained, flat bedded to massive, lenses of conglomerate with cobbles up to 1 ft diameter, multiple scoured, matrix supported, upper part mostly coarse grained, with flat beds and small scale cross beds.
46.0	541	Sandstone, pale red, coarse grained, pebbly

		at places, trough and tabular cross beds, fining upwards grain size, channel type sandstones.
19.0	323	Siltstone, greenish red, shaley becoming finer grained upwards.
70.0	541	Sandstone, pale red, coarse grained, trough and tabular cross beds, scoured base, upper part with shaley interbeds at places and pebbly layers, cross bedded throughout.
20.0	322	Siltstone, pale red, with sand and shale interbeds, pebbles at places, sandstone beds at top, up to 2 ft thick.
61.0	541	Sandstone, pale red, coarse grained, pebbly at places, massive.
200.0	543	Sandstone, pale red, coarse to medium grained, interbedded with silty shale, predominantly sandstone, flat bedded to tabular cross bedded, sandstone units up to 20 ft thick, pebbles at places, occasional shale interbeds up to 3 ft thick.

#### Sardhai Formation

120.0	332	Siltstone, yellowish grey, with interbeds of cross bedded sandstone up to 15 ft thick, probably faulted, thickness estimated.
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#### Amb Wargal Formation

50.01	900	Limestone - dolomite.
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### Section 33

Location: Lat 32/38/25N  
Long 71/48/10E

Date measured: 14 April, 1988

Section is south of Nammal Gorge and Mianwali road, north of Chidru, Permian coal locality, base of Tobra Formation in fault contact with Saline Series.

## Interval

Thkns (ft) Rock code Description

Section starts in Saline Series.

50.0+      XXX      Salt

Tobra Formation (fault contact with salt)

45.0	745	Conglomerate, pale red, mud matrix, matrix supported, boulders and cobbles of mixed rock type, mostly granite and black quartzite, occasional volcanics, limestone and green metamorphic rocks.
4.0	541	Sandstone, yellowish grey, medium grained, cross bedded, small scale tabular cross beds and ripples, sharp scoured base.
24.0	745	Conglomerate, pale red, mud matrix, matrix supported, same as below.
1.5	541	Sandstone, yellowish grey, massive to rippled, slightly calcareous,
19.0	745	Conglomerate, mud matrix, pale red, same as below.
14.0	745	Conglomerate, sandstone matrix, yellowish grey, sandstone medium to coarse grained, pebble lenses up to 4 ft thick throughout, scoured based.
60.0	745	Conglomerate, sandstone and mud matrix, pale red to yellowish grey, sandstone lenses up to 2 3 ft thick, conglomeratic throughout.
10.0	745	Conglomerate, pale red, conglomerate, cobbles throughout.
25.0	745	Conglomerate, sandstone matrix, yellowish grey, massive, poorly sorted.
2.0	333	Siltstone, medium grey, flat bedded, no pebbles.
25.0	745	Conglomerate, mud matrix, medium grey, cobbles and boulders.
8.0	745	Conglomerate, sandstone matrix, yellowish grey, medium to coarse grained, cross bedded

		to massive, cobbles and pebbles throughout.
2.0	745	Conglomerate, medium grey, mud matrix, pebbles in mud matrix.
1.0	332	Siltstone, light grey, with sandstone stringers, scattered small pebbles, no apparent rooting.
0.8	020	Coal, dull, shaley at places.
1.2	123	Carbonaceous shale, coaly stringers up to 1 inch thick.
0.8	037	Shaley coal, shale stringers up to 2 inches thick.
0.1	134	Claystone, pinkish grey, very soft, friable, lonsstein?, squeezed and not in a continuous layer, Sample TON-S33.
0.2	037	Shaley Coal, with shale stringers.

Note: Coal and carbonaceous shale bed faulted with a few inches displacement and irregularly squeezed.

1.0	745	Conglomerate, boulder beds, boulders up to 1 ft. long axis.
3.5	745	Conglomerate, sandstone matrix, yellowish grey, cobbles and pebbles throughout, matrix and grain supported.

#### Warebha Formation

28.0	541	Sandstone, yellowish grey, coarse to medium grained, cross bedded, scour base.
5.0	322	Siltstone, medium grey, with sandy lenses.
6.0	745	Conglomerate, sandstone matrix, pale red, coarse grained, small cobbles throughout.
3.0	322	Siltstone, medium grey, with sand lenses.
17.0	745	Conglomerate, with sandstone matrix, pale red, cross bedded, tabular cross beds? pebbly.
2.0	322	Siltstone, medium grey, with sandy lenses.



8.0	541	Sandstone, grey, medium to coarse grained, cross bedded to flat, tabular cross beds up to 3 ft thick.
9.0	322	Siltstone, medium grey, with sandstone lenses.
2.5	541	Sandstone, grey, coarse to medium grained, small tabular cross beds to ripples, crevasse type sandstone.
12.0	322	Siltstone, medium grey, with sandstone lenses.
15.0	543	Sandstone, medium grey, medium to fine grained, interbedded with siltstone, sandstone beds up to 2 ft thick, rippled and flat bedded, upper part of section faulted and dip changes, end section here.

## OBSERVATIONS

12 December, 1988

Mine visit. Mehr Nazar and Company, Mithathhoi area, Lat. 32/43/40N, Long. 73/16/25E, mining along fault, working along previous British workings, much packing material in mined-out areas, dip is very high, appx. 45 degrees, mine follows dip, Patala is mostly silty sandstone with many burrows, coal occurs as lenses surrounded by silty material, coal zone total is about 3 ft thick, but best coal is at base, coal consist of woody lenses surrounded by burrowed siltstone, at the base of the zone is 8-11 inches of bright woody coal overlain by sandy coal, coal is reported to thicken laterally, but this area is now mined-out.

Ft	Rock Code	Description
Floor	328	Siltstone, dark grey, burrowed.
0.97	023	Coal, with siltstone and sandstone layers, coal bright and woody, Sample ARA-MN-19.
2.33	749	Sandstone, with coal lenses <2 inches thick, resin is common, lenses of coal about 2 ft long with pyrite.
3.0+	328	Siltstone, dark grey, burrowed, carbonaceous material, sandy layers, pyrite.

7 January, 1988

Mine Visit. Mrs. Mohad Afzal and Fazalad Colliery, Captain Abid Mine No. 2, Lat. 32/41/00N, Long. 72/55/10E, south of Gandhala Nala, Dandot area

Ft	Rock Code	Description
Floor	124	Shale, dark grey, massive.
2.5	123	Carbonaceous shale.
1.2	020	Coal, thickens up to 1.5 ft 200 ft to the west, Sample Dandot-CA-2.
1.0	123	Carbonaceous shale.
Roof	338	Siltstone, light grey, burrowed.

16 January, 1988

- O-1 Location: Lat. 32/44/20N, Long. 73/11/35E  
Outcrop of Tertiary along road just southwest of Ara Rest House.

Ft	Rock Code	Description
50.0+	360	Siltstone, red, Baghanwala Formation.
10.0	745	Conglomerate, Tobra Formation.
30.0	541	Sandstone, grey, low angle cross bedding, sets 2 ft thick, bioturbation, lower part conglomeratic over Tobra, upper shore face?

16 & 18 January, 1988

- O-2 Location: Lat. 32/44/03N, Long. 73/11/45E  
Isolated Tertiary outcrop southwest of Ara Rest House.

Ft	Rock Code	Description
Baghanwala Formation		
50.0+	360	Siltstone, red.
Tobra Formation		
15.0	745/360	Conglomerate, silty sandstone matrix, with isolated pebbles and boulders of mixed rock type, pale blue, weathered top, granite clast altering to clay, fractured and iron stained along fractures.
Patala Formation		
25.0	541	Sandstone, light grey, quartzose, isolated pebbles of quartz, cross bedded, trough sizes up to 7 ft wide, 2 ft thick, multiply scoured, upper 15 ft has lens of shale and siltstone, very similar to lateral accretion units, tidal channel?, upper 15 ft flat bedded, rippled and burrowed, horizontal burrows, shaley and more iron stained, with low angle cross bedding, wave

reworked top?, generally coarsening upwards grain size, paleocurrent readings from trough cross beds in lower part of unit: S60E, N57E, N70E, S50E.

1.0	123	Carbonaceous Shale, silty to sandy at places, mine near by taking up to 2 ft of shaley coal.
3.0	541	Sandstone, grey, quartz rich, flat bedded, burrowed, top part iron stained.
1.0	332	Siltstone, light grey, sandy layers.
5.0	540	Sandstone, light grey, predominately clean quartz grains, iron stained.
10.0	000	Covered.

#### Nammal Formation

25.0	900	Limestone, mostly covered.
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0-3 Location: Lat. 32/44/15N, Long. 73/10/50E.  
Along escarpment west of Ara, NE of Sidhandi, abandoned coal mine, coal and carbonaceous shale on spoil pile, no or very thin quartz sandstone at base of Tertiary.

0-4 Location: Lat. 32/43/45N, Long. 73/11/55E.  
Visit Nezar and Co. Dholar Dher Mine No. 6, near S-8, mining 2.5 ft. (ave.), mostly carbonaceous shale.

Ft	Rock Code	Description
Roof	338	Siltstone, light grey, burrowed.
1.0	032	Shaley coal, with bright stringers up to 1 inch thick and 1 foot long.
1.0	123/030	Carbonaceous shale to shaley coal, Sample includes both units, 032 and 123 = ARA-DD-6.

This is a section from outside the mine taken from along the road.

Ft	Rock Code	Description
Baghanwala Formation		
50.0+	360	Siltstone, red, interbedded with

sandstone.

**Tobra Formation**

35.0	745/360	Conglomerate, siltstone matrix, boulders and cobbles of mixed rock types, clast size becomes less upwards.
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**Patala Formation**

2.2	543	Sandstone, yellowish grey, coarse to fine grained, poorly sorted, with silty layers, quartzose with scattered quartz pebbles <1 inch long axis, flat bedded to rippled sandstone beds up to 1 ft thick.
1.4	333	Siltstone, light grey to pale blue, with sandstone stringers, isolated quartz pebbles, massive, splintery.
2.0	750	Conglomerate, sandstone matrix, quartz rich, quartz pebbles throughout, flat bedded, some iron staining, matrix supported, upper part becomes finer grained.
11.25	540	Sandstone, light grey, coarse grained, cross bedded in places, general flat bedded, lower part contains graded bedding sets 3 inches thick , each fine upwards, upper part is burrowed, shaley and rippled.
1.5	540	Sandstone, light grey, coarse grained, quartz rich, burrowed and rooted, iron stained, plant fragments, friable.
0.4	337	Siltstone, light grey, carbonaceous, rooted.
1.2	123	Carbonaceous shale, weathered white.
0.7	332	Siltstone, light grey, with sandy layers, burrowed, carbonaceous.
3.8	541	Sandstone, coarse grained, iron stained, tabular cross bedded with sets 0.5 ft thick, burrowed.
10.0	000	Covered, marly shale.

**Nammal Formation**

50.0+      000      Covered, limestone.

19 January, 1988

O-5    Location: Lat. 32/44/50N, Long. 73/08/15E.  
Visit Munawer Corp. Area Jabram, Basharit, Mine No. 5, west  
of Saloi.

Ft	Rock Code	Description
Roof	333	Siltstone, light grey, flat bedded, interbedded with shale, Sample ARA-MC-5.
1.5	028	Coal with shale stringers, pyrite nodules up to 1-2 inch long axis, top of bed burrowed and laminated, Sample ARA-MC-5.
Floor	540	Sandstone, grey, quartzose.

22 January, 1988

O-7    Location: Lat. 32/47/45N, Long. 73/12/35N.

East end of Siki Walan Kas, no Tobra Formation, Cambrian in  
contact with Tertiary.

Ft	Rock Code	Description
Baghanwala Formation		
25.0+	360	Siltstone, red, interbedded with sandstone.
Patala Formation		
4.0	139	Shale, light grey, with forams.
1.0	439	Calcareous siltstone, with ostrea fossils.
Nammal Formation		
15.0	994	Limestone, fossiliferous, massive.

**23 January, 1988**

**O-8 Location: Lat. 32/46/50N, Long. 73/10/25E.**

Just east of Dhok Sagral, west of Sikki, several mines in this area, mining lateral distance up to 900 ft.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	540	Sandstone, light grey.
0.7-1.5	037	Shaley coal, with 1-2 inch bright stringers, lots of pyrite, thickness varies.
Floor	540	Sandstone, light grey.

**O-9 Location: Lat. 32/46/25N, Long. 73/11/05E.**

From mines southwest of Sikki.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	332	Siltstone and sandstone interbedded, flaser type bedding, clean quartz sand interbedded with black shale.
1.5	038	Shaley coal with bright stringers.

**O-10 Location: Lat. 32/45/50N, Long. 73/08/08E.**

Visit Naeem Colliery near Dhok Kharan Ara, District Chakwal, owned by Walayat Industries LTD, Sargodha, produce 18-20 tons/day, main coal body oriented north-south.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
0.5	020	Coal.
1.7	540	Sandstone, grey, parting thickness decreases toward the east.
1.0	020	Coal.

**O-11 Location: Lat. 32/46/15N, Long. 73/11/10E.**

Mine west of Ara, coal thickens toward the NW.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Roof</b>	<b>540</b>	<b>Sandstone, grey.</b>
<b>1.0</b>	<b>120</b>	<b>Shale, dark grey.</b>
<b>1.25</b>	<b>030</b>	<b>Shaley coal</b>
<b>2.0</b>	<b>123</b>	<b>Carbonaceous Shale.</b>
<b>Floor</b>	<b>540</b>	<b>Sandstone, grey.</b>

24, January, 1988

Sample ARA-TC-6, Location: Lat. 32/44/40N, Long. 73/10/30E.

Visit Tariq Coal Company, Location Doba, Mine No. 6, east of cement factory at Saloi, trend of canyon is NW-SE.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>roof</b>	<b>338</b>	<b>Siltstone and shale interbedded, burrowed.</b>
<b>0.5</b>	<b>128</b>	<b>Shale, dark grey, burrowed, burrows filled with white sand, Sample SH-ARA-TC-6.</b>
<b>1.0</b>	<b>020</b>	<b>Coal, bright, with pyrite, pinches out towards the north, trend of coal body is NW-SE, Sample ARA-TC-6</b>
<b>Floor</b>	<b>124</b>	<b>Shale, dark grey, carbonaceous.</b>

O-12 Location: Lat. 32/44/30N, Long. 73/10/05E.

Abandoned mines along fault.

28 January, 1988

O-13 Location: Lat. 32/47/05N, Long. 73/10/55E.

Mines at Sikki, miners say 2 ft coal bed thickens to 3 ft towards the NW.

O-14 Location: Lat. 32/46/10N, Long. 73/11/50E.

Directly NE of ARA at isolated outcrop of Tertiary.



<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	540	Sandstone, grey.
2.5	037	Shaley coal with sandstone stringers.
floor	540	Sandstone, grey, carbonaceous.

0-15 Location: Lat. 32/46/15N, Long. 73/13/25E.

Estimated thicknesses from section in NE flowing nala NE of Ara, east of mines.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Baghanwala Formation</b>		
20.0	360	Siltstone, red, interbedded with sandstone.
<b>Tobra Formation</b>		
6.0	745	Conglomerate, with cobbles and boulders of mixed rock type.
6.0	541	Sandstone, grayish white, cross bedded.
4.0	541	Sandstone, red, flat bedded.
<b>Patala Formation</b>		
5.0	543	Sandstone, yellowish white, interbedded with shale.
8.0	000	Covered, Shale?
1.0	894	Shaley Limestone, ostrea fossils, massive.
<b>Nammal Formation</b>		
20.0	996	Limestone, fossiliferous, nodular.
<b>Kamlial Formation</b>		
50.0+	541	Sandstone, grey, cross bedded

4 February, 1988

0-16 Location: Lat. 32/51/15N, Long. 73/26/30E.

Estimated thicknesses of faulted section exposed on road to top of Jogi Tila.

Ft	Rock Code	Description
-----		
Baghanwala Formation.		
50.0+	360	Siltstone, red.
Patala Formation		
15.0	130	Bauxite Claystone, light grey, with iron staining, varies in thickness, at places not present.
4.0	130	Claystone with very rounded shale pebbles up to 0.75 inch thick, may be secondary.
5.0	124	Shale, dark grey, massive, some abandoned mine adits.
1.0	439	Calcareous Siltstone, light grey, with ostrea fossils.

5 February, 1988

0-17 Location: Lat. 32/50/40N, Long. 73/23/40E.

Visit mines south of Pothi, Jogi Tilla area, 3-4 mines on NW side of mountain, no outcrop.

Ft	Rock Code	Description
-----		
Roof		
1.5	020	Coal, dull with specks of resin and burrows.
2.0-3.0	123	Carbonaceous Shale.
Floor		

6 February, 1988

**Sample Location: JT-MDM-5B**

**Location: Lat. 32/50/10N, Long. 73/23/40E.**

**Visit mines above Nara on south side of Jogi Tilla, Malik Dost Mohammad and Company, Mine No. 5B. dip is about 20 degrees, rocks highly fractured because of faulting and folding, see S-16.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, Sample SH-JT-MDM-5B.
2.0	020	Coal, bright, Sample JT-MDM-5B
Floor	332	Siltstone, light grey, sandy, with clay balls <1.0 inch thick.

**O-18 Location: Lat. 32/49/28N, Long. 73/23/25E.**

**Section exposed along road south of MDM Mines, Jogi Tilla area.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Baghanwala Formation</b>		
30.0+	360/543	Siltstone, red, interbedded with sandstone.
<b>Patala Formation</b>		
5.0	742	Conglomerate, red, silty sandstone with shale pebbles, all very rounded, lateritic.
1.0	439	Calcareous Siltstone, light grey, ostrea fossils.
<b>Nammal Formation</b>		
2.0	996	Limestone, fossiliferous, nodular.
<b>Kamlial Formation.</b>		
1.5	745	Conglomerate, contains rock pebbles and reworked pieces of Nammal.
50.0+	541	Sandstone, grey, cross bedded.

7 February, 1988

Shale Sample SH-TSD-7, Location: Lat. 32/43/07N, Long. 72/56/05E.

Shale sample taken for palynology from GSP-7 drill hole on Dalwal Plateau. Sample is directly above coal bed.

Ft	Rock Code	Description
313.40 - 314.15	124	Shale, dark grey N3, fissile, burrowed, pyrite veins, diameter 2 X 16 cm, 1 X 4 cm and framboidal pyrite, 3 X 4 cm.
314.15 - 314.90	020	Coal, Sample TSD-7-1.

O-19 Location: Lat. 32/51/20N, Long. 73/06/32E.

Diljaba area, near coal mines, poor exposures, dip changes all over, thrusting has disturbed the area very much, Baghanwala very thin, may be due to faulting.

Ft	Rock Code	Description
Section starts at base of Baghanwala Formation, at contact Jutana Formation.		
5.0	360	Siltstone, red, interbedded with sandstone, mostly covered.
Tobra Formation		
20.0	745	Conglomerate, with mixed type rock pebbles and boulders, mudstone matrix, grayish red.
5.0	745	Conglomerate, sandstone matrix, boulders up to 2 ft long axis.
Patala Formation		
7.0	070	Laterite, ironstone, red.
6.0	332	Siltstone, sandy, mottled, lateritic in places, partly covered, top rooted.
2.0	000	Covered, this is horizon that is being mined for coal at adjacent mine, Afghan Colliery, Mine No. 4, mining 1.25 ft

		coal, floor shale, roof sandstone and shale interbedded.
10.0	134	Shale, light grey, flat bedded.
10.0	000	Covered.
<b>Nammal Formation</b>		
30.0	996	Limestone, fossiliferous, nodular.
20.0+	996	Limestone, with chert, fossiliferous, nodular.

8 & 10 February, 1988

O-20 Location: Lat. 32/48/50N, Long. 73/06/25E.

Visit Qurban Hussain Corporation Mine No. 3 south of Choa Gauj Ali Shah.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, burrowed, Sample SH-CGAS-HCC-3.
0.7	027	Coal, bright with shale stringers, burrowed, burrows filled with pyrite, dip 20 degrees, Sample CGAS-HCC-3, coal thins out to only a 1 inch pyrite bed in less than 100 ft north of the sample location.
0.3	123	Carbonaceous Shale, Sample combined with 0.7 coal, CGAS-HCC-3.
Floor	124	Shale, dark grey, massive.

O-21 Location: Lat. 32/50/20N, Long. 73/06/00E.

Mine on western end of Diljaba mountain, facing Choa Gauj Ali Shah, steep dip to south at 50 degrees, mine on hill side, access is by foot.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.
1.25	021	Coal, bright banded, with very thin

shaley stringers <2 cm thick.

Floor        124        Shale, dark grey, massive.

9 February, 1988

O-22 Location: Lat. 32/47/10N, Long. 73/02/10E.

Visit Ali and Company Mine No. 12, this section is very disturbed, mine is taking coal from pillars of old workings, coal is shattered, section is faulted with appx. 45 degree dip SE.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
2.25	020	Coal, shattered.
Floor	324	Siltstone dark grey, massive.

O-23 Location: Lat. 32/44/50N, Long. 73/05/22E.

Visit mine west of Saloi on Basharat Plateau, Sakha Wat Shah Company, Mine No. ?, 350 ft into hill.

Ft	Rock Code	Description
Roof	540	Sandstone, light grey.
1.0	020	Coal, bright with thin shale stringers.
Floor	540	Sandstone, light grey.

18 February, 1988

O 25 Location: Lat. 32/41/10N, Long. 72/46/10E.

Mine NW of Karuli, just above road.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.

0.67	027	Coal, with shale stringers, lots of plant fossils, coal slickensided.
0.83	123	Carbonaceous Shale, rooted.
Floor	124	Shale, dark grey, massive.

0-26 Location: Lat. 32/40/40N, Long. 72/46/00E.

Mines directly SW of Karuli, 3-4 mines in this area.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
0.67	030	Coaly Shale, with bright stringers.
0.5	123	Carbonaceous Shale.
Floor	124	Shale, dark grey, massive.

0-27 Location: Lat. 32/41/15N, Long. 72/45/40E.

West side of Karuli and SE of Simbal, 3-4 abandoned mines, section completely covered except for isolated outcrop of laterite.

0-28 Location: Lat. 32/41/15, Long. 72/47/00.

North of Karuli, on escarpment above town, mine not working, thicknesses from miner.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
1.0	020	Coal, banded, resinous.
0.5	123	Carbonaceous Shale.
1.0	124	Shale, dark grey, massive.
1.0	540	Sandstone, grey.

1.0	020	Coal.
1.0	540	Sandstone, grey.
2.0	124	Shale, dark grey, massive.
1.0	020	Coal.
0.5	123	Carbonaceous Shale.
Floor	540	Sandstone, grey.

0-29 Location: Lat. 32/41/15N, Long. 72/47/20E.

East of Karuli, at last mine on escarpment.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
1.0	123	Carbonaceous Shale.
Floor	124	Shale, dark grey, massive.

19 February, 1988

0-30 Location: Lat. 32/40/43N, Long. 72/43/05E.

In Sohail Canyon, just south of Sardhai, 2-3 abandoned mines, chips of coal on old spoils, no outcrop.

0-31 Location: Lat. 32/40/35N, Long. 72/43/35E.

Section south of Sardhai along west side of Sohail Canyon, about 1 km south of Sardhai, near abandoned mines, poorly exposed section.

Ft	Rock Code	Description
Section starts in Sardhai Formation.		
50.0+	543	Sandstone, grayish red, fine to medium grained, micaceous, cross bedded at places, interbedded with mudstone of same color.
10.0	124	Shale, medium grey, pop corn texture,



massive.

**Fault contact with Patala Formation.**

3.0	332	Siltstone, light grey, with sandstone lenses, plant fragments through out, burrowed.
4.0	124	Shale, dark to medium grey, plant fragments throughout.
2.0	332	Siltstone, light grey, mixed with very fine sandstone, rippled, burrowed, plant fragments on bedding plains.
5.0	333	Siltstone, light grey, shales interbedded, flat bedded, occasionally plant material.
50.0+	000	Covered, probably Patala-Nammal Formations.

**0-33 Location: Lat. 32/37/00N, Long. 72/41/15E.**

**Visit mines north of Matan Khurd in isolated blocks of Tertiary.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	540	Sandstone, grey.
4.0	020	Coal, dull with bright stringers, some pyrite.
Floor	124	Shale, dark grey, massive.

**21 February, 1988**

**0 34 Location: Lat. 32/37/25N, Long. 72/42/25E.**

**Visit Gulzar and Company, Hasnain Colliery, Mine 8, located in isolated Tertiary outcrops east of small town in Bagri Nali, extreme structure problems, coal is faulted, Patala is acting as a slippage zone, miners are following coal belt but there is a large variation in seam thickness due to the squeezing and faulting, dip of coal varies from 45 degrees to vertical. From outcrops outside mine Patala Exposed but very faulted, section may be 10 shales overlain by limy**

sandstone of Nammal, Permian Sandstone is just below shales, no tertiary sandstone in section, Patala is mobile slip zone for competent Nammal and Permian sediments.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	128	Shale, dark grey burrowed, at places are sandstone stringers and scattered limestone nodules, shale Sample SH-KK-GH-8.
2.0	021	Coal, banded, generally dull with bright layers up to 2-3 inches thick, resinous, very little pyrite, shaley towards top, Sample, KK-GH-8A.
0.4	124	Shale, dark grey, massive.
0.3	020	Coal, bright , resinous as above, Top of Sample KK-GH-8B.
0.1	124	Shale, dark grey, massive, Sample KK-GH-8B.
0.3	020	Coal, bright, resinous, Sample KK-GH-8B.
0.2	037	Shaley coal, with pyrite framboids, bottom of Sample KK-GH-8B.
Floor	124	Shale, dark grey, massive, no apparent rooting.

O-35 Location: Lat. 32/37/35N, Long. 72/41/35E.

Section from isolated Tertiary blocks north of Matan Khurd, visit Huzar and Company Mine No. 4, laterally coal varies tremendously due to dip, in places clean quartzose sand is above coal, Patala is very faulted and folded.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.
3.0	020	Coal, banded, bright with pyrite.
Floor	124	Shale, dark grey, massive.

Section exposed along mine road is faulted and folded and the following thicknesses may not be true.

Ft	Rock Code	Description
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Section starts in Sardhai Formation

25.0	541	Sandstone, grey, cross bedded.
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Hangu Formation and Lockhart Limestone

25.0	230	Calcareous shale, light grey, with limestone nodules, fossiliferous, forams, mollusk.
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Patala Formation

4.5	332	Siltstone, light grey, with shale and sandstone stringers, carbonaceous at places, plant material, burrowed, no rooting.
3.0	038	Shaley Coal, with shale stringers, weathered.
4.0	541	Sandstone, light grey, fine grained, quartzose, friable, wash-over fan type?
5.0	330	Siltstone, light grey, mostly covered.

Nammal Formation

10.0	896	Shaley Limestone, fossiliferous, nodular.
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O-36 Location: Lat. 32/38/10N, Long. 72/40/45E.

North of Matan Kalan on edge of escarpment, 2 abandoned mines, coal was said to be 2 ft and consist of carbonaceous shale with coal stringers.

O-37 Location: Lat. 32/37/55N, Long. 72/40/25E.

South of Matan Kalan several mines in the area, similar to O-35, visit Malak Shabaz and Company, Mine 1C.

Ft	Rock Code	Description
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Roof	124	Shale, dark grey, massive.
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1.25	123	Carbonaceous Shale.
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1.25	124	Shale, dark grey, massive.
0.82	020	Coal, bright, banded.
Floor	124	Shale, dark grey, massive.

0-38 Location: Lat. 32/37/40N, Long. 72/40/40E.

South of Matan Kalan on the south side of ridge, visit Malak Shabaz and Company Mine No. 2.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.0	020	Coal, banded, bright, pyritic, with resin.
Floor	124	Shale, dark grey, massive.

0-39 Location: Lat. 32/37/35N, Long. 72/40/05E.

South of Matan Kalan, Malak Shabaz and Company Mine No. 5. Miner says adjacent mine 3D, was operating 3 years ago in 4 ft of coal but closed due to water problems.

Ft	Rock Code	Description
Roof	324	Siltstone, dark grey, with sandstone stringers.
1.5	027	Coal, with shaley stringers, pyritic.
Floor	124	Shale, dark grey, massive.

This is a section exposed along the road near 0-38, section is faulted and mostly covered.

Ft	Rock Code	Description
Section starts in Shardhai Formation.		
3.5	332	Shale, grayish red to medium grey, with sandstone and silty interbeds, up to 1 ft thick, mostly red shale.

Lockhart Limestone, contact not exposed.

25.0	896	Shaley Limestone, fossiliferous, with shell fragments, nodular.
2.0	994	Limestone, fossiliferous, coarse grained, crystalline at places, massive, shaley interbeds.
Patala Formation		
10.0	332	siltstone, light grey, with shale interbeds, plant fragments.
Nammal Formation		
50.0	996	Limestone, fossiliferous, forams, fine grained, nodular.

22 February, 1988

0-40 Location: Lat. 32/37/05N, Long. 72/40/15E.

South of Sar Kalan on faulted, isolated Tertiary block, visit Bhutnain Colliery Mine No. 3.

Ft	Rock Code	Description
Roof	323	Siltstone, light grey, with sandstone stringers.
4.0	037	Shaley Coal, with carbonaceous shale and coaly stringers mixed.
Floor	124	Shale, dark grey, massive.

Reconstructed faulted section exposed outside mine, thicknesses are estimated, section based on weathered profiles, contacts not clear.

Ft	Rock Code	Description
Section starts in Shardhai Formation.		
50.0+	363	Siltstone, maroon with sandstone and shale interbeds up to 1 ft thick.

Lockhart Limestone

25.0	230	Marly Shale, light grey, with limestone nodules, fossiliferous.
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2.0	894	Shaley limestone, filled with fossil debris, massive.
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**Patala Formation**

15.0	320	Shale and siltstone interbedded, dark grey, with some sandy layers, this includes 2.5 ft of carbonaceous shale and coal, section is covered.
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**Nammal Formation**

50.0+	996	Limestone, fossiliferous, forams, nodular.
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**O-41 Location: Lat. 32/36/45N, Long. 72/37/25E.**

Southeast side of Nilla Whan, visit Javed and Company, Mine No. ?, most mines on this side of canyon, abandoned.

Ft	Rock Code	Description
3.0+	332	Siltstone, light grey, burrowed, pyrite filling burrows, clay balls, Sample, SH-NW-JV-1.
0.5	332	Siltstone, light grey, with sandy layers, burrowed.
0.6	028	Coal with shaley coal bands, Sample NW-JV-1.
0.8	037	Shaley coal, with bright stringers at places, Sample (combined with above 028) NW-JV-1.
1.0	123	Carbonaceous Shale.
Floor	124	Shale, dark grey, massive.

**O-42 Location: Lat. 32/36/40N, Long. 72/37/28E.**

Visit Maulvi Akram Mine No. 13, Nilla Whan.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.

1.0	027	Coal with shaley stringers, coal appears to be better than that sampled at O-41.
Floor	124	Shale, dark grey, massive.

O-43 Location: Lat. 32/36/55N, Long. 72/39/10E.

Disturbed section exposed on isolated block of Tertiary in Narori Nala east of Nilla Whan, thicknesses estimated.

Ft	Rock Code	Description
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Section starts in Sardhai Formation

10.0+	360	Siltstone, red to green, interbeds of shale and sandstone.
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Lockhart Limestone (faulted contact)

50.0	239	Marly shale, greenish grey, with nodular limestone, forams and mollusk fragments, cherty streaks and limestone lenses.
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Patala Formation

15.0	332	Shale with sandy lenses, light grey, plant material, with thin layers of carbonaceous shale, mostly covered, faulted.
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Nammal Limestone

20.0+	000	Covered with limestone debris.
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23 February, 1988

O-44 Location: Lat. 32/39/05N, Long. 72/38/40E.

Sar Kalan, on northwest side of town at foot of limestone cliffs, section consists of jumbled slump blocks, Warchha type arkosic sandstone exposed but not continuous, below is a possible reconstruction of the faulted section, thicknesses are estimates.

Ft	Rock Code	Description
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Section starts in shale above Warchha sandstone

38.0+	124	Shale, medium dark grey, interbedded with shale of pale reddish brown, pop corn texture, upper part becoming silty.
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1.0	541	Sandstone, light grey, medium grained, cross bedded, rippled, micaceous, burrowed.
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50.0	360	Siltstone, grayish red, shaley, mottled, interbedded with grey shale.
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Lockhart Limestone (contact questionable, may be faulted)

8.0	894	Marly limestone, grayish orange, massive, with black chert lenses up to 2 inches thick, shell fragments.
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Faulted

40.0	996	Limestone, grayish orange, shell fragments, nodular.
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Patala Formation (contact covered)

5.0	332	Siltstone, light grey, with sandy layers.
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10.0	541	Sandstone, light grey, quartzose, plant fragments, rippled, flat bedded, burrowed.
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5.0	332	Siltstone, light grey, interbedded with shale and carbonaceous lenses up to 0.5 ft thick.
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5.0	439	Silty marl, light grey, with ostrea fossils.
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Nammal Formation

20.0+	996	Limestone, fossiliferous, nodular.
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0-45 Location: Lat. 32/38/25N, Long. 72/36/50E.

Nila Wahan, east side, midway from mouth to head of canyon, no mines active from south to midway of nala, miners do not know mines name.

Ft	Rock Code	Description
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Roof	324	Shale, dark grey, with sandstone stringers, massive.
0.5	123	Carbonaceous shale.
0.75	027	Coal, with shale stringers, bright, pyritic, resinous.
Floor	124	Shale, dark grey, massive.

**O-46 Location: Lat. 32/38/50N, Long. 72/36/50E.**

Visit northern most mine on northeast side of Nila Wahan, Sardar Mulazalm and Company, Mine A-1, mine has motorized pulley with track.

Ft	Rock Code	Description
Roof	324	Siltstone, dark grey, with sandstone layers.
0.82	027	Coal with shale stringers, bright, resinous, pyritic.
Floor	124	Shale, dark grey, massive.

**O-47 Location: 32/38/30N, Long. 72/39/08E.**

West side of Nila Wahan on west tributary, visit, Malik Naiz and Company Mine No. 9.

Ft	Rock Code	Description
Roof	323	Siltstone, dark grey, with sandstone stringers at places.
1.25	021	Coal, bright, pyrite, burrowed top, banded, no shale.
Floor	124	Shale, dark grey, massive.

**1 March, 1988**

**O-48 Location: Lat. 32/39/03N, Long. 72/36/02N.**

Northern most mine on the northwest end of Nila Wahan, mines north of here abandoned.

Ft	Rock Code	Description
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Roof	124	Shale, dark grey, massive.
2.0	123	Carbonaceous Shale.
2.0	124	Shale, dark grey, massive.
0.33	037	Shaley coal.
1.0	124	Shale, dark grey, massive.
0.66	027	Coal with shaley stringers, pyritic.
Floor	124	Shale, dark grey, massive.

2 March, 1988

O-49 Location: Lat. 32/38/05N, Long. 72/35/15E.

Visit mine on west side of Nila Wahan, Malik Ata Mohammad and Company, Haideria Collieries, Mine No. 2, has mine telephone and tracks, dip 15 degrees to west, mine workings over 12000 ft from escarpment.

Ft	Rock Code	Description
Roof 5.0+	124	Shale, dark grey, burrows filled with pyrite, Sample SH-NW-MAM-2.
0.85	021	Coal, bright, banded, with pyrite nodules in burrows, Sample NW-MAM-2.
Floor 1.0+	124	Shale, dark grey, no apparent rooting, sharp contacts.

O-50 Location: Lat. 32/37/15N, Long. 72/36/15E.

Visit mine about midway on west side of Nila Wahan.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.0	021	Coal, bright, banded, pyritic.
Floor	124	Shale, dark grey, massive.

O-51 Location: Lat. 32/36/02N, Long. 72/36/02E.

Visit Pir Nabla Shah Mine No. 8 on west side, towards the southern end of Nila Wahan.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.5	020	Coal, bright, with pyrite.
Floor	124	Shale, dark grey, massive.

5 March, 1988

O-52 Location: Lat. 32/36/30N, Long. 72/35/40E.  
Visit mines in nalla off Nila Wahan, just below Dhok Jabah.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.0	020	Coal, bright, pyritic.
Floor	124	Shale, dark grey, massive.

6 March, 1988

O-53 Location: Lat. 32/35/30N, Long. 72/35/35E.

Visit Khyber Coal Company Mine No. 12 on Salt Range Front, just west of Nila Wahan.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, with light tan clay stringers, slightly calcareous, Sample SH-P-KC-12.
1.5	027	Coal, bright, with pyrite and shale stringers, Sample P-KC-12.
Floor	124	Shale, dark grey, massive.

O-54 Location: Lat. 32/35/40N, Long. 72/39/30E.

Visit mine south of escarpment, west of Nila Wahan.

Ft	Rock Code	Description
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Roof	124	Shale, dark grey, massive.
1.5	020	Coal, bright, with pyrite.
Floor	124	Shale, dark grey, massive.

8 March, 1988

O-55 Location: Lat. 32/39/25N, Long. 72/33/25E.

Visit S.A. Latif and Company mine incline near Munarah.

Ft	Rock Code	Description
Roof 10.0+	124	Shale, dark grey, burrows with pyrite, massive, Sample SH-M-SAL-1.
0.8	020	Coal, Bright, with fractures filled with shale, Sample M-SAL-1.
Floor 15.0+	124	Shale, dark grey, massive, no rooting.

O-56 Location: Lat. 32/43/10N, Long. 72/32/05E.

West of Vasnal, visit Riaz Coal Company Mine No. 1.

Ft	Rock Code	Description
Roof	322	Siltstone dark grey, with sandstone stringers.
1.0	020	Coal, bright, with some shaley layers, burrows filled with pyrite.
Floor	124	Shale, dark grey, massive.

O-57 Location: Lat. 32/36/15N, Long. 72/35/50E.

Visit Malik Nazir and Company Mine No. 1 on main escarpment south of Dhok Chhab.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.0	037	Shaley coal, pyritic.
1.0	123	Carbonaceous Shale.

**Floor        124        Shale, dark grey, massive.**

**O-58 Location: Lat. 32/36/10N, Long. 72/35/10E.**

**Visit mine on main escarpment south west of PUNJMIN.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Roof</b>	<b>124</b>	<b>Shale, dark grey, massive.</b>
<b>1.0</b>	<b>037</b>	<b>Shaley coal, bright stringers with pyrite.</b>
<b>1.0</b>	<b>123</b>	<b>Carbonaceous shale.</b>
<b>1.0</b>	<b>037</b>	<b>Shaley coal, bright and shaley stringers with pyrite.</b>

**O-59 Location: Lat. 32/36/15N, Long. 72/29/48E.**

**Visit mine south of Bhahrar on escarpment.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Roof</b>	<b>124</b>	<b>Shale, dark grey, massive.</b>
<b>1.5</b>	<b>027</b>	<b>Coal, bright, with shaley stringers, pyritic.</b>
<b>Floor</b>	<b>124</b>	<b>Shale, dark grey, massive.</b>

**9 March, 1988**

**O-60 Location: Lat. 32/37/10N, Long. 72/29/28E.**

**Visit Karam Butsh and Company Ali Mine southeast of Pail on Chaminot Wala Mohar ridge on southeast side, mine has run into a fault.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
<b>Roof</b>	<b>124</b>	<b>Shale, dark grey, massive.</b>
<b>2.5</b>	<b>027</b>	<b>Coal, bright, with shaley layers and pyrite.</b>
<b>Floor</b>	<b>124</b>	<b>Shale, dark grey, massive.</b>

**O-61 Location: Lat. 32/36/40N, Long. 72/28/45E.**

**Visit Karam Butsh and Company Mine No. 6B, south of O-60, lateral variation in coal thickness is due to squeezing and faulting in Patala.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, with pyrite, and white clay streaks, Sample SH-P-KB-6B.
2.5	027	Coal, banded, with shaley bands, burrows filled with pyrite, base has sandstone stringers, Sample P-KB-6B.
Floor	322	Siltstone, dark grey, with sandstone stringers.

**O-62 Location: Lat. 32/37/20N, Long. 72/28/55E.**

**Visit Karam Butsh and Company Mine No. 9 on Chanlotwala Mohar, southeast of Pail.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, with pyrite nodules.
1.0	027	Coal, bright, with shale stringers, pyritic.
Floor	322	Shale, dark grey, massive, with sandstone stringers.

**O-63 Location: Lat. 32/37/00N, 72/28/15E.**

**Visit Karam Butsh and Company Mine No. 14, south of Pail on Chanlotwala Mohar.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.
1.0	027	Coal, bright, with shale stringers, burrows filled with pyrite.
Floor	322	Shale, dark grey, with sandstone

stringers and pyrite.

O-64 Location: Lat. 32/37/30N, Long. 72/38/10E.

Log of Haroor Coal Company Hole No. 1, east of PUNJMIN shaft, core has been laid out on the ground in a not so orderly fashion, there are some markings referring to depth, hard to determine amount of core loss, start logging core on 9 March, 1988, hole completed 28 March, 1988.

Ft	Rock Code	Description
0.0 - 65.0	994/239	Limestone, very light grey, fine grained, massive, forams with marly layers up to 3-4 ft thick, yellowish grey to greenish color, with forams, core broken.
65.0- 160.0	994	Limestone, fine grained, massive, forams throughout, some cherty layers, fractured, very light grey, nodular in places, thin marly layers between nodules.
160.0- 189.0	896/234	Shaley Limestone, fine grained, most of section consists of shaley material, dark greenish grey, nodular and fissile in places, filled with forams throughout, massive, hard, Sakesar - Nammal transition.
189.0- 207.0	994	Limestone, massive, nodular in places, medium grey, forams throughout, massive hard.
207.0-264.0	996	Limestone, nodular, with marl between nodules, marl and limestone with lots of forams, very light grey, limestone nodules up to 0.5 ft thick.
264.0 - 267.0	994	Limestone, massive, very light grey, fine grained, becoming darker near the bottom.
267.0- 288.0	894	Shaley Limestone, shale with forams, flat bedded, light grey.
288.0- 315.0	894/996	Shaley Limestone, core mixed up, shale layers up to 1 ft thick, marl dark grey, marly limestone with forams. lower part limestone.

315.0- 320.0	994	Limestone, forams, massive.
320.0- 358.0	894	Shaley Limestone, marly, white, hard.
358.0- 384.0	894	Shaley Limestone, marly, light grey, shaley layers up to 3 inches thick, at places shale, dark grey.
384.0- 385.5	124	Shale, dark grey, with pyrite, massive.
385.0- 390.0	894	Shaley Limestone, marly, light grey, forams, hard, compact.
390.0- 409.5	894	Shaley Limestone, same as above.
409.0- 420.00	129	Shale, dark grey, forams, Patala.
420.0- 422.16	239	Marl, shaley, fossiliferous, light grey.
422.16-428.66	129	Shale, dark grey, forams.
428.66-443.50	000	Not logged.
443.50-444.00	020	Coal.
444.00-445.66	124	Shale, dark grey, massive.
445.66-446.16	020	Coal.
446.16-447.74	124	Shale, dark grey, massive.
447.74-448.57	020	Coal.
448.57- ?	000	T.D. unknown.

20 March, 1988

O-65 Location: Lat. 32/36/15N, Long. 72/36/48E.

Section exposed on major escarpment east of Pail road and Katha Collieries.

Ft	Rock Code	Description
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Section starts in Amb Formation.

53.0+	894	Arenaceous Limestone, pelecypods and brachiopods, hard, cliff former.
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Hangu Formation



45.0          541          Sandstone, grayish orange, flat bedded,  
and rippled throughout, massive, thick  
bedded, some burrows.

**Lockhart Limestone**

39.0          896          Shaley Limestone, fossiliferous,  
nodular, mostly covered.

**Patala and Nammal Formations**

60.0          000          Covered.

**21 March, 1988**

**O-66 Location: Lat. 32/33/50N, Long. 72/26/15E.**

**Visit Karam Butsh and Company Mine No. 4.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	540	Sandstone, grey.
1.5	030	Shaley Coal, with pyrite.
Floor	124	Shale, dark grey, massive.

**O-67 Location: Lat. 32/34/15N, Long. 72/24/22E.**

**Visit Suhedar Janadar and Company Mine No. 10 in  
Chambalwalan Nala, south of Nurshingphoara.**

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	540	Sandstone, grey.
0.85	027	Coal, bright, with shale stringers and pyrite.
2.0	124	Shale, dark grey, massive.
0.75	027	Coal, bright, with shale stringers.
Floor	124	Shale, dark grey, massive.

**22 March, 1988**

**O-68 Location: Lat. 32/34/25N, Long. 72/25/10E.**

Visit Katha Collieries Mine No. 3, location Kruhmi.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, Sample SH CB-KC-3.
1.2	332	Siltstone, light grey, burrows filled with orangish material, stringers of sandstone.
0.9	027	Coal, bright, burrows filled with pyrite, sandstone and shale stringers, Sample CB-KC-3B.
0.7	332	Shale with Sandstone stringers, sandstone clean, white, up to 1 cm thick, shale dark grey, burrowed.
0.4	027	Coal, bright, burrows filled with shale and pyrite, Sample CB-KC-3A.
Floor	127	Shale, dark grey, partly rooted,

O 69 Location: Lat. 32/32/15N, Long. 72/20/00E.

Visit Amin Brothers Limited, Mine PCM-3, west of Pail and Kushab road, near Ianwala Walan, large mining operation, electricity in mines, aerial tramways, tracks in mines, 4 mines in this area.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.
0.5	020	Coal, bright, pyritic.
2.0	540	Sandstone, grey, thickness varies.
2.0	020	Coal, pyritic.
0.5	540	Sandstone, grey, thickness varies.
Floor	124	Shale, dark grey, massive.

23 March, 1988

O-70 Location: Lat. 32/33/50N, Long. 72/23/22E.

West side of Chambalwala Nala, large incline operation with power generators and track haulage, Malik Allah Busksh Coal Company Mine No. 1.

Ft	Rock Code	Description
Roof 4.0+	540	Sandstone, grey.
0.5	020	Coal, bright.
2.5	540	Sandstone, grey.
1.5	020	Coal, bright.
Floor	124	Shale, dark grey, massive.

O-71 Location: Lat. 32/33/10N, Long. 72/32/30E.

Visit Jhelum Valley Coal Company, Arara, Mine No. 7.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
0.5	124	Shale, dark grey, massive, Sample SH-ARA-JV-7.
1.5	020	Coal, bright, not sampled, not currently mined.
4.0	540	Sandstone, grey, with siltstone, quartz rich, burrowed.
1.8	027	Coal, bright, banded, bright lenses up to 2 inches thick, up to 3-4 ft long, woody, with shale stringers, calcite and gypsum along cleats, resinous, pyrite, Sample ARR-JV-7.
1.1	332	Siltstone, light grey, with quartzose sandstone stringers, and carbonaceous material.
Floor	541	Sandstone, grey, quartzose, cross bedded.

O-72 Location: Lat. 32/33/05N, Long. 72/21/30E.

Section exposed just west of Aara in big nala at Jhelum Valley Coal Company, strike of Wargle Limestone N65W, dip 12 NE.

Ft	Rock Code	Description
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-----  
Section starts in Wargle Limestone.

100.0+	994	Limestone, fossiliferous with brachiopods, bryozoians, crinoids, and shell fragments throughout, rubbly, flat bedded, 2-3 ft thick beds sets, fractured.
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#### Hangu Formation

3.0	070	laterite, red to maroon, ironstone, pisolitic.
1.0	100	Bauxite, shaley, locally dark grey shale.
2.5	332	Siltstone, light grey, with sandstone stringers.
2.0	541	Sandstone, light grey, fine grained, burrowed, non-calcareous.

#### Lockhart Limestone

58.0	896	Shaley Limestone, marly and nodular, fossiliferous.
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#### Patala Formation

16.0	541	Sandstone, light grey, quartzose, medium grained, cross bedded with large tabular sets up to 2 ft thick, dewatering structures, friable, iron stains, scoured into top of limestone, Sample SS-072-1.
3.0	000	Covered, coal in this horizon, see mine notes 0-71.
5.0	333	Siltstone, light grey, mottled.
10.0	000	Covered.

#### Nammal Formation

50.0+	996	Limestone, fossiliferous, nodular, marly
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at places.

24 March, 1988

O-73 Location: Lat. 32/33/20N, Long. 72/23/50E.

Visit M-Fazal Haq Coal Company Mine Inam on west side of Chambalwala Nala east of Arara.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
0.25	020	Coal, bright, pyritic.
4.0	540	Sandstone, grey.
1.0	020	Coal, bright, pyritic.
1.0	320	Siltstone, grey.
Floor	540	Sandstone, grey.

O-74 Location: Lat. 32/32/15N, Long. 72/23/22E.

Visit M-Fazal Haq and Company Mine Tariq, southeast of Arara.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
1.0	020	Coal, Bright, pyritic.
2.0	540	Sandstone, grey.
1.0	020	Coal, bright, pyritic.
Floor	332	Siltstone, light grey, sandstone stringers.

O-75 Location: Lat. 32/31/50N, Long. 72/23/50E.

Visit Amin Brothers Mine 28, PCM No. 2, southeast of Arara, west of Chambalwala Wala, on west side of divide.

Ft	Rock Code	Description
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Roof	330	Siltstone, light grey.
0.5	020	Coal, bright, pyritic.
2.0	540	Sandstone, grey.
0.75	020	Coal, bright, pyritic.
Floor	540	Sandstone, grey.

O-76 Location: Lat. 32/32/20N, Long. 72/22/35E.

Section of Patala at mine office at point south of Arara.

Ft.	Rock Code	Description
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Section starts in Patala Formation

15.0+	541	Sandstone, light grey, medium grained, quartzose, flat bedded to cross bedded, upper part has shale partings 1-2 inches thick.
0.9	123	Carbonaceous Shale, with silty stringers, no apparent rooting below carb shale.
0.6	027	Coal, with shale stringers, weathered.
1.4	548	Sandstone, light grey, fine grained, quartzose, burrowed.
0.4	124	Shale, dark grey, plant material throughout, massive.
0.4	027	Coal, with shale stringers.
0.2	332	Siltstone, light grey, sandstone stringers, plant material.
0.6	027	Coal, with shale stringers.
2.0	548	Sandstone, light grey, quartzose, flat bedded, burrowed.
9.0	124	Shale, dark grey, massive.
2.0	547	Sandstone, light grey, fine grained, silty at places, flat bedded, rooted, plant material throughout.

2.0	548	Sandstone, light grey, burrowed, with limestone nodules.
15.0	124	Shale, dark grey, massive.
Nammal Formation (possible faulting and slumping at contact)		
10.0	894	Shaley limestone, marly, fossiliferous.
50.0+	996	Limestone, fossiliferous, nodular.

26 March, 1988

O-77 Location: Lat. 32/32/10N, Long. 72/21/20E.

Visit M-Fazal Haq and Company Mine No. 20 west of Arara on west bank of Sanqliwala Nala, mine has track and train.

Ft	Rock Code	Description
Roof	540	Sandstone, grey.
1.0	020	Coal, bright.
4.0	540	Sandstone, grey.
2.0	020	Coal.
Floor	332	Siltstone, light grey, with sandstone layers.

O-78 Location: Lat. 32/32/28N, Long. 72/20/25E.

Visit Hayat-Ul-Mir Coal Company Rasheed Mine west of Sanqliwala on south facing escapement.

Ft	Rock Code	Description
Roof	330	Siltstone, light grey.
0.75	020	Coal.
2.0	540	Sandstone, grey.
1.5	020	Coal.
Floor	330	Siltstone, light grey.

O-79 Location: Lat. 32/32/50N, Long. 72/20/55E.

Visit Hayat-Ul-Mir Coal Company Mine RT, north of Rasheed mine, mine is new and is somewhat mechanized.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive, pyrite, Sample SH-ARR-HM-RT.
2.0	338	Siltstone, light grey, with sandstone layers, burrowed.
0.3	027	Coal, bright, pyrite, with some sandstone streaks, Sample ARR-HM-RT-B.
0.1	123	Carbonaceous Shale, included with above Sample ARR-HM-RT-B.
0.2	124	Shale, dark grey, massive, slickensided.
0.7	548	Sandstone, grey, burrowed.
0.4	338	Siltstone, light grey, burrowed.
1.2	027	Coal, with shale streaks, bright, pyritic, Sample ARR-HM-RT-A.
0.2	123	Carbonaceous Shale, Sample included with above ARR-HM-RT-A.
Floor	124	Shale, dark grey, massive.

27 March, 1988

O-80 Location: Lat. 32/28/50N, Long. 72/14/15E.

Section exposed west of Nali, east of Kathwai, on front escarpment, section is faulted, slumped and covered, the following are estimated thicknesses for the section.

Ft	Rock Code	Description
Section starts in Wargle Limestone		
50.0+	994	Limestone, massive, fossiliferous with brachiopods etc.
Hangu Formation		
25.0	541	Sandstone, coarse grained, mixed mineralogies, cross bedded, iron



stained.

**Lockhart Formation**

25.0	896	Shaley Limestone, dusky yellow, fossiliferous.
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**Patala Formation**

30.0	541	Sandstone, light grey, fine to medium grained, quartzose, scattered clay lenses up to 1 ft thick, upper part burrowed, locally mined for sand.
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10.0	333	Siltstone, light to dark grey, with sandstone stringers, scattered plant fragments.
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**Nammal Formation**

50.0+	996	Limestone, fossiliferous with gastropods and forams, nodular to layered.
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0-81 Location: Lat. 32/29/05N, Long. 72/14/30E.

Visit Mecca Coal Company Shakeel Mine west of Nali in isolated blocks of Tertiary, most mines in this area are abandoned, the coal bed is probably very discontinuous.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
3.0	027	Coal, with shale stringers.
Floor	124	Shale, dark grey, massive.

28 March, 1988

0-82 Location: Lat. 32/28/55N, Long. 72/11/55E.

Visit abandoned Abdul Haliq Coal Company Mine No. 5, south of Kathwai, just east of Khushab road.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.0	030	Shaley coal, dull.

Floor        540        Sandstone, grey.

29 March, 1988

O-83 Location: Lat. 32/30/25N, Long. 72/08/50E.

Visit Chodry Younis Shafiq and Company, Location Surukki, Mine No. ?, west of Kathwai, along road west of Sodis.

Ft	Rock Code	Description
Floor	124	Shale, dark grey, massive, no rooting seen.
1.8	027	Coal, with shale stringers, dull, white gypsum and calcite on cleats, pyrite, Sample KW-CYS-1.
0.6	328	Siltstone, dark grey, burrowed, with sandstone stringers.
2.0	124	Shale, dark grey, massive, thickness varies due to faulting, Sample SH-KW-CYS-1.
3.0	548	Sandstone, light grey, fine grained, plant material, upper part faulted.
2.0	332	Siltstone, light grey, with sandstone layers, burrowed.
5.0+	548	Sandstone, light grey, fine grained, quartzose, faulted.

O-84 Location: Lat. 32/31/15N, Long. 72/03/32E.

Vertical section exposed along abandoned road south of Kuraddi, southeast of Uchhali, section faulted and thicknesses are estimated.

Ft	Rock Code	Description
Section starts in Permian - Triassic		
15.0+	994	Limestone, dusky yellow, brachiopods, mostly covered.

Hangu Formation (fault contact?)

10.0	541	Sandstone, grey, cross bedded.
Fault?		
20.0	323	Siltstone, dark grey, sandstone stringers, carbonaceous.
5.0	600	Calcareous Sandstone.
20.0	333	Siltstone, light grey, sandstone stringers.

#### **Patala Formation**

20.0	541	Sandstone, light grey, medium to fine grained, quartzose, carbonaceous, upper 15 ft cross bedded.
50.0	120	Shale, dark grey, mostly covered.

#### **Nammal Formation**

50.0+	996	Limestone, fossiliferous, nodular.
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21 April, 1988

O-85 Location: Lat. 32/39/40N, Long. 72/50/30E.

Visit Chittidaud Colliery Dalwal Ltd. mine No. 4 West, south of Dalwal Plateau, Chittidaud area.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive, burrowed, pyritic, Sample SH-CD-DL-4.
1.25	027	Coal, bright, with shale stringers and resin, Sample CD-DL-4.
Floor	124	Shale, dark grey, massive, burrowed.

O-86 Location: Lat. 32/40/25N, Long. 72/51/50E.

Visit Chittidaud Colliery Mine 7B, North Section, on east side of Chittidaud.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.

1.25	020	Coal, bright.
Floor	124	Shale, dark grey, massive.

O-87 Location: Lat. 32/39/55N, Long. 72/52/05E.

Visit Chittidaud Colliery Mine 2, South Section, same area as above.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
2.0	020	Coal.
Floor	124	Shale, dark grey, massive.

O-87 Location: Lat. 32/41/30N, Long. 72/50/25E.

Visit Malik Ali Shah and Company, Malkarrah Area, Mine No. 1, on northeast side of Chittidaud.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.25	123	Carbonaceous Shale.
Floor	124	Shale, dark grey, massive.

O-89 Location: Lat. 32/41/45N, Long. 72/50/10E.

Visit Captain Ahmad Khan Malkahub Colliery Mine No. 4A, northwest of O-88.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
2.0	123	Carbonaceous Shale.
Floor	124	Shale, dark grey, massive.

O-90 Location: Lat. 32/42/05N, Long. 72/48/05E.

Visit Malah Asharaf Coal Company Mine No. 3 near Malot.

Ft	Rock Code	Description
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Roof	124	Shale, dark grey, massive.
1.5	123	Carbonaceous Shale, with coaly layers.
Floor	124	Shale, dark grey, massive.

22 April, 1988

O-91 Location: Lat. 32/41/30N, Long. 72/49/18E.

Visit Khwaja Mushtaq Coal Company Mine No. ? south of Waralah.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
1.5	123	Carbonaceous Shale, with coaly layers.
Floor	124	Shale, dark grey, massive.

O-92 Location: Lat. 32/41/05N, Long. 72/49/50E.

Visit Khwaja Mushtaq Coal Company Mine No. 6, south of Waralah.

Ft	Rock Code	Description
Roof	124	Shale, dark grey, massive.
0.5	020	Coal, bright, resinous, pyritic.
1.0	123	Carbonaceous Shale, with pyrite and coaly layers and stringers.
Floor	124	Shale, dark grey, massive.

O 93 Location: Lat. 32/41/35N, Long. 72/49/10E.

Visit Khwal Mushtaq Coal Company Mine No. 1.

<b>Ft</b>	<b>Rock Code</b>	<b>Description</b>
Roof	124	Shale, dark grey, massive.
0.5	027	Coal, with shaley layers, pyrite.
1.0	123	Carbonaceous Shale, with coaly stringers, pyritic.
Floor	124	Shale, dark grey, massive.

## **APPENDIX II**

### **MEASURED SECTIONS AND BOREHOLE LOGS FROM THE TERTIARY COAL-BEARING SECTION OF THE SALT RANGE**

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Measured Sections from  
the Early Tertiary of  
the Eastern Salt Range

ESR Series

By: S. T. A. Mashhadi  
T. Shakoor  
Geological Survey of Pakistan



## Section No. 1

lat 32/43/10 N  
Long 73/17/10 E

ESR 1

PATALA FORMATION (PALEOCENE EOCENE)		meters	
14.	Limestone; grey, weathers yellowish grey, medium grained, nodular, marl along the nodular interspaces, nodules 5 x 10 cms diameter.	0	75
13.	Limestone; grey, weathers pale yellow, one bed, highly fossiliferous, Ostrea shells abundant.	0	45
12.	Limestone; grey, weathers yellow, one bed.	0	22
11.	Shale; ash grey, thin bedded.	0	53
10.	Siltstone; ash grey, thin bedded.	0	45
9.	Shale; ash grey and dark grey with coal partings.	0	22
Total		2	62
HANGU FORMATION (PALEOCENE)			
8.	Sandstone; grey, medium grained, thick bedded with coal lenticles at surface and coal seam in mine sections.	1	00
7.	Shale; bright red, thin bedded, lateritic.	0	05
6.	Sandstone; grey white and yellow, coarse grained at places pebbly, pebbles of quartz, coal lenticles, thick bedded massive and hard.	3	63
Total		4	68

# TOBRA FORMATION (PERMIAN)

5.	Boulder bed; boulders and pebbles of igneous rock and quartzite, maximum boulder diameter 50 cm, 30x37 cms boulders in diameter common.	0	15
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# BAGHANWALA FORMATION (CAMBRIAN)

4.	Siltstone; greenish grey, fine grained thin bedded, breaks into even surfaced small blocks, Selenite plates scattered over surface.	1	50
3.	Siltstone; buff grey, fine grained, thin bedded, micaceous.	1	80
2.	Siltstone; greenish grey, thin bedded, Sandy at places, yellow and red ochrous.		
1.	Siltstone; reddish brown, medium to thin bedded, with green rounded spots of 3 to 5 cms common over the surface.	25	00
Total		2	30

# SECTION NO.2

ESR - 2

Lat 32/43/45N

Long 73/17/0E

Stratigraphic section  
Mitha Chhol Nala

# KAMLIAL FORMATION (MIOCENE) meters

17.	Sandstone; grey, medium grained, thick bedded, massive	4	00
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# MURREE FORMATION (MIOCENE)

## FATEHJANG ZONE.

16.	Conglomerate; comprised of boulders and pebbles of Eocene limestone in coarse grained sandy matrix.	1	50
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# SARESAR LIMESTONE (EOCENE)

15.	Limestone; cream to grey, weathers grey with yellow and red patches on the surface, nodular, nodules 7.5 x 15 cms dimension common.	1	80
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#### NAMMAL FORMATION (MIOCENE)

14.	Marl; grey, thin bedded, fossiliferous.	0	15
13.	Limestone; nodular, nodules 25 x 30 cms dimensions, argillaceous hard, marl along nodular interspaces, fossiliferous	1	80
12.	Limestone; nodular, argillaceous with predominating marl in lower part, marl bluish grey, thin bedded partly covered.	3	30

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Total	5	25
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#### PATALA FORMATION (PALEOCENE)

11.	Limestone; grey, weathers yellowish grey, medium grained, medium bedded, nodular, nodules 10x4 cms dimension, coalesce together, rare Ostrea and other Mollusks.	1	50
10.	Limestone; grey yellow, weathers yellow, medium grained, medium to thick bedded, hard.	0	50
9.	Limestone; grey, weathers yellowish grey, richly fossiliferous with Ostrea shells, two beds of 60x15 cms thickness.	0	75
8.	Shale; ash grey and greenish grey, thin bedded, grey siltstone intercalated at places.	2	42
7.	Shale; dark grey with coal seam (0.15)	1	00

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Total	6	17
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HANGU FORMATION (PALEOCENE)		meters	
6.	Sandstone; buff violet and grey, weathers to grayish white, fine to medium grained, medium bedded, contains two red ochrous & lateritic beds.	0	30
5.	Sandstone; yellowish white and violet, medium grained, medium bedded, compact.	1	50
4.	Sandstone; grayish white and violet, medium to coarse grained, medium to thick bedded, massive, compact.	2	72
Total		4	52

#### TOBRA FORMATION (PERMIAN)

3.	Boulder bed in coarse grained sandstone, contains boulders and pebbles of igneous rocks and quartzite.	0	15
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#### BAGHANWALA FORMATION (CAMBRIAN)

2.	Siltstone; greenish grey, thin bedded.	1	80
1.	Siltstone; reddish brown, fine grained, thin to medium bedded, at places sandy, contains green rounded spot, few beds of brick red sandstone.	30	00
Total		31	80

## SECTION NO. 3

ESR-3

Lat 32/44/30 N  
Long 73/13/05 E

Stratigraphic section of Permian-Early Tertiary rocks exposed south east of ARA Rest House.

## SAKESAR LIMESTONE (EOCENE)

meters

24.	Limestone; grey to cream, weathers to grayish white, fine grained, nodular, nodules closely spaced, contains irregular nodules and concretions of chert.	1	50
NAMMAL FORMATION (EOCENE)			
23.	Limestone; grayish white, fine grained, nodular, marl along nodular interspaces, fossiliferous.	11	81
22.	Clay; reddish brown, equivalent to Sidhandi shale.	0	60
21.	Marl; grayish yellow, highly fossiliferous, with micro fossils, forams visible with naked eyes, compact, forms a prominent horizon.	0	30
20.	Limestone; grey weathers to chalk-grey, nodular, argillaceous, bluish grey marl along nodular interspaces, forams abundant, rarely forams mollusc occurs.	2	65
19.	Limestone; grey, weathers to grayish white, bluish grey marl along nodular interspaces, highly fossiliferous.	6	06

Total

21

42

## PATALLA FORMATION (EOCENE)

18.	Shale; yellowish grey, thin bedded.	0	95
17.	Shale; grey, fine grained, thin bedded, silty.	0	30

16.	Shale; with coal seam (0.15 m) and coal lenticles.	0	30
15.	Sandstone; greenish grey, medium grained, medium bedded, contains coal lenticles.	0	30
14.	Siltstone; greenish grey, fine grained, thin bedded micaceous and compact.	0	30
Total		2	15

#### HANGU FORMATION (PALEOCENE)

13.	Sandstone; yellow and red, medium grained lateritic, hard, forms uneven rubbly surface indicating an erosional unconformable horizon.	0	45
12.	Sandstone; white, weathers with yellow patches, coarse grained, contains 90% quartz grains may be used as Silica sand.	1	35
11.	Sandy shale; light greenish grey, thin bedded.	0	60
10.	Shale; light greenish grey, thin bedded.	1	20
9.	Shale; maroon, violet green and purple thin bedded.	3	90
8.	Sandstone; pink and green, coarse grained, pebbly, medium bedded.	1	13
7.	Sandstone; white and grey, weathers to greenish white, fine to medium grained, massive, compact.	1	65
6.	Sandstone; greenish white, coarse grained massive, chloritized.	0	60
5.	Sandstone; pink and white, weathers to pinkish white coarse grained, contains altered K Feldspar.	0	22
Total		11	10

#### TOBRA FORMATION (PERMIAN)

4.	Siltstone; greenish grey, fine grained contains boulders, maximum boulder size 20 x 10 cms.	0	25
3.	Siltstone; reddish brown, weathers to yellowish brown, thin bedded, contains rare pebbles of igneous rock.	3	40
2.	Boulder bed; boulders of granite, sandstone, and quartzite 25 x 12 cms boulders common, maximum boulder size 75x40 cms smallest pebble 1 2 mm diameter boulders embedded in sandy, and silty matrix of violet and brown color.	1	50

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Total	5	15
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#### PAGHANWALA FORMATION (CAMBRIAN)

1.	Siltstone; reddish brown and greenish grey, fine grained, micaceous, compact, exhibits green rounded spots of 1 2 cm dia. contains brick red sandstones and sandy siltstone beds.	30	0
Total		30	00

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Lat - 32/44/30 N  
Long - 73/12/30 E

#### SECTION NO.4 ESR-4

Stratigraphic section of Permian-Early Tertiary rocks exposed west of Ara Rest house near Tadi-B Mine Area.

#### SAKESAR LIMESTONE (EOCENE)

		Meters	
10.	Limestone; grey, weathers to grayish white, fine grained, nodular.	3	0

# NAMMAL FORMATION (EOCENE)

9.	Limestone; grey, weathers to dirty grey, fine grained, argillaceous nodular, marl along nodular interspaces. Marl bluish grey fine grained, thin partings, fossiliferous, forams common.	17	0
8.	Marl. grey, weathers to bluish grey with nodular argillaceous limestone, fossiliferous.	6	0
Total		23	00

# PATALA FORMATION (PALEOCENE - EOCENE)

7.	Shale; grayish yellow, thin bedded with coal seam (0.15 m).	2	00
6.	Sandstone; grey, medium grained, medium bedded with coal lenticles and silty.	0	30
Total		2	30

# HANGU FORMATION (PALEOCENE)

5.	Sandstone; grayish white coarse grained thick bedded.	2	00
4.	Siltstone/Sandstone; grey and reddish brown, fine to medium grained, thin bedded, compact, lateritic.	0	60
3.	Sandstone; grey, weathers to grayish white, coarse grained to pebbly, quartzite. Thick bedded to massive.	3	03
Total		5	63

# TOBRA FORMATION (PERMIAN)



2.	Siltstone; reddish brown, with boulders of igneous rock.	7	80
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#### BAGHANWALA FORMATION (CAMBRIAN)

1.	Siltstone; reddish brown and grey with green rounded spots sparsely scattered over surface.	30	00
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Lat - 32/44/05 N  
Long - 73/09/15 E

#### SECTION NO. 8 ESR- 8

Stratigraphic section of Permian-Early Tertiary rocks exposed in North West of Sidhandi village near coal mines.

#### SAKESAR LIMESTONE (EOCENE) meters

17.	Limestone; cream color, weathers to grey, nodular, nodules closely spaced, hard chert nodules commonly embedded in the upper part.	35	00
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#### NAMMAL FORMATION (EOCENE)

16.	Marl and Limestone; marl, grayish white, thin bedded, fossiliferous, limestone, grey weathers to grayish white, argillaceous, marly, nodular, highly fossiliferous.	20	00
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#### PATALA FORMATION (PALEOCENE EOCENE)

15.	Shale; grayish black, thin bedded.	1	20
14	Shale with coal seam, (0.15 m).	0	30
13.	Shale and Sandstone; shale: grayish black, thin bedded, sandstone: yellowish grey, fine to medium grained, contain coal lenticles.	0	30

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Total	1	9
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#### HANGU FORMATION (PALEOCENE)

12.	Sandstone; grey, yellow and red, fine to medium grained, medium bedded, compact quartzose, upper 15 cm highly lateritic and forms uneven surface.	2	45
11.	Shale; grey, thin bedded, grades to siltstone.	2	45
10.	Sandstone; red, reddish, brown, fine to medium grained, medium bedded hard, lateritic.	0	95
9.	Siltstone and shale; siltstone: grayish white fine to medium grained, thin bedded, shale: thin bedded and fissile, surface lateritic.	1	90
8.	Sandstone; grayish white, coarse grained quartzose, massive.	9	00
		<hr/>	
		Total	14 55
		<hr/>	

#### TOBRA FORMATION (PERMIAN)

7.	Siltstone; red ochreous and brick-red, at places greenish ash grey, thin bedded.	00	45
6.	Siltstone; greenish and ash grey with pebbles and boulders of igneous rock, 37 x 18 cm boulder size common	00	95
5.	Siltstone; ash grey with pebbles.	00	60
4.	Siltstone; reddish brown, friable.	00	15
3.	Siltstone; greenish grey with pebble and boulders of igneous rock.	1	45

2.	Siltstone; reddish brown with rare pebbles.	00	15
Total			75

#### BAGHANWALA FORMATION (CAMBRIAN)

1.	Siltstone; reddish brown, thin bedded with rare sandstone beds and salt pseudomorph crystals.	35	00
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Lat 32/46/40 N  
Long - 73/11/30 E

#### SECTION NO.9

#### ESR-9

Stratigraphic section of Permian-Early Tertiary rocks exposed east of Sikki village around abandoned mine.

#### NAMMAL FORMATION (EOCENE)

meters

3.	Limestone and Marl; limestone, grey, weathers to grayish white, fine grained argillaceous, fossiliferous.	1	00
2.	Limestone; grey, detrital, massive.	3	00
1.	Marl and Limestone; marl, bluish grey, fine grained, thin bedded. Limestone, grey, weathers to grayish white, fine to medium grained, nodular, argillaceous.	3	00
0.	Limestone; grey, weathers to grayish pink, detrital, massive, fossiliferous.	3	00
1.	Limestone and Marl; limestone, grey, weathers to grayish white, fine to medium grained, nodular, argillaceous fossiliferous, contains forams. Marl, grey, thinly interbedded along nodular interspaces, fossiliferous.	2	50
1.	Marl; greenish white to bluish grey, thin bedded, fossiliferous.	00	15
Total			65

#### PATALA FORMATION.

7.	Ostrea bed;	00	5'
6.	Shale; dark grey,	00	3'
Total		00	9'

#### HANGU FORMATION.

5.	Laterite; red, pissolitic, pissolites rounded to ellipsoidal shapes, exhibits irregular bauxitic network.	2	2'
4.	Sandstone; grayish white, medium to coarse grained, compact.	1	5'

#### TOBRA FORMATION.

3.	Siltstone; grayish black with pebbles of igneous rock.	1	00
2.	Siltstone; green and brownish grey with pebbles and boulders of igneous rock.	4	00
Total		5	00

#### BAGHANWALA FORMATION (CAMBRIAN)

1.	Siltstone; reddish brown, greenish grey, fine to medium grained, thin to medium bedded, at places sandstone of brick red color interbedded, green rounded spot on the surface common, salt pseudomorph crystals also occur.	30	00
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lat 32/45/00 N

SECTION NO. 11

ESR-11

Long 73/06/00 E

Stratigraphic section of Permian-Early Tertiary rock exposed at Saloi village.

SAKESAR LIMESTONE (EOCENE)

meters

12.	Limestone; cream color, weathers to
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grayish white, fine grained, thick bedded, massive, hard, nodular with chert nodules abundant in the upper part, fossiliferous, forams common.	30	00
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#### NAMMAL FORMATION (EOCENE)

11. Marl and limestone; Marl, grey, thin bedded, fossiliferous. Limestone, grayish white, weathers grey, nodular, argillaceous and marly, fossiliferous, forams common, slope forming	41	51
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#### PATALA FORMATION (PALEOCENE EOCENE)

10. Shale; yellowish grey and greenish grey thin bedded, sandy and coal bearing.	1	65
9. Sandstone; ash grey, fine grained, thin bedded.	1	20

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Total:	2	85
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#### HANGU FORMATION (PALEOCENE)

8. laterite; reddish brown, pissoilitic bauxitic and massive, highly fractured.	1	95
7. Sandstone; grayish white, medium grained quartzose, surface, lateritic.	1	35
6. Shale; orange brown and yellow, thin bedded, sandy, lateritic.	1	65

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Total:	4	95
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#### WARCUHA SANDSTONE (PERMIAN)

5. Sandstone; olive yellow, medium to coarse grained, specked white, thick bedded, massive.	1	67
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#### DANDOT FORMATION (PERMIAN)

4.	Shale, olive green, thin bedded, carbonaceous at bedding planes, upper part compact and appears to be silty and massive.	13	03
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#### TOBRA FORMATION (PERMIAN)

3.	Sandstone; greenish grey to olive green coarse grained, contains pebbles and random boulders of igneous rocks, hard, massive.	20	60
2.	Boulder bed; in coarse grained sandy matrix, boulders comprised of igneous rock and quartzite.	0	60
Total:		21	20

#### RAGHANWALA FORMATION (CAMBRIAN)

1.	Siltstone; reddish brown, thin bedded with salt pseudomorph crystals, brick red sandstone at places.	4	00
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Lat - 32/41/15 N  
Long - 72/56/00 N

### SECTION 12

Stratigraphic section of Permian-Early Tertiary rock exposed in Pith.

SAKESAR LIMESTONE (EOCENE)		meters	
20.	Limestone; cream, weathers to yellowish grey, fine grained, massive, nodular, upper part is cherty.	12	12

#### NAMMAL FORMATION (EOCENE)

19.	Marl and limestone; Marl grey to greenish grey, lime in lower part, fossiliferous. Limestone, grayish white, fine-grained, argillaceous, nodular, fossiliferous, forams and mollusk.	18	18
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#### PATALA FORMATION (EOCENE-PALEOCENE)

18.	Shale; grey to yellowish grey, thin	7	57
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bedded, at places sandy, partly covered,  
with coal seam (0.20 m).

#### WARCHHA SANDSTONE (PERMIAN)

17.	Clay and Sandstone; clay, reddish brown, sandy, highly weathered. Sandstone, reddish brown, coarse grained, thin to medium bedded.	6	00
16.	Sandstone; greenish grey, medium bedded, hard, with a little shale.	3	00
15.	Sandstone; light brown, weathers grey, coarse-grained, massive, hard.	10	60

#### DANDOT FORMATION (PERMIAN)

14.	Siltstone; olive green, greenish grey, fine grained, compact, micaceous, contains clay concretions and nodules.	18	00
13.	Shale and Siltstone; shale, greenish grey, fissile, at places carbonaceous. Siltstone, olive grey, thin bedded, compact.	6	00
12.	Sandstone; greenish grey, medium grained, medium bedded, hard, slightly lateritic.	0	15
11.	Siltstone; yellowish to greenish grey, fine grained, thin bedded, micaceous.	1	50
Total		25	65

#### TOBRA FORMATION (PERMIAN)

10.	Sandstone; olive green, coarse grained, contains pebbles and boulders of igneous rocks, massive, hard.	4	00
9.	Siltstone; greenish grey, hard, fractured contains pebbles and boulders of igneous rocks.	7	00

		Total	11	00
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BAGHANWALA FORMATION (CAMBRIAN)				
8.	Siltstone; reddish brown, medium bedded, compact, exhibits salt pseudomorph crystals.	1	3	
7.	Sandstone; greenish grey and white, coarse grained, massive, micaceous.	2	2	
6.	Siltstone; greenish grey, medium grained, compact, massive, micaceous.	1	00	
5.	Siltstone; reddish brown, fine to medium grained, medium bedded, compact	1	00	
4.	Siltstone; greenish grey, fine grained, thin bedded.	1	00	
3.	Siltstone; reddish brown, thin bedded.	0	60	
2.	Siltstone; greenish grey, fine to medium grained, thick bedded.	3	00	
1.	Siltstone; reddish brown, fine to medium grained, thick bedded, with salt pseudomorph crystals.	4	00	
<hr/>				
	Total	14	20	
<hr/>				

Lat - 32/42/50 N  
Long - 72/42/50 E

#### SECTION NO.13          ESR-13

Stratigraphic section of Permian-Early Tertiary rocks exposed south east of Choa Saidan Shah.

#### SAKESAR LIMESTONE (EOCENE)

9.	Limestone; grey, weathers to grayish white fine grained, nodular, hard, cherty, thick bedded.	13	0
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#### NAMMAL FORMATION (EOCENE)

8.	Marl and Limestone; marl, bluish grey	24	0
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weathers to grayish white, fine grained,  
thin bedded, fossiliferous, forams  
are common.

Limestone, grey, weathers grayish white  
fine grained, nodular, argillaceous and marly,  
fossiliferous.

#### PATALA FORMATION (EOCENE-PALEOCENE)

7.	Siltstone; buff brown, fine grained	0	15
6.	Shale; yellowish grey, thin bedded, fissile.	6	00
5.	Shale; greenish grey and yellow, thin bedded sandy and silty	3	50
Total		9	65

#### HANGU FORMATION (PALEOCENE)

4.	Laterite and lateritic sandstone; reddish brown, hard and fractured lateritic sandstone, brownish red, coarse grained, pebbly, hard.	1	50
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#### WARCHHA SANDSTONE (PERMIAN)

3.	Clay and Sandstone; Clay, reddish brown, sandy, highly weathered. Sandstone, reddish brown, medium grained, medium bedded.	17	00
2.	Sandstone; grayish brown, medium to coarse grained, thick bedded, hard.	3	00
Total		20	00

#### DANDOT FORMATION (PERMIAN)

1.	Siltstone; greenish grey, medium grained, medium bedded, hard.	10	00
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EASTERN SALT RANGE  
MEASURED SECTIONS

By

S. Javed, H. Hussain,  
and S.T.A. Mashhadi

Geological Survey of Pakistan

Dandot Section 1

(D 1) (Hamid and Shahid, GSP)

Lat - 32/41/10 N  
Long - 72/55/50 E

Warchha Formation (Permian)

m

- 1.5+ Silty shale; mottled, moderate reddish brown and greenish grey.
- 2.4 Sandstone; pale red, coarse grained, friable, flat bedded and speckled.
- 1.5 Siltstone; moderate reddish brown, interbedded with sandstone pale red.
- 3.0 Sandstone; pale red, medium grained, ripple marked, cross bedded, shaley.

Sardhai Formation (Permian)

- 1.5 Siltstone; moderate reddish brown and greenish grey, mottled.
- 13.4 Covered.

Patala Formation (Paleocene)

- 1.6 Sandstone; very pale orange, friable, fine to medium grained, scour based, cross-bedded.
- 3.0 Siltstone; Pale brown sandy in lower 1 m.
- 1.0 Sandstone; yellowish grey with silty shaley intercalations, scour based, tabular cross-bedded, fine to medium grained.
- 3.0 Sandstone; very pale orange, medium grained, ripple marked, cross bedded.
- 1.5 Siltstone; moderate reddish brown mottled.
- 1.0 Sandstone interbedded with siltstone; sandstone is moderate reddish brown, fine grained.

- 1.2      Sandstone and siltstone interbedded; sandstone greenish grey, fine grained, siltstone is reddish brown.
- 5.4      Covered - (probably siltstone).
- 1.8      Shale; moderate brown to olive grey mottled.
- 4.8      Sandstone; light grey to very pale orange, cross bedded, coarse grained.
- 1.4      Siltstone; light greenish grey, rippled.
- 3.6      Sandstone; light brownish grey to dark yellowish orange, medium grained, quartz pebbles at the base, burrows, some carbonaceous material present.
- 4.5      Sandstone; coarse grained, coarse quartz grains and pebbles along the bedding, cross bedded (tabular), coarsening upwards sequence, iron stained.
- 8.2      Silty shale; medium grey, plant material, splintery, gypsiferous iron staining along joints, streaks of sand in shale.
- 0.9      Silty shale; medium light grey, more sandy, more plant material than below.
- 1.8      Sandstone; light grey, very fine grained, rippled, some burrows, iron staining and plant material.
- 0.4      Siltstone; yellowish grey, calcareous, fossiliferous (gastropods).
- 1.5      Silty shale; pale brown, plant material present.
- 0.8      Siltstone; yellowish grey, calcareous.
- 6.1      Shale; medium grey fissile.
- 0.4      Siltstone.
- 0.9      Shale; medium grey, fissile.
- 0.6      Shale; carbonaceous, rooted.
- 0.18      Coal; weathered.
- 0.9      Impure coal with sandstone layers.
- 2.4      Siltstone; pale brown no plant material.
- 4.2      Shale; medium grey

0.9 Shale; greenish grey.

NAMMAL FORMATION

15.01 Marly limestone; fossiliferous mostly covered.

DANDOT SECTION 2

D 2

(Hamid and Shahid, GSP)

Lat. 32/39/15 N

Long 72/55/10 E

m Warchha Sandstone (Permian)

5.0 Sandstone.

Sardhai Formation (Permian)

5.2 Clay; mottled, dark reddish brown light olive grey  
5Y6/1, slightly silty.

0.9 Sandstone; grayish orange pink, medium grained,  
carbonate cemented, hard, cross bedded.

0.5 Shale; grayish red, silty, slightly calcareous.

0.4 Gritstone; yellowish grey, sandy matrix, pebbles of  
sandstone and siltstone.

0.5 Sandstone; light olive grey, fine grained, cross  
bedded, loosely cemented.

2.3 Sandstone; very pale orange, medium grained, massive,  
soft, loosely cemented.

3.5 Clay; dark reddish brown, silty.

FATALA FORMATION (Paleocene)

2.6 Sandstone; yellowish grey, medium to coarse grained,  
quartzose, calcareous, scour based, cross bedded,  
loosely cemented, with coarse quartz grains.

4.5 Sandstone; very light grey to grayish purple medium to  
coarse grained, quartzose, cross bedded, scoured base.

1.7 Sandstone; very light grey to grayish purple, medium to  
coarse grained, quartzose, sugary, scour based, cross  
bedded, coarse quartz grains.

2.51 Shale; brownish grey, slightly silty, plant material, gypsiferous, fine sand streaks.

Fault.

Dandot Section - 3  
(D 3)

(Hamid and Shahid, GSI)

m Lat. 32/40/20 N  
Long 72/55/15 E

TOBRA FORMATION (Permian)

2.0 Sandstone; moderate olive brown, 5Y 4/4, medium to coarse grained, gritty, massive, pebbles of igneous and sedimentary rocks.

Dandot Formation (Permian)

3.5 Sandstone; yellowish grey, fine to medium grained, massive, cross laminated, black minerals soft.

0.5 Siltstone.

0.7 Sandstone; same as above.

1.7 Siltstone.

4.0 Sandstone; same as above.

1.0 Siltstone.

3.0 Sandstone; same as above.

1.2 Siltstone.

4.0 Sandstone; yellowish grey, fine grained, massive, cross laminated, black minerals.

4.6 Siltstone.

1.0 Siltstone; yellowish grey 5Y7/2, weathered to greenish grey, cross laminated.

Warchha Formation (Permian)

- 1.0      Sandstone; pale red to blackish red, thick bedded, hard, cross bedded.
- 1.2      Sandstone; brownish grey, fine grained, thick bedded, hard, cross bedded.
- Sardhai Formation (Permian)
- 2.3      Clay; mottled, dark reddish brown, greenish grey. .
- 2.0      Sandstone; pinkish grey, 5YR 8/1, fine to medium grained, cross bedded, soft.
- 1.0      Clay; mottled.
- 1.0      Siltstone.
- 1.0      Clay; mottled.
- 5.0      Clay; mottled, dark reddish brown, greenish grey.
- 1.0      Sandstone; pinkish grey to greenish grey, fine to medium grained, soft.
- 2.5      Clay and sandstone interbedded.
- 4.0      Covered.
- Patala Formation (Paleocene)
- 1.2      Siltstone; light grey, iron stained, plant material.
- 2.0      Shale; medium grey, white sand inclusions, plant material.
- 17.3      Shale; medium grey to brownish grey, partially covered.
- 1.0      Shale; medium grey, iron stained.
- 0.3      Sandstone; very light grey, fine grained, quartzose, plant material.
- 1.0 +      Shale.

Dandot Section 4

(D-4

(Shahid)

Lat - 31/39/25 N

Long - 72/55/20 E

Sardhai Formation (Permian)

- 1.0 Clay; mottled, moderate brown, 5YR 3/4, pale olive 10Y 6/2.

Palala Formation (Paleocene)

- 9.5 Sandstone; white, fine to coarse grained, quartzose, cross bedded (planar), scoured, iron stained at places, sugary, friable, very coarse quartz grains along bedding and irregularly dispersed throughout the sand body.
- 3.1 Shale; light brownish grey, 5YR 6/1, plant material, sandy.
- 0.4 Sandstone; very light grey, medium to coarse grained, quartzose, plant material.
- 0.4 Sandstone; dusky yellow, fine grained, calcareous.
- 2.6 Shale; light brownish grey, 5YR 6/1, silty, plant material.

Fault.



Wahabi Bale I

(W 1)

(Shahid, GSP)

Dandel Formation (Permian)

Lat 32/46/10 E  
Long 73/03/55 E

m

- 1.0 + Sandstone; greenish yellow, 5Y B/4, medium grained, thin bedded, cross bedded, black minerals.
- Patala Formation (Paleocene)
- 0.6 Laterite; grayish red, 5R 4/2, pisolitic, pebbly, gritty, thick bedded, pebbles consist of siltstone and claystone.
- 2.75 Laterite; moderate reddish brown, 10R 4/6 to white and dark reddish brown, pisolitic, thick-bedded.
- 1.0 Laterite; dark reddish brown 10 R 3/4 pisolitic, massive.
- 6.0 Shale; dark brownish grey (partially exposed).
- 3.0 + Shale; medium grey (partially exposed).

Wahabi Bale II  
(W-2)

(Shahid, GSP)

Lat - 32/46/00 N  
Long - 73/03/30 E

- m  
Dandot Formation (Permian)
- 1.0 + Sandstone; grayish yellow, thin bedded cross-bedded.
- Patala Formation (Paleocene)
- 2.0 Sandstone; very light grey, grayish purple and pale yellow orange, fine grained, quartzose, coal lenticles, iron stained, burrowed.
- 10.0 + Shale; light grey, white sand layers partially exposed.

Wahati Bala III  
W-3 (Shahid)

Lat 32/46/20 N  
Long - 73/04/30 E

- m  
Dandot - Warchha Sandstone (Permian)
- 1.0 + Sandstone; light olive grey, 5Y 5/2, fine grained, thin bedded, cross bedded, black minerals.
- 2.15 Sandstone; pale greenish yellow 10 Y 8/2, to grayish red purple 5 RP 4/2, fine grained, thin to medium bedded, cross bedded.
- 0.5 Sandstone; pale red purple, 5 RP 6/2, fine grained, argillaceous, burrowed, ferruginous.
- Patala Formation (Paleocene)
- 3.2 laterite; pale reddish brown, 10 R 5/4, dark reddish brown, 10 R 3/4, splintery, at places white.
- 1.25 laterite; pale reddish brown, pisolitic.
- 0.25 Bauxite; purple, white
- 1.0 Claystone; very light grey, iron stained.
- 0.6 Bauxite; pale reddish brown and white, nodular
- 1.5 Shale; light brownish grey, weathers to very light grey, iron stained, plant material, slightly silty.

0.78	<u>Shale</u> ; covered.
3.96	<u>Shale</u> ; grayish black, carbonaceous, fissile.
0.5	<u>Shale</u> ; brownish grey, plant material, splintery.
0.8	<u>Sandstone</u> ; very light-grey to light grey, fine grained, cross bedded, burrowed, plant material, iron stained.
1.36	<u>Shale</u> ; light brownish grey, plant material, iron-stained.
	Fault.

#### Nila Section I

(N 1)

(Mashhadi and Shahid, GSP)

Lat - 32/39/55 N

Long - 72/54/20 E

m

#### Warchha Sandstone (Permian)

2.0 +	<u>Sandstone</u> ; pinkish grey, 5 YR 8/1, coarse grained, cross bedded, thick bedded.
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#### Sardhai Formation

9.40	<u>Clay</u> ; mottled, dark reddish brown, 10 R 3/4 to greenish grey, 5 GY 6/1, slightly silty.
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0.5	<u>Shale</u> ; greenish grey, 5 GY 6/1, sandy.
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#### Patala Formation (Paleocene)

1.5 m	<u>Sandstone</u> ; very light grey, N-8, coarse grained, quartzose, soft, friable, iron stained.
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2.3 m	<u>Shale</u> ; brownish grey 5 YR 4/1, white sand layers, plant material, iron stained at places.
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2.23	<u>Sandstone</u> ; very light grey, N-8, coarse grained, quartzose, soft, friable, iron-stained.
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0.25	<u>Shale</u> ; light brownish grey, 5 YR 6/1, plant material.
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- 0.25 Sandstone; very light grey, N-8, coarse grained, quartzose, soft, friable, iron stained.
- 0.50 Shale; light brownish grey, 5 YR 6/1, plant material.
- 5.18 Sandstone; very light grey, N-8, fine to medium grained, quartzose, soft, friable, iron stained at places, occasional plant material.
- 1.60 Shale; light brownish grey, 5 YR 6/1, plant material, white sand inclusions.
- 6.0 Siltstone.
- 6.46 Shale; medium grey, N-5, iron staining.
- 0.20 Sandstone; very light grey, very fine grained, plant material, rooted.
- 0.15 Coal; weathered, sandy inclusions.
- 0.20 Shale, light brownish grey, 5 YR 6/1, sandy, plant material.
- 6.0-1 Shale; brownish grey, 5 YR 4/1, plant material, splintery.

#### Manhiela Section 1

(M-1)

(Hamid and Shahid, GSP)

Lat. 32°44'25" N  
Long. 73°00'25" E

m

#### Sardhai Formation

- 3.0-1 Clay; dark reddish brown, partially exposed.
- 1.20 Sandstone; pale pink, fine grained, massive, soft.
- 0.50 Sandstone; light brownish grey, fine grained, laminated, cross bedded, soft.
- 1.0 Siltstone; brownish grey and greenish grey.

1.0	Sandstone; yellowish grey, medium grained soft, massive.
6.25	Clay; mottled, dark reddish brown and greenish grey, silty.
Patala Formation	
3.5	Siltstone; mottled, moderate orange pink, pale olive and greenish red, iron rich.
1.7	Shale; light grey, weathers grayish yellow, silty, rich in plant material.
1.0	Sandstone; yellowish grey, very fine grained, iron staining, plant material.
1.5	Siltstone; light grey to light brownish grey, iron staining, dolomite nodules.
8.48	Shale; light grey, plant material.
0.5	Shale; brownish grey, white sand stringers.
0.5	Sandstone; light grey, very fine grained rich in plant material.
10.0	Shale; light grey, mostly covered.

#### Pidh Section No 1

(P-1)

(Hamid and Shahid, GSP)

Lat - 32/41/25 N

Long - 72/58/30 E

m

Sardhai (Permian)

5.0	Clay; dark reddish brown.
1.65	Sandstone; grayish orange pink, 5 YR 7/2, medium to coarse grained, cross-bedded, soft, calcareous at places gritty.
7.1	Clay; mottled dark reddish brown, greenish grey, partially exposed

- 4.5 Sandstone; pale red to light greenish grey, fine grained, laminated, micaceous, cross-bedded, burrows, clay balls, interbedded with clay, mottled, dark reddish brown to greenish grey.
- Patala Formation (Paleocene)
- 4.1 Sandstone; brownish grey, medium grained, cross bedded soft with hard beds at intervals.
- 0.8 Sandstone; grayish orange, pink, 10 R 8/2, medium grained, quartzose, loose, friable.
- 3.74 Shale; brownish grey, weathers to light grey, plant material, iron staining.
- 1.10 Siltstone; light grey, very fine grained, coal lenses, burrows iron staining.
- 10.1 Shale.

Gandhara Section  
(G 1)

(Hamid and Shahid)

Lat - 32/42/40 E  
Long 72/58/25 N

m

Warchha Sandstone (Permian)

- 5.0-4 Sandstone
- Sardhai Formation (Permian)
- 4.17 Clay; dark reddish brown, partially exposed.
- 0.3 Sandstone; yellowish grey, medium grained, cross bedded, compact.
- 0.64 Clay; dark reddish brown.
- 1.73 Sandstone; yellowish grey, medium grained, compact interbedded with siltstone, yellowish grey and brownish grey to dark brownish grey
- 7.07 Mostly covered; clay, dark reddish brown.

- 2.20 Sandstone; yellowish grey, fine to medium grained, calcareous, ripple marked.
- 1.05 Clay; greenish grey, partially exposed.
- 0.75 Sandstone; greenish grey, medium grained, thin bedded, cross bedded.
- 1.69 Clay; mottled, dark reddish brown and olive grey, silty, partially exposed
- Patala Formation (Paleocene)
- 1.5 Sandstone; pinkish grey, weathers brownish grey, fine grained massive.
- 3.6 Sandstone; very light grey, weathers to grayish orange, coarse grained, quartzose, sugary, iron rich, coarse quartz grains.
- 7.18 Shale; medium dark grey, slightly silty.
- 6.5 Shale; moderate yellowish brown, silty, pyritic, clay balls.
- 5.6 Shale; medium grey.

#### Gandhala Section 2

G 2

(Shahid)

Lat 32/42/00 N  
m Long 72/56/50 E

#### Warchha Sandstone (Permian)

- 5.0 Sandstone; pinkish grey, coarse grained, soft, massive, cross bedded.
- Patala Formation (Paleocene)
- 3.6 Sandstone; dark yellowish orange, 10 YR 6/6 to moderate orange pink, 10R 7/4, medium to coarse grained, iron stained, ripple marked, cross-bedded, worm tracks, very coarse quartz grains dispersed along bedding at places.
- 2.3 Sandstone; dark yellowish orange, 10 YR 6/6c coarse grained, quartzose, iron stained, very coarse quartz grains dispersed throughout sand body cross bedded.

3.75	Sandstone; dark yellowish orange, 10 YR 6/6, fine grained, medium bedded iron stained.
4.6	Shale; dusty yellow.
0.10	Limestone; grayish orange, 10 YR 7/4, hard, fossiliferous (forams).
0/97	Shale; dusky yellow, 5G 6/4.
0.15	limestone; grayish orange, fossiliferous (forams).
3.32	Shale; dusky yellow
0.13	limestone; grayish yellow, forams.

### Gandhara Section 3

(G 3)

(Shahid, GSP)

	Lat	32/56/00 N
m	Long	72/41/50 E

#### Patala Formation

2.0	Shale; covered.
1.9	Shale; brownish grey, 5YR 4/1, carbonaceous, at places white sand stringers.
6.25	Sandstone; very light grey, quartzose, fine grained, well sorted, soft, sugary, friable, scoured.
3.0	Shale; medium grey, plant material.
12.0	Shale; covered.



Measured Sections of  
Early Tertiary Sediments of  
the Central Salt Range

CSR Series

by S. I. M. Shah  
Geological Survey of Pakistan

SECTION NO. 1

CSR\_1

Lat 32/38/15 N  
Long 72/36/55 E

NILAWAN

SECTION MEASUREMENT IN NILAWAN IN THE SOUTHEASTERN PORTION OF THE GORGE.

THE SECTION IS IN THE EAST OF THE MAPPED AREA.

From the top of Productus Limestone.

1' 9" Productus limestone beds: Lower portion is yellow and upper is pink. Persistent locally, friable, upper most portion turned yellow on weathering, contains thin beds of selenite.

DIJOK PASS BEDS:

1' 8" Laterite bed. Olive grayish green mottled with yellow and very dusky red purple. Pisolitic. Fresh color of pisolites is olive grayish green. Impure and persistent.

10' 9" Shale, lower 2 feet is lateritic in color and upper grayish green. Friable, loose contains selenite particles. Slope former and persistent.

KHAIRABAD LIMESTONE:

5'-6" Marl. Dark grey, with limestone pieces and thin beds embedded. Friable.

2'-9" Limestone. Grey weathers to yellow, persistent medium bedded.

24'-0" Marl with grey weathers to yellow limestone beds in part, marl turns bluish grey on weathering, scree covered.

42'-0" Limestone. Grey weathers to yellow. Nodular with clay, cliff former upper most 25" is marl with very thin limestone bed.

PATAIA SHALE:

9' 0" Shales. Grayish olive green, fissile. Contains limestone of grey color. Very thinly bedded limestone beds are covered with selenite, very thin beds of selenite are also present. These selenite beds are in alternate position with shales. Upper most 7" is limestone bed.

10' 0" Shales. Bluish grey weathers to yellowish brownish grey, fossil contains yellowish brown small nodules, which show exfoliation, weathering also contains thin siltstone beds.

6' 6" Shales. Brownish yellowish grey, with very thin coal. Coal seam is not exposed, however, the coal seam's position is suspected here. Contains silt stone beds as usual.

28'-0" Shales, brown color, loose, fissile, slope former, no coal seam exposed, scree covered.

NAMMAL MARL:

40' 0" Scree covered, at places nodular limestone with marl.

7' 0" Shale. Brown color grey thinly bedded fissile contains abundant selenite crystals distributed on the cleaved surfaces. Upper portion is yellowish brown, but with no coal, NON CALCAREOUS.

12'-0" Limestone, with marl of light bluish green color. Supposed to be the marl beds.

SAKESAR LIMESTONE:

300' 0" Sakesar Limestone. Massive, Nummulitic, cherty. Nodular. Cliff former persistent.

CSR-2  
Lat 32/38/20 N  
Long 72/34/50 E

SECTION NO. 2

NILAWAN.

SECTION MEASUREMENT EAST OF JABA  
DHOK  
UPWARDS FROM PALEOCENE BASE.

DHOK PASS BEDS.

- 3' 0" Covered with sereol. Bauxite. Dark grey to black, pisolite (rounded) etc.
- 12' 0" Sandstone. Grayish green, weathers to grayish black or dark grey, coarse grained to gritty, harder. Compacted cliff former, dip 20 degrees NW.
- 1' 4" Sandstone. Clayey, grayish green with megascopic fossil shells, soft, friable.
- 10' 6" Sandstone. Same as above, harder.
- 2' 2" Sandstone. Grayish green, coarse grained, medium bedded, hard and compacted.
- 1' 4" Sandstone. Grayish green, soft, gritty and clayey etc.
- 6' 3" Sandstone. Same as above with hard beds of the order of 9" thick.

KHAIPAPAD LIMESTONE.

- 28' 0" Limestone. Nodular with Marl beds.
- 20' 3" Limestone. Same as above.

PATAIA SHALE.

- 21' 0" Shale. Covered with sereol.

PATAIA and NAMMAL.

- 115' 0" Covered with sereol.

SAKESAR LIMESTONE.

- 219' 0" Limestone. White, nodular to well bedded, cliff former (fossiliferous).

SECTION NO. 3.

CSR-3

LAT 32/36/50 N

LONG 72/35/40 E

NILAWAN.

JABA DHOK (AT FALL.)

.....

UPWARDS FROM PALEOCENE BASE.

DHOK PASS BEDS.

- 4' - 3" Claystone. Dark grey, weathers to yellow, with salt incrustation.
- 5' 0" Pauxite, color of pisolites dark bluish grey, upper portion contains sparsely pisolites. It is in gritty sandstone.
- 10' 10" Sandstone, grey. Medium grained to gritty, thick bedded, cliff former etc.
- 5' 0" Sandstone. Calcareous, grey etc.

KHAIRABAD LIMESTONE.

- 9' - 0" Covered with serec, lower portion shale dark grey and upper nodular limestone of dark grey color
- 23' 0" Limestone. Nodular and thin bedded limestone of grey color. Nodules are smaller in size, 4" - 5" in diameter. Thick unit is 50% clay or marl which envelopes limestone beds.
- 8' 0" Limestone. Same color as above, Nodular, nodules are over one foot diameter.
- 5' 0" Limestone. Same as above with less clay.
- 11' 0" Limestone. With more than 50% clay. Nodular.
- 9' 0" Limestone. Nodular, upper half well bedded, thick bedded, medium grained etc. Yellow weathering.
- 10' 0" Limestone. Nodular, same as above.

FATALA SHALE.

- 10' 0" Shales. Grey, fissile etc.

PATALA, NAMMAL, and SAKESAR.

362' 0" Covered with scree.

SAKESAR LIMESTONE

72' 0" Limestone. White, cliff former, fossiliferous.

CSR-4

Lat. 32/36/20 N  
Long 72/31/50 E

NULAWAN

SECTION MEASUREMENT AT (SIKH MINES) NULAWAN WESTERN CUTTINGS.  
From the top of Productus limestone.

DHOK PASS BEDS.

- 4' 6" Laterite. Sandstone of lateritic appearance, fine grained, medium bedded. Bluish grey.
- 0' 6" Laterite clay. same color as above with yellow weathering, fissile etc.
- 17' 9" Sandstone. light grayish brown, thick bedded, medium grained, friable fracture, loose, etc.
- 3' 0" Sandstone. Same as above but calcareous.

KHAIRABAD LIMESTONE:

- 6' 0" Marl of grayish yellow color.
- 47' 0" Nodular limestone.
- 9' 0" limestone. Well bedded, brownish yellow color, medium bedded, fine grained.
- 3' 0" Limestone. Well bedded, marly, platy etc. Earthy color.

PATALA SHALE

- 69' 0" Covered with scree, patches exposed show grey to brownish grey color, fissile.

NAMMAL and SAKESAR

- 318' 0" Limestone. Covered with scree. Upper 100 feet is a cliff of limestone very thick bedded, white, fractured.

SECTION NO. 5

CSR-5

Lat 32/36/15 N

Long 72/30/15 E

SAMA WALI

ACROSS KATHA COLLIERIES  
MINE

SECTION STARTED FROM THE TOP OF PRODUCTUS  
BEDS

DHOK PAS WSA.

- 10' 0" Sandstone. Covered with serec. Exposed faces show olive grey i green color, much weathered, medium bedded, medium grained, up portion contains coarse grained particles in the medium grained surrounding. In the lower portion fine grained material is also found. Non calcareous.
- 15' 0" Sandstone. Light olive grey to dark grey. Very fine to fine grained Impure laterite zone starts from here. Formation is covered with serec. Upper portion gets darker. Some of the patches exposed are mottled.
- 14' 0" laterite bed. Olive grayish green. Mottled with yellow and ver dusky red. Pisolitic in part. Thick bedded persistent.

KHAIRABAD LIMESTONE.

- 56' 0" Limestone. Grey weathers to yellow color nodular. Nodules are embedded in clay of marly nature. Lower portion contains marl beds, persistent, unevenly bedded. Uppermost 2 feet well bedded limestone. Persistent. Highly fossiliferous.

PATALA SHALE.

- 11' 0" Shale. Brownish yellowish grey. Fissile, contains thin beds of siltstone, selenite and alum. Fossiliferous (forams).
- 0' 4" Coal Seam. Black, lumpy, uneven, dipward increasing in thickness 4" coal seam becomes 1 foot at a distance of about 80 feet.
- 4' 0" Shales. Same as above.

PATALA SHALE, NAMMAL and SAKESAR.

- 292' 0" Limestone. Covered with serec. The unit is Patala Nammal and Sakesar.
- 100' 0" Limestone. Grey to white in color, mostly, nodular, in part well bedded, fractured, fossiliferous.



CSR-6  
Lat 32/34/30 N  
Long 72/29/25 E

SECTION NO. 6

.....  
DHOK CHHAB.

UPWARDS FROM THE BASE OF PRODUCTUS LIMESTONE.

DHOK PASS BED.

- 10' 0" Clay. Buff color with silt beds.
- 7' 5" Bauxite Grey. Pisolitic with thin beds of clay or silt etc. Pisolites are as big as 3/4" diameter.
- 5' 5" Silty sandstone. Same as above.
- 15' 8" Sandstone. massive, medium grained, cliff former and cross bedded.
- 4' 4" Sandstone. Bluish grey, same as 5'-2" unit.
- 0' 8" Sandstone. Medium grained, yellowish brown color not persistent.
- 5'-2" Sandstone. Very fine grained, silty with 4 inch thick sandstone beds of yellow color, cross bedded, color bluish grey.
- 12' 6" Sandstone. Brownish grey, bad cliff former, massive medium to coarse bedded and cross bedded.
- 7' 5" Sandstone. Grey, weathered to yellowish brown. Marly, calcareous, medium bedded, medium grained, loose, slope former.

KHAIRABAD LIMESTONE.

- 65' 0" Limestone. Grey, weathers yellow, nodular, upper 2 feet well bedded, highly fossiliferous. Contains pyritic grains.

PATALA SHALE.

- 96' 0" Shale. Covered with scree, patches exposed show grey to brownish grey color, fissile shale.

NAMMAL PATALA and SAKESAR.

- 291' 0" Covered with scree.

SAKESAR LIMESTONE.

- 96' 0" Limestone. Mostly nodular, hard & compact cliff former.

CSR-7  
Lat. 32/38/10 N  
Long 72/29/15 E

SECTION NO. 7

TAJU WALA

SECTION MEASUREMENT AKBAR KUNJALA MINE.

TAJUWALA NORTHERN EXTENSION

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE.

DHOK PASS BEDS.

42' 0" Sandstone. Covered with scree, patches exposed show lower 10 feet lateritic clay and siltstone, upper sandstone and shale of grey color, sandstone is medium to coarse grained and shale is fissile.

KHAIRABAD LIMESTONE.

40' 0" Grey, weathers to yellow, nodular, nodules are embedded in marl of the same color. Upper one foot is well bedded and lower 7 feet are marl. Mostly covered with scree.

PATALA AND NANMAL.

155' 0" Covered with scree. Few patches exposed show the lower portion is shale of grey color with few sandstone beds of grey color. Sandstone is medium to fine grained. Upper portion is nodular limestone, nodules are embedded in marl.

SAKESAR LIMESTONE

218' 0" Limestone. White, very thick bedded or massive, partly nodular, contains chert grains, cliff former, compacted.

CSR-8  
Lat. 32/36/05 N  
Long 72/27/25 E

SECTION NO. 8.

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TAJU WALA.

SECTION MEASUREMENT AT KATHA COLLIERIES WESTERN CORNER.

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE.

DIHOK PASS BEDS.

26' 0" Sandstone. Grey, weathers brownish grey to earthy color, medium to coarse grained, lower 10 feet lateritic.

KHAIRABAD LIMESTONE.

59' 0" Limestone. Grey weathers yellow, nodular with abundant marl, loose. This unit is mostly composed of alternated beds of shales.

PATALA SHALE.

67' 0" Shale. Grey, mostly covered with scree contains few beds of sandstone of the same color, sandstone, is medium to fine grained.

PATALA, NAMMAL and SAKESAR

120' 0" Covered with scree.

SAKESAR LIMESTONE.

222' 0" Limestone. White to grey with bluish grey marl beds interbedded, limestone is very thick bedded or massive, contains grains of chert and pyrite.

CSR-9  
Lat 32/33/45 N  
Long 72/26/40 E

SECTION NO. 9.

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BETWEEN SHAH BIHOT and TAJU-WALA.

SECTION MEASUREMENT NORTH OF SHAH BIHOT,  
WEST TO TAJU WALA.

UPWARDS FROM THE TOP OF PRODUCTS LIMESTONE.

DIKOK PASS BEDS.

42' 0" Covered with serec, exposed patches show sandstone medium to coarse grained, lower portion silty and lateritic, contains fossiliferous shale beds.

KHATRABAD LIMESTONE.

40' 0" Limestone. Grey weathers yellow, nodular, upper 2 feet well bedded, contains pyrite grains, fossiliferous.

PATALA and NAMMAL MARL.

166' 0" Covered with serec

SAKESAR LIMESTONE.

198' 0" Limestone. White, thick bedded, with impersistent beds of shale interbedded, limestone is massive, cliff former, resistant to weathering and erosion, contains chert pieces.

CSR-10  
Lat 32/34/10 N  
Long 72/25/25 E

SECTION NO. 10

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JHAKKAR KOT.

SECTION MEASUREMENT IN THE EASTERN KATTHA AREA.

UPWARDS FROM THE TOP OF PRODUCTUS BEDS.  
-----

DHOK PASS BEDS.

57' 0" Siltstone. Grey, weathers to yellowish grey, thick bedded. Lower 10 feet is an impure laterite. Siltstone is marked with black carbonaceous streaks. Mostly the unit is covered with scree.

Uppermost 3 feet is very fine grained sandstone of olive green color, thick bedded, contains yellow colored small nodules of foreign material, cross bedded.

18' -5" Siltstone. Same as above, but weathers to yellowish white, much clay.

3' 5" Shale. Bluish grey, friable, silty in nature.

KHAIRABAD LIMESTONE.

42' -0" Limestone. Grey weathers to yellowish white, semi-nodular. Nodules are embedded in the clay matrix, contains shale and marl beds. Covered with scree.

PATALA SHALE.

60' -0" Shale. Bluish grey, contains siltstone beds interbedded. Although patches of the shale unit are exposed, no coal outcrop is visible.

NAMMAL BEDS.

25' -0" Nammal beds. Whole covered with thick scree, thickness is approximate.

SAKESAR LIMESTONE.

287' 0" Limestone. Grey, weathers to grayish white, very thick bedded, cliff former, partly nodular, full of fossils.

CSR 11  
Lat 32/33/50 N  
Long 72/23/50 E

SECTION NO. 11

CHAMUL EAST.

KATHA COLLIERIES MINE NO. 1

UPWARDS FROM THE TOP PRODUCTUS LIMESTONE.

DHOK PASS BEDS.

- 8' 0" Siltstone. Violet color, medium to thick bedded.  
In between very fine grained to fine grain sandstone.
- 2' 4" laterite. Light yellow, brownish red and white, lower side middle and upper respectively, pisolitic, medium bedded, pisolites are not perfect.
- 1' 2" Sandstone. Reddish yellowish brown. Thin bedded, fine to medium grained etc
- 45' 0" Covered with scree. Mostly sandstone.
- 15' 2" Sandstone. Pinkish yellowish brown, medium to coarse grained with abundant quartz crystals and gritty. Thick bedded, cliff former.
- 10' 6" Siltstone. Light yellowish brown, clayey at places, looks like silty claystone, medium to thick bedded.
- 15' 9" Siltstone. Same as above but harder and coarser with grey color or earthy.
- 2' 8" Siltstone. Grey, with yellow weathering especially upper portion loose soft, calcareous.

RHAIRABAD LIMESTONE.

- 61' 0" Limestone. Lower 6' is marl, grey weathers yellow, nodular with marl around the nodules, Uppermost 2 feet well bedded limestone, fossiliferous.

KATALA SHALE.

- 13' 0" Shale. Grey, weathers brownish grey, fissile.
- 2' 3" Coal. Black contains sulphur.

PATALA and NAMMAL.

84' 0"      Covered with scree.

SAKESAR LIMESTONE.

201' 0"      Limestone. Grey to white, thick bedded, well bedded, with marl beds of 10 feet to 15 feet thickness. Cliff former. Contains pyrite and chert grains, fracture.

CSR -12  
Lat 32/33/00 N  
Long 72/23/50 E

SECTION NO. 12

CHANYOT MUHAR.

DIOK NIDI SAN VALLEY.

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE;

DIOK PASS BEDS.

3' 0" Covered with scree, laterite horizon.

19' 7" Sandstone. Grayish brown, fine to medium grained, thick bedded, covered with scree. Lower portion is friable and very fine grained cross bedded.

9' 5" Sandstone. Grayish brown, very fine grained to fine grained. Lower portion silty upper portion being medium grained and gritty. Well bedded, weathers to olive grayish green, cross bedded, impervious.

KHAIRABAD LIMESTONE.

5' 2" Marl. Grey weathers to yellow, friable.

50' 5" Limestone. Grey, nodular, contains marl beds interbedded.

KATALA SHALE.

57' 3" Shale. Covered with scree, exposed places show shale of grey color with sandstone beds of fine to medium grain size.

NAMMAL BEDS.

12' 4" Marl and limestone. Lower portion is marl and the upper nodular limestone nodules are embedded in marl. Limestone nodules contains pyrite crystal.

SAKESAR LIMESTONE.

210' 0" Limestone. White, weathers grey, Massive, jointed medium to coarse grained with calcite films on the surface and in joints.



CSR -13  
Lat 32/32/15 N  
Long 72/21/15 E

SECTION NO.13

CHANYOT MUJAR.

AT THE TOP OF DHOK CHANGIAN

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE.

DHOK PASS BEDS.

- 12' 0" Siltstone. Light grey weathers to yellowish white. Thin bedded, regular, brownish colored nodules embedded. Cross bedded, contains black carbonaceous streaks lined up in haphazard way.
- 4' 8" Shale. Reddish brown, silty, lateritic (heavy), hard and compacted. It is a mixed conglomerate unit, of silt, shale and clay. It is persistent under the laterite bed but uneven.
- 4' 0" Laterite bed. Reddish brown. Impure conglomeratic pisolite. Mottled with various colors. Hard and compacted. Persistent.
- 35' 0" Shales. Grey, weathers to yellowish grey, loose, upper portion is silty, friable in part. Upper 3 feet exposed is almost siltstone.
- 11' 3" Sandstone. Light green, weathers to brownish grey, mottled with white, contains yellow colored patches of some foreign materials. Cross bedded, medium to thick bedded. Very fine grained to fine grained. Contains streaks of black carbonaceous material. Silty in part. Actually all size of grains are available here, coarse grained quartz pieces are also embedded in the silty ground mass. Quartz grains are rounded to sub-rounded.
- 3' 6" Sand as above. But weathers to yellowish grey.
- 37' 0" Sandstone. Dirty yellowish brown weathers to dark grey and to light yellowish brown. Very thick bedded or massive. Contains patches and cavities of coarse grained quartz pieces concentration. Medium to coarse grained, quartz concentration is in the form of lenses. Weathers to nodular form in the middle part of this unit. Clay content is also a fair percentage. Joined with no definite pattern. Knocked out foreign material leaves yellow colored cavities. Upper portion is slightly calcareous. Cliff former, persistent. Actually it is medium grained sand in the lower part, but coarse quartz grains also have considerable distribution. These quartz grains are rounded to sub rounded. Very few are regular. It is presumed to be shallow water deposit as:

1. Contains all sorts of grain size.
2. Fresh color is stained.
3. Cross bedded.

Upper portion becomes pebbly and contains fair percentage of shell fragments. Highly mottled with carbonaceous material, and selenite. Some of the quartz grains are as big as 15 inches and few of them are fractured.

17' 9" Siltstone. Light grey weathers to dirty yellowish grey. Very fine grained material is also embedded. Highly calcareous, medium bedded, jointed perpendicular to the bedding, not much compacted. Susceptible to weathering and erosion. Contains foreign material. Joints are filled with selenite at places, others joints are filled with clays.

#### KHAIRABAD LIMESTONE.

51' 0" Limestone. Grey weathers to yellow semi-nodular with clay around. Contains few beds of marl interbedded, medium grained, upper most portion is medium bedded. Highly fossiliferous.

#### PATALA SHALE

3' 8" Shale. Grey, full of selenite section above this unit is covered with selenite.

#### PATALA and NAMMAL.

127' 2" Shale and nodular limestone, grey and grayish brown color with selenite.

#### SAKESAR LIMESTONE.

243' Limestone. Well bedded, in part nodular, cliff former, fossiliferous, fractured. Very thick bedded.

CSR - 14  
Lat 32/31/15 N  
Long 72/18/35 E

SECTION NO. 14

CHAMTL.

PILI ON KHUSHAB-PAIL ROAD (KALRA WIAHN).  
UPWARDS FROM THE TOP OF PRODUCTUS LIME-STONE.

DIHOK PASS BEDS.

- 5' 0" Laterite. Impure, reddish brown, mottled, with white silty claystone.
- 43' 0" Sandstone. Scree covered with shale at the base.
- 13' 0" Sandstone. Dusky yellow, greenish at places, very thick bedded, fine grained, jointed, cliff former, resistant and compacted.
- 8' 0" Siltstone. Grey, weathers to yellowish grey. Thick bedded, cross bedded, with carbonaceous streaks.
- 13' 0" Sandstone. Same as above.

KHAIRABAD LIMESTONE.

- 82' 0" Limestone. Grey, weathers to yellow. Nodular, nodules are embedded in marl. Pyritiferous, lower 7 feet is marl.

PATALA and NAMMAL.

- 174' 0" Covered with scree.

SAKESAR LIMESTONE.

- 226' 0" Limestone. White, massive, lower portion is well bedded. Upper is well bedded to nodular. Fractured, hard and compacted.

CSR - 15  
Lat 32/35/25 N  
Long 72/27/35 E

SECTION NO. 15

CHAMIL PLATEAU

PTH. ON KHUSHAB PATH ROAD (AT ROAD TERMINUS).

UPWARDS FROM PALEOCENE BASE.

DHOK PASS BEDS.

- 12' 1" Laterite. Flesh cream and white color, thick bedded, impure, light, silty.
- 1' 7" Mudstone. Silty, black or dark grey, lower portion pisolitic, etc.
- 15' 0" Sandstone. Yellow, medium grained, loose, medium bedded, weathered and friable.
- 9' 0" Sandstone. Fine to medium grained, yellowish grey to buff colored. Siltstone at the base, thick bedded.
- 14' 6" Siltstone. Clayey, light grey, medium to thick bedded, etc.
- 14' 0" Sandstone. Yellow, weathered. Fresh grey color, thick bedded, medium.

KHATRABAD LIMESTONE.

- 4' 0" Limestone. Grey turned yellow, well bedded, thick bedded and fine grained.
- 77' 0" Limestone. Grey, nodular with marl, interbedded. Fossiliferous.

PATALA SHALE

- 64' 0" Shale covered with sereco.

NAMMAL BEDS.

- 69' 0" Covered with sereco.

SAKESAR LIMESTONE.

- 267' 0" Limestone. Grey to white, cliff former, mostly nodular fractured. Fossiliferous.

CSR - 16  
Lat 32/35/25 N  
long 72/28/05 E

SECTION NO. 16  
.....

CHAMIL SOUTH EAST CORNER.

SECTION MEASUREMENT AT THE TERMINUS OF THE ESCARPMENT.

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE.  
.....

DHOK PASS BEDS.

82' 0" Covered with scree, patches exposed show grey color sandstone, weathers to grayish brown or earthy color. Sandstone is medium to coarse grained, lower portion is highly silty, and lateritic, cross bedded.

KHAIRABAD LIMESTONE.

59' 0" Limestone. Grey to yellowish grey, nodular, contains marl beds, interbedded.

FATALA, NAMMAL and SAKESAR.

180'-0" Covered with scree.

SAKESAR LIMESTONE.

200'-0" Limestone. Well bedded, white, fractured, massive, in part cliff former, hard and compacted.

CSR 17  
Lat 32/35/30 N  
Long 72/27/20 E

SECTION NO.17

.....  
CHAMIL WEST.

SECTION MEASUREMENT IN KATHA COLLIERIES AREA.

SECTION MEASURED UPWARD FROM THE TOP OF PRODUCTUS BEDS.

DHOK PASS BEDS.

- 4'-0" Laterite clay. Reddish brown, hard and compacted, mottled with white.
- 26'-0" Lateritic bed. Reddish brown. Speckled, hard and compacted, in part bauxitic, well bedded, persistent, very thick bedded. Fine to medium grained. Impure.
- 7'-0" Bauxite, light bluish white, weathers to dirty white, thick bedded, not much compacted, pisolitic, pisolites are well rounded and are of blue color, embedded in silty ground mass. Evenly bedded as is exposed.
- 1'-4" Clay. White, hard, silty, persistent through out this locality, pisolitic in part.
- 39'-0" Sandstone. Yellowish brown, lower part of about 4 feet is siltstone. Again after 3 feet a bed of siltstone occurs and then massive sandstone. Jointed, cross bedded, medium to coarse grained. Quartz grains are sub-rounded. Upper 7 feet is slightly calcareous.

KHAIRABAD LIMESTONE.

- 3'-0" Marl. Grey, loose.
- 70'-0" Khairabad limestone. Grayish brown, weathers to yellowish brown, nodular. Nodules are embedded in marly clay. Highly fossiliferous.
- 5'-0" Marl. Dirty grey, loose, poorly friable.
- 1'-0" Limestone. Grey, weathers to yellowish grey, evenly bedded, medium bedded, fossiliferous, persistent, contains black streaks.

PATALA SHALE.

- 89'-0" Shale. (Patala) Olive, grayish green, weathers green to light yellowish brown, fissile and friable in part with siltstone beds

interbedded. In the upper part calcareous sandstone also exists. No coal seam exposed.

1'-0" Limestone. Yellowish brown, much weathered, fossiliferous, fine grained, medium bedded and persistent.

#### NAMMAL BEDS.

37'-0" Nammal beds. Actually there is no hard and fast line to draw the contact of Nammal beds and Patala shales. However, the start of limestone signifies the start of calcareous beds, lower part of the Nammal beds is marl and the upper half is nodular limestone. These nodules have much marly material around them.

#### SAKESAR LIMESTONE.

225'-0" Sakesar Limestone. It is grayish green massive more than half portion is nodular, cliff former, persistent. Uneven beds of shale are interbedded.

CSR - 19  
Lat 32/34/45 N  
Long 72/23/15 E

SECTION NO.19

.....

KHRHUMI NURSINGPHOAR (TERMINUS)

UPWARDS FROM THE TOP OF PRODUCTUS LIMESTONE.

DHOK PASS BEDS.

- 9'-5" Laterite. Clay, buff color, mottle with grayish green and dark grey patches, thin bedded.
- 16'-0" Bauxite. White weathered, pisolite with 1 inch diameter maximum. Thick bedded, loose, etc.
- 15'-0" Sandstone. Dark grey, medium grained. Medium to thick bedded, cross bedded, etc.

KHAIRABAD LIMESTONE.

- 62'-0" Limestone grey, nodular. Nodules are embedded in marl of the same color Pyritiferous.

PATALA SHALE.

- 54'-0" Shale. Covered with scree. Patches show grey color shale and sandstone of fine to medium grained size.

PATALA, NAMMAL and SAKESAR.

- 149'-0" Covered with scree. Lower portion shale, middle nodular limestone, and the upper is well bedded limestone.

SAKESAR LIMESTONE.

- 259'-0" Limestone, white or light grey, hard and compacted, cliff former.



CSR - 20  
Lat 32/34/15 N  
Long 72/24/30 E

ARARA

SECTION MEASUREMENT SOUTH WEST OF NUSINGPHOAR (TERMINUS).

Upwards from the base of Paleocene.

---

DHOK PASS BEDS.

- 8'-0" Laterite, usual.
- 5'-0" Claystone, white bauxite, light in weight etc.
- 1'-6" Claystone, grey white upper portion yellow. Fissile or shale.
- 16'-0" Sandstone, brownish yellow fine to medium grained, very thick bedded cliff former.
- 0'-7" Sandstone, light brown very fine grained, very thin bedded to thick bedded.

KHAIRABAD LIMESTONE:

- 67'-9" Limestone, nodular, lower 5 feet marl of grayish brown color, fossiliferous.
- 8'-5" Limestone, well bedded, yellowish grey, thin to medium bedded.

PATALA NAMMAL and SAKESAR:

- 368'-5" Covered with scree, upper portion is limestone, very thick bedded cliff former and the lower portion is shale, fissile, etc.

CSR - 21  
Lat 32/33/30 N  
Long 72/23/50 E

SECTION NO. 21  
.....

ARARA EAST.

SECTION MEASUREMENT IN MOHAMMAD-E-WALA CHAHR. M.

FAZAL HAQUE & CO. TARAQUE MINE.  
.....

UPWARD FROM THE TOP OF PRODUCTUS LIMESTONE BEDS.

5'-0" Limestone. (Productus) Yellowish white, weathers to black, medium to coarse grained. Contains chert. Fossiliferous, very thick bedded, hard and compacted.

DHOK PASS BEDS.

22'-1" Laterite bed. Impure, reddish brown, weathers to grayish red, very thick bedded. Conglomeratic, jointed and cliff former.

4'-4" Bauxite. Bluish white, turned yellow on exposure, much weathered, soft surface, pisolitic, pisolites embedded in clay, thick bedded, persistent and unevenly bedded.

18'-0" Shale. Bluish grey, fissile, silty impersistent and cover with scree.

13'-2" Sandstone yellowish brown, fine to medium grained, with black spots, bedded in cross part, very thick bedded or massive, persistent and compacted, ridge former and jointed.

7'-4" Sandstone. Same as above and conglomeratic in part, medium to coarse grained.

5'-0" Shale. Grey, calcareous.

KHAIRABAD LIMESTONE.

109'-0" Limestone. Grey weathers to yellow, nodular, embedded in clay.

PATALA SHALE.

40'-0" Shale. Covered with scree, brownish grey of usual nature.

1'-3" Coal seam. Black with ash, uneven, but persistent.

36'-0" Shales. Scree covered, contains siltstone beds embedded in it.

Upper most portion is medium bedded limestone (one layer).  
Siltstone is uncompacted and much weathered.

NAMMAL and SAKESAR.

269'-0" Covered with scree.

CSR - 22  
Lat 32/32/15 N  
Long 72/22/10 E

SECTION NO.22

ARARA SOUTH

SOUTH MEASUREMENT OF INDUSTRIES MINING CORPORATION.

UPWARDS FROM TOP OF PRODUCTUS LIMESTONE.

DHOK PASS BEDS.

13'-0" Reddish brown, pseudo-conglomerate, impure, thick bedded and  
impersistent.

KHAIRABAD LIMESTONE.

14'-0" Limestone. Well bedded, medium to thin bedded. Medium grained,  
hard AND compacted, fossiliferous.

37'-0" Limestone, grey, weathers yellow, nodular with marl interbedded,  
pyritiferous, fossiliferous.

PATALA SHALE.

2'-0" Shale, grey and fissile.

32'-0" Sandstone (Dilliwala). Brownish grey to light grey medium  
grained, cross bedded, impersistent, loose at places, friable.  
Contains few black minerals at places. It is good quality silica  
sand and it is evenly grained.

34'-0" Shale. Covered with scree.

NAMMAL MARL.

30'-0" Limestone. Lower portion marl and the upper is nodular limestone,  
grey, weathers yellow, nodules are embedded in the marl,  
fossiliferous.

SAKESAR LIMESTONE.

211'-0" Limestone, white to grayish white, thin bedded, medium to coarse  
grained, nodular, in part well bedded, cliff former fossiliferous.

Borehole logs from GSP drilling in the Salt  
Range during the 1960'S

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GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGICAL DRILL HOLE LOG

GSP-BM

BRANCH: SOLID FUELS      PROJECT: D-7      AREA: SALOI  
LOCATION: MOHRA      LAT: 32/44/35N      LONG: 73/04/40E  
TOTAL DEPTH: 278.08 ft      LOGGED BY: N. A. BHATTI  
DATE BEGUN: 12.4.61

From	To (ft)	Description
0	72.5	Limestone, very light grey, to brownish white, hard and massive, fossiliferous, chert grains, calcite and some blackish grains present, fractured, gets brownish on weathered surface, clayey matter between fractures at very few places, bedding not distinct, core as blocks.
72.5	81.5	Limestone, with silty bands, limestone as above from 0 - 72.5, silty bands, very light grey, to dirty grey, fractured, highly fossiliferous, chert grains present, gives salt and pepper appearance due to fossils on core surface, yellowish brown on fractures, contact with limestone not distinct, gradually merges into limestone, silt about 20% as regards with limestone, core as blocks.
81.5	101.5	Shale, greenish grey to medium gray, well fissile, nonfissile at a few places, somewhat compact, fossils, chert grains and some other foreign matter present.
101.5	102.5	Marl, almost yellowish brown, impurities abundant, reddish iron oxide, fossiliferous, highly calcareous, slightly cleared, other foreign matter present, bedding not distinct, quite broken core.
102.5	112.5	Limestone, very light yellowish grey to medium grey, fissured, hard to massive, fossiliferous, with rare megafossils of gastropods, pyrite pebbles 1/2 X 1/3 inch present, dolomite at places, calcite and chert present, gets yellowish due to ferruginous matter, core as broken blocks.
112.5	124.5	Limestone, interbedded with marl, almost light yellowish brown, somewhat shaley limestone with soapy cleaved surface gradually nodular bed of limestone at the base, bedding not distinct.
124.5	130.0	Limestone, interbedded with marl as above, light bluish grey, nonfissile, somewhat compact.

- 130.0- 141.0 Limestone, interbedded with marl as above, percentage of marl increases downward from 5 to 20%.
- 141.0- 151.0 Claystone, almost buff colored, hard, slightly silty, surface soapy, calcite present, core almost as bits.
- 151.0- 176.0 Limestone, almost medium grey, vertically fractured and small blackish specks visible, a 0.25 ft thick light colored claystone at 182.5.
- 176.0- 182.0 Limestone, almost medium grey, highly fractured, brownish, fossils rarely visible, slightly brownish on fractures.
- 182.0-222.5 Limestone, almost light grey to medium grey, silty material, fossiliferous, calcite, chert and pyrite present, with calcite layers at places, two bands 3/4 inch thick, calcareous siltstone with calcite cement, patterned calcite, chert and silty matter, yellowish.
- 222.5- 224.5 Siltstone, almost light grey, cleaved at places, calcareous and fossiliferous, medium hard, calcite present, pyrite rarely visible.
- 224.5- 235.0 Siltstone, almost medium grey, cleaved at places, argillaceous, calcareous, calcite present, fossiliferous, chert present.
- 235.0- 237.0 Siltstone, medium grey in color, with salt and pepper pattern only on the surface, medium hard, small greenish and black specks abundant, calcareous with calcite present.
- 237.0- 247.0 Claystone, almost medium grey to dark grey, cleaved, thin bedded, and laminated at places, slightly silty, somewhat siliceous at the bottom.
- 247.0- 251.0 Sandstone, fine to medium grained, light grey colored on top and dirty white below, argillaceous, arenaceous and carbonaceous specks irregularly present.
- 251.0- 260.5 Claystone, grey to dark grey, carbonaceous at places, very thin siliceous streaks at 254.0, 2 ft thick, band is somewhat laminated at 252.5.
- 260.5- 261.0 Dolomitic limestone, gold grey in color, very hard and heavy.

- 261.0- 268.5 Siltstone, light medium grey, calcite, bedding not distinct.
- 268.5- 271.0 Claystone, light - dark grey in color, foreign impurities present, like mudstone on top, cleaved at the bottom, cleaved surface soapy, core as bits and pieces.
- 271.0- 278.08 Not logged.



GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGIC DRILL HOLE LOG

GSP-B m

Page 1

BRANCH SOLID FUELS PROJECT D-7 AREA SALOI  
HOLE NO. LOCATION MOHRA COLLAR ELEV. ANGLE FROM VERT. NIL  
BEGUN 19.4.61 FINISHED DEPTH OF OVERBURDEN NIL BEARING OF ANGLE HOLE  
DEPTH OF WATER TABLE TOTAL DEPTH OF HOLE 278'-1" LOGGED BY N.A. BHATTI

CORE RECOVERY			DEPTH & LOG	CLASSIFICATION AND DESCRIPTION	WATER TABLE WATER LOSS ETC.
FROM	TO	CORE (FT)			
0.0	12.0	12.0	10	Lst. very light gray to light brownish white, hard and massive, fossiliferous, chert grains, calcite and some blackish specks present; fractured, gets brownish on weathered surface, clayey matter in between fractures at very few places, bedding not distinct, core as blocks.	Water loss almost thorough out from 0 to 64.
12.0	15.0	3.0	20		
15.0	20.5	5.5	30		
20.5	24.0	3.5	40		
24.0	25.5	1.5	50		
25.5	27.5	2.0	60		
27.5	28.2	0.7	70		
28.2	32.0	3.8	80		
32.0	34.0	2.0	90		
34.0	39.0	5.0	100		
39.0	40.5	1.5	110		
40.5	41.2	0.7	120		
41.2	46.0	4.8	130		
46.0	49.0	3.0	140		
49.0	50.6	1.6	150		
50.6	52.5	1.9	160		
52.5	54.0	1.5	170		
54.0	64.0	10.0	180		
64.0	67.5	3.5	190		
67.5	69.2	1.7	200		
69.2	71.3	2.1	210		
71.3	81.1	9.8	220		
81.1	83.0	1.9	230		
83.0	96.0	13.0	240		
			250		
			260		
			270		
			278'-1"		
				Shale, greenish gray to medium gray, well fissile, non fissile at few places, somewhat compact, fossils, chert grains and some other foreign matter present.	
				Marg. almost yellowish brown, impurities abundant, reddish tinge of iron oxide, fossiliferous, highly	

30% water loss from 64 to 69.

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGIC DRILL HOLE LOG

Page 2

BRANCH SOLID FUELS PROJECT D-7 AREA SALOI  
HOLE LOCATION MOHRA COLLAR ELEV NIL ANGLE FROM VERT NIL  
BEGUN 19-4-61 FINISHED NIL DEPTH OF OVERBURDEN NIL BEARING OF ANGLE HOLE  
DEPTH OF WATER TABLE NIL TOTAL DEPTH OF HOLE 272'-1" LOGGED BY N.A. BHATTI

CORE RECOVERY			DEPTH & SIZE	% LOG	CLASSIFICATION AND	DESCRIPTION	WATER LOSS ETC.
FROM	TO	CORE (FT)					
96.0	105.0	8.3				Calcareous, slightly cleaved, other foreign matter present; bedding not distinct. Calcite broken core.	
105.0	115.0	9.4	110			L-st. very light yellowish gray to medium gray, fissured, hard and massive, fossiliferous with rare mega fossils of Gastropods, pyrite pebbles present, dolomitic at places, calcite and chert present; belt yellowish due to ferruginous matter, core as broken blocks.	
115.0	119.2	4.0				L-st. interbedded with marl, almost light yellowish gray marl with soapy surface, fossiliferous, yellowish brown thin somewhat sandy L-st with soapy cleaved surface. Gradually nodular bed of L-st at the base, bedding not distinct, core	
119.2	121.6	2.2	120				
121.6	123.8	2.2					
123.8	124.1	0.3					
124.1	127.0	2.5					
127.0	129.5	1.0					
			130				
129.5	137.6	2.5				L-st. interbedded with marl as above (112-6" to 126-6") Percentage of marl increases downward from 5 to 20%. A 8" thick band as of 117-6"	
137.6	141.6	3.5	140				
141.6	145.5	4.1				Claystone. Almost buff colored, hard, surface soapy, calcite present, a 3" thick L-st. not distinct, core almost as hits.	slightly silty, a 3" thick L-st.
145.5	150.5	4.5	150				
150.5	154.0	2.3					
154.0	159.5	5.1				L-st. Almost medium gray, vertically fractured and small blackish specks visible. A 3" thick L-st. colored claystone at 162-6". A 3 1/2" thick Sha and hits.	
159.5	162.5	3.0	160				
162.5	169.5	7.6					
			170				
169.5	177.8	8.3					
177.8	179.1	1.3				L-st. Almost medium gray, highly fractured, brown abundantly present, fossils rarely visible. A band with soapy surface, slightly brownish on fractures	
179.1	182.1	3.1	180				
182.1	191.6	9.5				L-st. Almost light gray to medium gray, silty marl fossiliferous, calcite, chert and pyrite present with calcite layers at places. Two bands of 4" thick calcareous silt-st with calcite chert and silty matter, yellowish on leach	
			190				
			200				

BRANCH SOLID FUELS PROJECT AREA SALOI  
HOLE NO.            LOCATION Mohra COLLAR ELEV.            ANGLE FROM VERT. NIL  
BEGUN            FINISHED            DEPTH OF OVERBURDEN            BEARING OF ANGLE HOLE             
DEPTH OF WATER TABLE            TOTAL DEPTH OF HOLE            LOGGED BY N.A. Bhatti

CORE RECOVERY		DEPTH & SIZE	% LOG	CLASSIFICATION AND DESCRIPTION	WATER TABLE WATER LOSS ETC.
FROM	TO				
191.6	201.5			Silt-st. Almost <sup>light</sup> medium gray, cleaved at places, argillaceous, calcareous and fossiliferous, medium hard, calcite present, pyrite rarely visible.	
201.5	211.5	10.6		Silt-st. Almost medium gray, cleaved at places, argillaceous, calcareous, calcite present, fossiliferous, chert present.	
211.5	221.7	10.2		Silt-st. medium gray in colour, with salt & pepper pattern only on the surface, medium hard, small, greenish and black specks abundant, calcareous with calcite present.	
221.7	227.6	4.1		Clayst. Almost medium gray to dark gray, cleaved, thin bedded and laminated at places, slightly silty, somewhat siliceous at the bottom.	
227.6	230.5	2.6		Silt-st. fine to medium grained, light gray coloured on top and dirty white below, argillaceous, arenaceous and carbonaceous specks irregularly present.	
230.5	233.1	2.3		Clayst. Almost medium gray to dark gray, cleaved, thin bedded and laminated at places, slightly silty, somewhat siliceous at the bottom.	
233.1	235.6	2.5		Silt-st. fine to medium grained, light gray coloured on top and dirty white below, argillaceous, arenaceous and carbonaceous specks irregularly present.	
235.6	240.8	4.4		Clayst. Almost medium gray to dark gray, cleaved, thin bedded and laminated at places, slightly silty, somewhat siliceous at the bottom.	
240.8	244.3	2.5		Silt-st. fine to medium grained, light gray coloured on top and dirty white below, argillaceous, arenaceous and carbonaceous specks irregularly present.	
244.3	250.0	5.7		Clayst. Almost medium gray to dark gray, cleaved, thin bedded and laminated at places, slightly silty, somewhat siliceous at the bottom.	
250.0	256.6	6.3		Silt-st. light-medium gray, calcitic bedding not distinct.	
256.6	262.0	2.0		Clayst. Light-dark gray in colour, foreign impurities present, like mudst on top, cleaved at the bottom, cleaved surface sooty, core as bits & pieces.	
262.0	270.3	6.0			
270.3	278.0	8.1			

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGICAL DRILL HOLE LOG

GSP-B6

BRANCH: SOLID FUELS      PROJECT: D-7    AREA: BASHARAT PLATEAU  
LOCATION: UMRILLA      LAT: 32/48/30N      LONG: 73/08/25E  
TOTAL DEPTH: 263.00 ft      LOGGED BY: N. A. BHATTI  
DATE BEGUN: 20.2.61

From	To (ft)	Description
0.0 - 5.0		Alluvium.
5.0 - 74.0		Limestone, light grey in color, massive hard thick bedded, calcite present, fissured, gets light brown on fractures, fossils and chert grains invariably present, core as blocks and pieces.
74.0 - 81.0		Limestone, interbedded with, marl, limestone, dirty yellowish white, slightly arenaceous, chert grains and other organic material present, microforams visible, calcite crystals present, rough on touch, bedding not distinct, limestone 40% as respect to marl which is dirty yellow in color, arenaceous, highly fossiliferous with mica grains.
81.0- 103.0		Shale, light grey to medium grey, purple yellowish and blue as speckled on top, laminated with no fissility at few places, chert grains abundant at 93 ft.
103.0- 118.0		Limestone, almost light grey, nodular, marl between nodules, limestone nodules very hard and massive with calcite and chert grains present, marl about 10%, bedding not distinct, core as pieces.
118.0- 148.5		Limestone, interbedded with siltstone, limestone light dirty grey, hard massive, calcite and chert grains present, gets brownish on fractures, siltstone, light grey, calcite, chert fossils and small greenish specks present, core of lower bands gives salt and pepper appearance, percentage of limestone decreases from 50% to 10% downward, core surface rough.
148.5- 151.0		Limestone, light grey, dolomitic, fractured surface brownish, core as pieces.

- 151.0- 155.0 Limestone, light grey, calcite specks and veins, gives salt and pepper appearance, dolomitic crystals abundant, chert grains present, core as blocks.
- 155.0- 174.0 Limestone, with marl bands, limestone medium grey, marly matrix, chocolate colored on fractured surface, marl light grey, forms wavy bands about 3 inches thick, soapy surface on bedding, chert grains, pyrite, mica and other foreign material present, about 20% as a whole.
- 174.0 189.0 Limestone, medium grey, somewhat nodular, hard and massive, soapy on cleaved surfaces, calcite, chert grains and darkish green specks present, brownish on fractures, core as bits.
- 189.0- 196.0 Limestone, grey to medium dark grey, hard and massive, wavy streaks, gives nodular appearance, calcite present, core as blocks.
- 196.0- 200.0 Siltstone, medium grey, calcareous, calcite gives crescent pattern, pyrite present, fossiliferous, core as small blocks.
- 200.0- 203.0 Claystone, medium grey, calcite irregularly present, 3 inch light grey mudstone.
- 203.0- 205.0 Claystone, chocolate colored, calcareous, pyrite particles, and black particles visible, core as bits.
- 205.0- 221.0 Shale, medium dark grey, 5 ft on top nonfissile, not well fissile, fossiliferous, mica particles visible.
- 221.0- 228.5 Sandstone, with irregular shaley layers and streaks, sandstone fine to medium grained, dirty white in color, shale, 45%, dark grey to black, slightly carbonaceous at a few places, mica and resin present, pyritic pebbles and grains present at the lower part, core as blocks and bits.
- 228.5- 239.0 Sandstone, fine grained, almost white, soft and loose, angular to subrounded grains, carbonaceous and coaly streaks at about 50%, one coaly layer 1/4 inch at 233.67, and 0.76 ft at 231.83.
- 239.0-241.0 Sandstone, light grey, medium grained, angular to subrounded grains, very coarse, small sized pebbles of quartz and pyrite grains about 1/2 inch

thick on top, medium grey specks, visible on core surface.

- 241.0- 245.5 Sandstone, almost light dark grey, gritty, medium grained with abundant pebbles.
- 245.5- 259.5 Sandstone, medium to coarse grained, very light greenish grey, somewhat gritty with subangular grains, bedding not distinct, core as small broken blocks.
- 259.5- 261.0 Gritty bed with grey sandstone matrix containing pink and greenish grey pebbles of granite, rhyolite and chert etc., size of pebbles range from 0.25 X 0.25 inches to 1.5 X 1.0 inches, core as small blocks and pebbles.
- 261.0- 263.00 Claystone, medium grey, with pinkish and greenish, grey pebbles, arenaceous at places.

GSP-B6

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGIC DRILL HOLE LOG

Page 1

BRANCH SOLID FUELS PROJECT AREA BASHARAT PLATEAU (Umsilla)  
HOLE NO 6 LOCATION Umsilla COLLAR ELEV.        ANGLE FROM VERT. NH  
FIGURE 10-2-11 FINISHED DEPTH OF OVERBURDEN 5' BEARING OF ANGLE HOLE         
DEPTH OF WATER TABLE        TOTAL DEPTH OF HOLE 263' LOGGED BY N. A. Bhatti

CORE RECOVERY FRCT	TO CORE (FT)	DEPTH (FT)	% LOG	CLASSIFICATION AND		NOTES WATER TABLE WATER LOSS ETC.
				1/8" SAMPLES	DESCRIPTION	
0.0	5.58				1.5' light gray to clay, massive, hard, thick bedded, calcite and dolomite crystals present, fissured, gets light brown on fractures, fossils and chert grains invariably present. Core as blocks and pieces.	40% Water Loss from 21-34
5.58	9.2					
9.2	10.5	10				
10.5	14.0					
14.0	24.0	20				Complete water loss at 34
24.0	34.0	30				
34.0	37.0					
37.0	41.0	40				
41.0	45.5					
45.5	51.5	50				
51.5	61.5	60				40% Water loss from 61-6" to 84-6"
61.5	66.5					
66.5	74.0	70				40% Water loss from 84-6" to 110-7"
74.0	81.2				1.5' inter bedded with host. 1.5' dirty yellowish white, slightly arenaceous, chert grain and other organic material present, micritic, brownish blue calcite crystals present, rough horizontal bedding not distinct. 1.5'-40% as respect to host which is dirty yellow in color, arenaceous, highly fissile, porous, with micritic grains.	110-7" Core in at 87-8, 104 and 5 at 107.
81.2	84.5	80				
84.5	86.5	85				40% Water loss from 110 to 118.
86.5	89.6				Shale: light gray to medium gray, purple yellowish and blue as speckled on top, laminated with no fissility at few places, chert grains abundant at 93.	
89.6	94.5	90				
94.5	96.5					

BRANCH SOLID FUELS PROJECT AREA BASHAGAT PLATEAU  
HOLE NO. 6 LOCATION Ummilla COLLAR ELEV. 111.0 ANGLE FROM VERT. 5  
BEGUN 11.11.55 FINISHED 11.11.55 DEPTH OF CMBURDEN 5 BEARING OF ANGLE-HOLE 111.0  
DEPTH OF WATER TABLE 111.0 TOTAL DEPTH OF HOLE 183 LOGGED BY N. A. R. Khat

CORE RECOVERY			DEPTH & SIZE	% LOG	CLASSIFICATION AND DESCRIPTION	NOTES WATER TABLE WATER LOSS ETC.
FROM	TO	CORE (FT)				
96.5	104.0	2.7			h-st. Almost light gray, nodular, marl in between nodules. L-st. nodules very hard and massive with calcite and chert grains present, marl about 10% bedding not distinct, core as pieces.	25% water loss from 125
104.0	107.1	1.3				
107.1	109.0	1.1				
109.0	111.0		10			100% water
111.0	116.0					loss from
116.0	118.0				h-st. inter bedded with silt-st. h-st. light dirty gray, hard and massive calcite and chert grains present, marl about 10% Gels brownish on fractures.	135 to 174
118.0	119.0		120			
119.0	125.0					
125.0	135.0		130		Silt-st. light gray, calcite, chert; fossils and small greenish specks present, core of lower bands give salt and pepper appearance. Percentage of h-st. decreases from 5% to present downward, core surface rough.	40% water loss of 174
135.0	137.5					
137.5	145.0		140			100% water
145.0	146.5				h-st. light gray, dolomitic, fractured surface brownish, core as pieces.	loss from
146.5	151.0					
151.0	154.0		150		h-st. light gray, calcite specks and veins gives salt and pepper appearance, dolomite crystals abundant; chert grains present, core as blocks.	175 to 205
154.0	156.0					
156.0	159.8		160		h-st. with Marl bands; h-st. medium gray, mostly matrix, chert calcite calcified on fractured surface Marl light gray, forms wavy bands about 3" thick, softy surfaced on bedding, chert grains, pyrite, mica and other foreign material present about 20% as whole.	
159.8	166.0					
166.0	168.0		170			
168.0	174.6				h-st. medium gray, somewhat nodu- lar, hard and massive, softy on clea- ved surface, calcite, chert grains and darkish green specks present brownish on fractures, core as hills.	
174.6	175.0					
175.0	179.6		180			
179.6	182.1					
182.1	187.0					
187.0	188.5		190			
188.5	197.5				h-st. gray to medium dark gray, hard and massive, wavy streaks, gives nodular appearance, calcite pro- -vill, core as blocks.	
197.5	198.0				h-st. medium gray, calcite, chert grains concentrated pattern, pyrite present, fossiliferous core as small blocks.	
198.0	199.6					



BRANCH Solid Fuels PROJECT AREA PIASHHARAT PLATEAU  
HOLE NO. 6 LOCATION UMRILLA COLLAR ELEV. \_\_\_\_\_ ANGLE FROM VENT. \_\_\_\_\_  
BEGUN \_\_\_\_\_ FINISHED \_\_\_\_\_ DEPTH OF OVERBURDEN \_\_\_\_\_ BEARING OF ANGLE HOLE \_\_\_\_\_  
DEPTH OF WATER TABLE \_\_\_\_\_ TOTAL DEPTH OF HOLE \_\_\_\_\_ LOGGED BY N. A. BHATTI

CORE RECOVERY FROM	TO	CORE (FT)	DEPTH & SIZE	% LCG	CLASSIFICATION AND DESCRIPTION	NOTES WATER TABLE WATER LOSS ETC.
199.6	205.0	205.0			Claystone, medium gray, calcareous, irregularly bedded, 3" thick light gray mudstone.	
205.0	210.0		210		Claystone, chocolate coloured, calcareous, pyritic particles and black particles visible, core as bit.	
210.0	220.0		220		Shale, medium dark gray, 5' on top non-fossiliferous but well fossiliferous, mica and pyritic visible.	
220.0	225.7		225.7		Sst with irregular shaly layers and streaks, sst. fine to medium grained, dirty white in colour, hard.	25% Water loss after Cementing
225.7	228.4		228.4		Shale, 45% dark gray to black, gets slightly calcareous at few places, mica and resin present, pyritic pebbles and grains present at the lower part, core as black and bit.	
228.4	231.0		231.0		Sst, fine grained, almost white, soft and loose, angular to sub rounded grains, carbonaceous and earthy streaks about 5% one earthy layer 1" thick at 231-8" and 8" thick earthy layer at 231-10."	from 205 to 210.
231.0	235.7		235.7		Sst, light gray, medium grained, angular to sub rounded grains, very coarse to small sized pebbles of quartz and pyritic grains about 1" thick on top, medium gray specks visible on core surface.	100% Water loss from 210 to 250
			240		Sst, almost light dark gray, gritty, medium grained with abundant pebbles.	
			250		Sst, medium to coarse grained, very light greenish gray, somewhat gritty with sub angular grains, bedding not distinct, core as small broken blocks.	
			260		Gritty bed with gray sst. matrix containing pink and greenish gray pebbles of granite, rhyolite and chert etc. Size of pebbles ranges from 1/4" x 1/4" to 1 1/2" x 1".	
			270		Core as small blocks and pebbles.	
			280		Claystone, medium gray with pinkish and greenish gray pebbles, arenaceous, at one place.	
			290			
			300			

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGICAL DRILL HOLE LOG

GSP-B3

BRANCH: SOLID FUELS      PROJECT: D-7    AREA: BASHARAT PLATEAU  
LOCATION: REST HOUSE      LAT: 32/46/55N      LONG: 73/06/05E  
TOTAL DEPTH: 296.00 ft      LOGGED BY: N. A. BHATTI  
DATE BEGUN:

From	To (ft)	Description
0.0 -	88.5	Limestone, pinkish grey to brownish grey, hard and compact, silty layers, fossil, calcite and chert grains invariably present, core as blocks.
88.5 -	96.5	Limestone, light brownish grey to medium grey, compact and massive, argillaceous material invariably present, salt and pepper appearance, cherty and dolomitic grains present, bedding not distinct, core almost unbroken.
96.5 -	113.0	Shale, dark greenish grey to dark grey, cleaved and laminated, somewhat friable, calcareous with few pyrite on the top, fossils rare, chert grains present.
113.0 -	115.0	Claystone and shale, yellowish brown to greenish grey, calcareous matter rarely present.
115.0 -	126.5	Limestone with marl in between, yellowish grey, gets yellowish brown on the weathered surfaces, compact but quite fractured, black places on the fractured surface visible, core in broken pieces.
126.5 -	132.0	Limestone, medium light grey to medium grey, compact, nodular at the base, arenaceous at a few places, chert grains present, core in blocks with rare bits.
132.0 -	175.0	Limestone, with siltstone, light grey to medium grey, both interbedded on the top with decreasing siltstone downward, limestone rarely fissured, dark greenish grains present in limestone, calcite visible, siltstone somewhat fissile but less than shale, core almost unbroken.
175.0 -	184.0	Siltstone, light yellowish, massive, slightly fissile, arenaceous, chert grains present at the base, 6 inch thick siltstone at 180.0, core almost broken, bits and pieces at the base.

- 184.0 - 229.0 Limestone, light grey to medium grey, nodular hard and massive, siltstone between nodules, core broken.
- 229.0 - 231.0 Limy siltstone, light medium grey, fissured at top, calcite irregularly present, gives elliptical pattern.
- 231.0 - 235.0 Calcareous siltstone, light medium grey, massive, calcite rare, core somewhat broken.
- 235.0 - 240.0 Shale, chocolate colored, slightly calcareous, part fissile, core almost unbroken.
- 240.0 - 241.0 Shale, darkish grey, core unbroken.
- 241.0 - 248.0 Limestone, medium grey with salt and pepper pattern, hard and compact, core unbroken.
- 248.0 - 263.0 Shale, dark grey to black, almost thin laminated with rare non-fissile bands 2 - 3 inches thick, silty band at base, pyrite grains scarcely present.
- 263.0 - 264.92 Sandstone, fine grained, light medium grey with grayish white irregular siliceous specks, grains and vertical streaks, calcareous matrix, pyritic specks scarcely present, bedding not distinct, core as blocks.
- 264.92-265.67 Sandstone, as immediately above with streaks of carbonaceous shale about 1/16 inch thick at 2 places.
- 265.67-269.83 Sandstone, as above (263.0 - 264.92), with shale bands of 3 to 5 inch thick, each about 1 ft apart, medium grey to dark grey, contains foreign particles, mica flakes are present, not well fissile, very slightly carbonaceous, core as blocks.
- 269.83-285.00 Shale, light medium grey to medium grey, silicious streaks with calcareous matrix present up to 278.0, pyrite specks and grains and mica flakes present, not well fissile at places, calcareous shell impressions at 284.0.
- 285.00-296.00 Claystone, light medium grey in color, pyrite specks rarely present, very slightly silicious at places, foreign grains probably quartz rarely visible, gets fissile at 295.0.

65P-B3

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGIC DRILL HOLE LOG

Page No. 1

BRANCH SOLID FUELS PROJECT D-7 AREA BASHARAT PLATEAU  
HOLE NO 3 LOCATION BEST HOUSE COLLAR ELEV. \_\_\_\_\_ ANGLE FROM VENT. \_\_\_\_\_  
BEGUN \_\_\_\_\_ FINISHED \_\_\_\_\_ DEPTH OF OVERBURDEN NIL BEARING OF ANGLE HOLE \_\_\_\_\_  
DEPTH OF WATER TABLE \_\_\_\_\_ TOTAL DEPTH OF HOLE \_\_\_\_\_ LOGGED BY N. A. Bhatt

CORE RECOVERY		DEPTH & SIZE	% LOG	CLASSIFICATION AND DESCRIPTION	WATER TABLE WATER LOSS ETC.
FROM	TO				
		(FT)			
		10		Lst. Pinkish gray to brownish gray, hard and compact, silty layers, fissile calcite and chert - grains invaria- bly present. Core as blocks.	
		20			
		30			
		40			
		50			
		60			
		70			
		80			
		90		Lst. light brownish gray to medium gray, compact and massive, argillaceous material invariably present; salt and pepper appear- ance, cherty and dolomitic grains present; bedding not distinct. Core almost unbroken.	
				Shale, dark greenish gray to dark gray, cleaved and laminated, some -	

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGIC DRILL HOLE LOG

Page 2

Page 2

BRANCH SOLID FUELS PROJECT D-7 AREA BASHARAT PLATEAU  
HOLE 3 LOCATION RENT HOUSE COLLAR ELEV ANGLE FROM VERT NIL  
BEGIN FINISHED DEPTH OF OVERBURDEN NIL BEARING OF ANGLE HOLE  
DEPTH OF WATER TABLE                      TOTAL DEPTH OF HOLE                      LOGGED BY N.A. Bhatt

CORE RECOVERY			DEPTH & SIZE	% LOG	CLASSIFICATION AND DESCRIPTION	NOTES WATER TABLE WATER LOSS, ETC.
FROM	TO	CORE (FT)				
					what friable, calcareous with few fossils on the top, fossils rare, chert grains present.	
108.5	120	11.5	110		Claystone and shale, yellowish brown to greenish gray, calcareous matter. Rarely present. L-st with marl in between, yellowish gray, yet yellowish brown on the weathered surfaces, compact but quite fractured, black patches on the fractured surface visible, core in broken pieces.	
124.0	123.0	1.0	120			
123.0	131.0	8.0	130		L-st, medium light gray to medium gray, compact, nodular at the base, arenaceous in few places; chert grains present; core in blocks with rare fossils.	
131.0	132.0	1.0	130			
132.0	137.5	5.5	140		L-st with silt-st; light gray to medium gray, both interbedded on the top with decreasing silt-st downward, L-st. rarely fissured, dark greenish gray present in L-st; calcite visible silt-st somewhat fissile but less than shale, core almost unbroken.	
137.5	147.0	9.5	150			
147.0	154.0	7.0	160			
154.0	164.0	10.0	170			
164.0	174.0	10.0	180			
174.0	184.0	10.0	182		L-st, light yellowish, massive, slightly fissile old arenaceous, chert grains present at the base, 6" wide silt-st at 180, core almost broken, bits at the base.	
184.0	190.0	6.0	190		L-st; light gray to medium gray, nodular, hard and massive, silt-st in between nodules, core broken.	
190.0	195.0	5.0	195			
195.0	199.0	4.0	200			

BRANCH SOLID FUELS PROJECT D-7 AREA BASHARAT PLATEAU  
HOLE 3 LOCATION REST HOUSE COLUMN ELEV \_\_\_\_\_ ANGLE FROM VERT NIL  
GRIND FINISHED DEPTH OF OVERBURDEN \_\_\_\_\_ MEASURING OF ANGLE HOLE  
DEPTH OF WATER TABLE \_\_\_\_\_ TOTAL DEPTH OF HOLE \_\_\_\_\_ LOGGED BY N.A. Bhatti

CORE RECOVERY FROM TO	CORE (FT)	DEPTH LUG SIZE	CLASSIFICATION AND DESCRIPTION	NOTES WATER TABLE WATER LOGS ETC.
			LUG SAMPLES	
199.0	206.5	5.0		
		210		
206.5	207.0	9.7		
217.0	219.0	2.0		
219.5	220.0	1.5		
221.0	224.0	3.0		
		230		
224.0	232.0	7.5		
		230		
232.0	237.0	7.0		
		240		
237.0	247.0	4		
		250		
247.0	257.0	5.0		
		260		
257.0	261.0	1.5		
		270		
261.0	275.0	13.75		
		280		
275.0	278.0	2.0		
		280		
278.0	285.0	5.7		
		290		
285.0	288.0	2.5		
288.0	292.0	3.5		
292.0	296.0	4.0		
			Bottom of the hole	

GEOLOGICAL SURVEY OF PAKISTAN  
GEOLOGICAL DRILL HOLE LOG

GSD PV

BRANCH: SOLID WELS      PROJECT: D-7      AREA: RASHARAT PLATEAU  
LOCATION:      LAT: 32° 18' 25N      LONG: 73° 07' 10E  
TOTAL DEPTH: 312.00 FT      LOGGED BY:  
DATE RECORDED:

From	To (FT)	Description
0.0	87.0	Dark grey and light blue stone
87.0	105.0	Shale
105.0	218.0	Medium blue stone
218.0	236.0	Shale
236.0	312.0	Shale

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Log of Drill Hole No.2 - CDH-2  
 Topo sheet - 43 D/6  
 District - Khushab  
 Lat - 32/36/0  
 Long - 72/26/45

<u>Depth</u>	<u>Core Recovery (Ft)</u>	<u>Description</u>
000.0-302.2	0	SAKESAR LIMESTONE (NO CORE)
302.2-369.9	0.	NAMMAL FORMATION (NO CORE)
369.9-376.3	0.3	Marl, greenish grey, fossiliferous.
	370.2	TOP PATALA FORMATION NAMMAL FORMATION BASE
	5.9	Shale, light grey, fossiliferous, occasional claystone lenses.
376.3-381.5	5.2	Shale, dark grey, well fissile, highly brittle, pyritic.
381.5-391.2	0.2	Shale, same as overlying unit.
	0.3	Shale, light grey, highly fossiliferous,.
	7.0	Shale, dark grey, well fissile, papery, fossiliferous, occasional clay nodules, slightly carboniferous.
	1.4	Claystone, dark grey to medium grey.
	0.9	Claystone, medium grey, calcareous, occasional carbonaceous shale stringers.
	1.5	Shale, medium grey, not well fissile, brittle, slightly calcareous, occasional pyritic grains.
	2.5	Shale, grey, fissile, very brittle, slightly, occasional pyritic replaced, fissile.
	0.3	Sandstone, dark grey, medium grained, moderately sorted, occasional carbonaceous lenses and pyritic nodules.
	0.3	Shale, grey, to dark grey, carbonaceous.
401.2-406.4	0.3	Shale, dark grey, carbonaceous, a coal

stringer grades in to siltstone at base.

	0.3	Coal, black, slightly calcareous, occasional shale stringer.
	0.3	Shale, dark grey, not fissile, pyritic.
	0.4	Claystone, dark grey, occasional pyritic nodules.
	1.4	Shale, dark grey to medium grey, occasional silt stringers.
	0.1	Claystone, brownish grey.
	2.4	Shale, dirty grey, occasional clay and pyritic nodules. ?
406.3-416-3	9.9	Shale, light grey, frequent pyritic nodules. ?
416.3-418.0	0.4	Shale, same as the overlying unit.
417.3	0.6	Lockhart Marl, light grey, fossiliferous, frequent pyritic grains.
	0.3	Shale, dark grey, calcareous,
418.0-427.3	0.3	Shale, same as overlying unit.
	0.4	Limestone, light grey, fossiliferous, frequent siltstone lenses and pyritic nodules.
	2.9	Marl, medium grey, fossiliferous, occasional pyritic grains.
	0.9	Marl, dark grey, fossiliferous.
	1.0	Limestone, light grey, fine grained, crystalize, fossiliferous, massive, vertically fractured.
427.3-437.3	0.4	Limestone, same as above, shale lenses at joints plains.
	1.3	Marl, dark, grey, fossiliferous.
	3.0	Nodular limestone, same as overlying limestone, occasional marl lenses.
437.3-447.3	9.4	Nodular Limestone, same as the overlying unit, occasional thin stringer of marl.

	0.6	Marl, dark blackish grey, fossiliferous, occasional calcite veins.
477.3-456.0	8.5	Nodular limestone, same as overlying unit.
456.0-466.2	10.2	Nodular limestone, same as overlying unit.
466.2-476.3	10.2	Nodular limestone, same as the overlying unit.
476.3-486.5	8.7	Nodular limestone, same as the overlying unit.
485.0 HANGU		TOP HANGU FORMATION - LOCKHART LIMESTONE
	1.3	Sandstone, medium grey, fine grained, moderately sorted, subangular to subrounded.
486.5-496.5	9.9	Sandstone, light grey, fine grained moderately sorted, Subrounded, occasional grey, claystone grey and pyritic calcareous,
496.5-506.9	0.4	Sandstone, light grey, medium grained, moderately sorted rounded, medium bedded, calcareous.
	3.7	Sandstone, dark grey, fine grained, moderately to well sorted, rounded, calcareous, thin bedded.
506.9-517.0	0.5	Sandstone, same as the overlying unit.
	9.5	Sandstone, light grey, coarse grained, mottled, moderately sorted, occasional pyritic grains.
517.0-527.1	0.3	Siltstone, dark grey, micaceous, thin, bedded, hard.
	5.1	Sandstone, grey, medium grained, and mottled with black irregular zones, making slightly micaceous, moderately. Sorted rounded, occasional clay stringers.
	2.4	Shale, dark grey.
	2.1	Sandstone, light grey-to dark grey, coarse grained, moderately-sorted, subrounded occasional pyritic grains.
527.1-537.3	4.5	Sandstone, same as the overlying unit.

	1.0	Siltstone, dark grey, thin bedded.
	1.5	Laterite, light grey, frequent concretions of different color, light grey, grey, whitish grey, embedded with light grey cementing material, smooth and hard.
	2.7	Laterite, light grey, frequent, colored concretions, grey, yellowish grey.
537.3-547.3	0.5	Laterite, same as the overlying unit.
	8.5	Laterite, light grey, occasional pissolites and pyritic grains.
	0.3	Shale, light brown,
	0.3	Shale, dark grey, occasional carbonaceous, stringers.
54.7.3		TOP ZALUCH GROUP.
547.3-557.6	9.7	Limestone, light grey, fine grained, fossiliferous, thin bedded.

Log of Drill Hole No.2a  
 Topo sheet - 43 D/6  
 District - Khushab  
 Lat - 32/34/55N  
 Long - 73/26/05E

<u>Depth</u>	<u>Core Recovery (Ft)</u>	<u>Description</u>
0.0-300.9	300.9	SAKESAR LIMESTONE (NO CORE)
300.9-310.0	5.3	Limestone, light grey, <u>cliff forming</u> . ?
	4.7	Limestone, same as the overlying unit.
310.9-320.9	10.0	Marl, light grey to medium grey, crystalline, fine grained, fossiliferous.
320.9-330.9	4.3	Marl, same as the overlying unit.
	5.7	Marl, light to medium grey, fossiliferous ?
330.9-337.3	0.2	Marl, similar to the overlying unit,
	0.2	Shale, grey, not fissile and fossiliferous.?
337.3-347.3	1.9	Shale, same as the overlying unit,
	8.0	Marl, light to medium grey, marl, is fossiliferous, occasional pyritic nodules.
347.3-352.6	1.3	Marl, same as the overlying unit.
	4.0	Marl, same as the overlying marl.
352.6-361.9	8.8	Marl, same as the overlying unit.
361.9-370.4	2.6	Marl, same as the overlying unit.
	1.9	Shale, grey, not well fissile, occasional pyritic nodules, fossiliferous.
	1.9	Marl, same as the overlying unit.
	4.5	Marl, same as overlying unit.
370.4-374.5	3.7	Marl, same as the overlying unit.
374.5-384.5	5.0	Marl, grey to medium grey, fossiliferous, occasional limestones the nodules, pyritic.?

# TOP PATALA FORMATION

	4.6	Shale, grey, fossiliferous, occasional pyritic nodules, grades in to marl.
384.5-394.5	5.7	Marl, light grey, fossiliferous, pyritic, grades in to shale at top.
	4.3	Shale, medium grey, and fossiliferous.
394.5-490.5	5.7	Shale, same as the overlying unit.
	1.6	Limestone, light grey, fine grained, fossiliferous, silty, thin bedded.
	0.1	Shale, grey, not well fissile.
400.5-41-.5	6.9	Color. Its upper part.
	0.2	Limestone, light grey, fossiliferous, hard, thin bedded.
	2.2	Shale, grey, and fossiliferous.
410.5-418.5	4.7	Shale, dark grey, fissile, pyritic, fossiliferous.
	2.9	Claystone, grey, fossiliferous, frequent claystone nodule, grades into marl at top.
	0.1	Shale, same as the overlying unit.
418.5-428.5	5.9	Shale, dark grey, pyritic, claystone, nodules.
	1.0	Siltstone, grey, frequent claystone and pyritic nodules.
	0.4	Coal, is black, pyritic,
	0.6	Shale, light grey, not well fissile.
428.5-437.5	0.7	Sandstone, light grey, medium grained, moderotely sorted, subrounded.
	1.4	Shale, grey, and pyritic.
	0.7	Sandstone, whitish grey, med to fine grained, moderately, sorted, subrounded, occasional carbonaceous stringers.

	4.1	Shale, light grey, and well occasional light brown clay, modules in upper part.
437.5-446.6	0.1	Claystone, sight yellowish brown, color hard, compact and pyritic.
	9.0	Shale, grey, silty at places.
	1.0	Limestone, light grey, fine nodules, hard compact and.
446.6-457.9	0.5	Limestone, same as the overlying unit.
	3.4	Marl, light greenish grey, fossiliferous.
	0.9	Limestone, light grey, and fine grained crystalize, fossiliferous.
	1.0	Marl, dark greenish grey, mottled with calcified microfossil. ?
	1.0	Limestone, same as the overlying unit.
	0.5	Marl, same as described above.
	2.6	Limestone, light grey, fossiliferous, occasional marl, lenses, nodular, bedded.
457.9-468.0	9.8	Limestone, same as the overlying unit.
468.0-476.6	8.6	Limestone, same as above overlying unit.
476.6-486.5	9.2	Limestone, same as the overlying unit.
486.5-496.6	9.9	Limestone same as the overlying unit.
496.6-506.3	9.3	Limestone, same as the overlying unit.
506.3-516.5	10.0	Limestone, same as the overlying unit.
		TOP HANGU FORMATION - BASE LOCKHART LIMESTONE.
516.5-526.3	5.8	Shale dark grey, slightly calcareous, silty, grades in to shale at base.
526.3-536.5	2.5	Shale, same as the overlying unit.
	1.9	Sandstone, greenish grey to grey, pyritic, sorted, subrounded pyritic medium bedded.
	5.4	Sandstone, light grey, medium grained,

		moderately sorted, subrounded, lightly pyritic, thin bedded.
536.5-546.6	4.7	Sandstone, same as the overlying unit.
	4.5	Sandstone, grey sandstone, coarse grained, moderately sorted, subrounded, occasional pyritic grains.
546.6-553.9	2.4	Sandstone, similar as overlying unit.
	2.9	Siltstone, dark grey, occasional clay moderate. ?
	1.0	Shale, dark grey, not well fissile, pyritic frequent pockets of organic fragments of different sizes and orange colored lateritic concentration, grades to sandstone at top.
	0.7	Claystone, is grey, hard and mottled brown-orange, dark grey color, pyritic.
553.9-556.1	2.0	Claystone, light to brownish grey, occasional pyritic nodules, hard.
556.1-566.0	0.6	Claystone, same as the overlying unit.
	6.1	Lateritic Bauxite, light to bluish-grey pissolitic, and pyritic.
	2.7	Lateritic Bauxite, dirty white, dark grey, bluish to brownish grey, pissolitic and pyritic,
	0.7	Lateritic Bauxite, same as the overlying unit. Occasional iron nodules.
566.0-573.7	1.4	Lateritic Bauxite, dirty white and mottled with brown patches of iron oxide.
	6.3	Claystone violet to dark brown, occasional modules, thin bedded.



Log of Drill Hole No.3  
 Topo sheet - 43 D/6  
 District - Khushab  
 Lat - 32/35/30N  
 Long - 72/25/45E

<u>Depth</u>	<u>Core Recovery</u>	<u>Description</u>
0.0-301		SAKESAR LIMESTONE (NO CORE)
308.1-318.3	10.2	Base Sakesar Limestone-Top Nammal Formation. Limestone, light grey to dark grey, with light brown iron staining, hard, massive, irregular streaks of marl-intercalated limestone nodules - elliptical appearance. marl along the joints common Calcite crystals, occasional forms plans.
318.3-328.3	10.0	<u>Marl</u> , light grey to dark grey, mettled with white forams light brown on fresh surface common, lamellibranches 1/2' common pyrite nodules 1/2" and pyritized forams, hard.
328.3-338.5	12.5	Marl, Shale, dark grey, light brown mottled with white forams, common, lamellibranches shell, pyrite resin, fissile, brittle at bottom.
	2.0	Marl, dark grey mottled with white forams, silty touch, pyritic, hard and horizontal joined, silica sand.
338.5-349.0	1.8	Marl, same as overlying unit.
	8.6	Limestone and claystone, 80%-20% respectively limestone, medium grey to light grey, mottled with light brown staining, hard and fine grained, crystallized into calcite crystals, common lamellibranches fossils, horizontal jointed with irregular fractures filled by calcite crystals.  Claystone, dark grey, mottled with white forams with dark brown organic materials, occasional lamellibranches shells impression, highly calcareous, frequent pyrite nodules irregularly distributed throughout in the limestone but prominent at few places as 2"-4" inches lenticular lenses, hard, few jointed.

349.0-359.0	8.4	Same as above.
	0.8	Shale, dark grey, mottled with white forams, abundant lamellibranches, staining of light brown color, pyrite, not good fissile.
	0.8	Claystone, light grey, slightly silty, hard, 3 inches long pyritic cavity filled with calcite crystals.
359.0-379.1	4.0	<u>Limestone and claystone</u> , same as overlying unit, common radiated pyrite crystals.
	0.3	<u>Claystone</u> , same as underlying unit,
369.0-379.1	4.0	<u>Claystone</u> , dark grey, mottled with white forams, highly fossiliferous, pyritic, hard and compact.
	383.1	TOP PATALA SHALES - BOTTOM NAMMAL FORMATION AT 373
	5.1	Shale, dark brown, well preserved forams light brown on fresh surface, not so much mottled with white forams as found in the previous units pyritic, not well fissile at the bottom, more brittle than the above, hard and massive, present clay nodules 1/2 inch size.
379.1-382	1.0	<u>Claystone</u> , dark grey, mottled with white forams, silica sand silty, common pyrite and calcite veins, hard and joined.
	1.6	<u>Claystone</u> , same as the overlying unit.
	1.3	<u>Shale</u> , black, shinny, micaceous, silica sand lenses present, pyritic, common resin and lamellibranchs fossils impressions 1/2" nodules clay and pyrite nodules.
	9.0	<u>Shale</u> same as the overlying unit, but well fissile.
	1.2	<u>Shale</u> , grey, mottled with white forams, common lamellibranch shell impressions, not well fissile, compact.
392.3-397.9	0.5	<u>Shale</u> , same as above, grades into. Sandstone.
	2.0	<u>Sandstone</u> , light grey, fine grained, rounded, mottled with white forams, pyritic nodules 1/2 inch present occasional calcite vein along

- horizontal joints, no bedding hard.
- 1.1 Shale, dark grey, mottled with white forams, pyritic, silty, not well fissile.
- 1.1 Shale, black brittle, well fissile, unfossiliferous.
- 397.9-407.7 1.0 Shale, dark grey, compact, not have good cleavage, unfossiliferous slightly pyritic.
- 0.6 Shale, dark grey, mottled with white forams on the surface, forams abundant, compact, not food fissile.
- 2.7 Shale, dark grey, compact, very poorly occasional pyrite nodules 1/2" forams.
- 3.0 Shale, black, hard, not well fissile, fossiliferous.
- 0.7 Shale, black, mottled with forams, white on the core surface, brown inside the core, pyritic.
- 1.7 Shale, dark grey, compact, poorly fissile, pyrite, frequent nodules pyritic, fossils impression.
- 407.7-417.9 3.8 Shale, dark grey, compact, not well fissile, pyritic, few forams are present,
- 2.1 Sandstone, medium grey to dark grey, mottled with lamellibranches shells, hard claystone light brown 1/2 inch lenticular interbedded, occasional pyrite nodules 1/4 to 1/2" Calcareous material mottled on the surface in white color, with irregularly intercalation with dark grey shale.
- 4.1 Shale, dark grey, hard, compact, not well fissile, pyritic, occasional brown clay nodules, lamellibranchs.
- 417.9-427.0 1.8 Coal streaks with shale bands.
- 2.0 Shale, dark grey, mottled with silica sand grains, common pyritic nodules and veins, soapy touch, not carbonaceous, two very thin coal streaks.
- 1.5 Carbonaceous shales, brownish mottled with 5

coal streaks 1/32" - shining and lenticular, hard and compact smooth touch at the joints plan, frequent pyrite nodules 1/2 to 1/4".

- 1.0      Carbonaceous shales, same as overlying zone occasional coal streaks ranging 1/10" to 1/8" of an inch with very little silica, sand coal, jet black, shiny, lenticular.
- 0.5      Carbonaceous-shale, same as above with 3 coal streaks 1/8 to 1/10 an inch thickness.
- 1.5      Carbonaceous Shale, same as overlying shales.
- 0.5      Carbonaceous Shale, black with three coal streaks 2/10" 1/10", 1/10", of an inch respectively in thickness.
- 1.5      Carbonaceous Shale, black frequent with 1/4" 1/10" shiny coal streaks.
- 0.5      Carbonaceous Shale, brownish black 1/0 1/32: two coal streaks, very thin coal streaks intercalated in haphazard way.
- 4.0      Carbonaceous shale, dark grey, two coal streaks 1/10 size thick, pyrite in traces, more shaley, smooth touch, poorly carbonaceous.
- 1.0      Shale, dark grey, hard, not well fissile, occasional pyrite 1-32" nodules, slightly carbonaceous.
- 0.7      Shale, dark grey, hard, grades into sandstone light grey medium grained, angular to sub-angular grains, shale intercalated with sandstone more sandy at the bottom.
- 2.0      Sandstone, light grey mottled with black irregular layers of shales and coaly layers more concentrated at near the bottom, pyrite nodules 1/2" are abundant.
- 0.2      Coal streaks with sandstone at contact thin layers of blackish grey shale mottled with silica sand, medium grained, light grey.

Sandstone, medium grained, rounded to subrounded grains, light grey to blackish grey, mottled with carbonaceous shale and very thin coal streaks common pyrite modules 1/10"

resin, lower wavy contact.

Coal, jet black, shiny, good cleavage, mottled with silica sand grains, light grey elliptical shape, pyrite nodule of (3"-1/2") size.

Carb shales, brownish grey common nodules.

- 427.0-437.0
- 4.5      Shale, dark grey, mottled with clay nodules, pyritic, two horizontal lenticular streaks present, hard, compact and carbonaceous, bottom shale soft and brittle.
- 0.3      Shale, same as overlying unit but frequent pyrite.
- 0.3      Shale, brownish, grey, very hard, compact, not fissile, contact plain of kidney structure, vertical fracture filled by pyrite, slightly calcareous.
- 0.3      Shale, dark brown, not well fissile, hard slightly carbonaceous, brown organic material with fossils fragments are present.
- 0.3      Shale, dark brown, fissile, mottled with free silica white on the surface are present.
- 0.3      Shale, dark brown, fissile, mottled with silica white on the surface, pyrite.
- 2.0      Shale, dark grey, with free silica, not mottled on the surface, replaced fossil and organic material by silica making rings 1/16" black organic material, more silty and pyritic.
- 0.9      Sandstone, grey, fine grained, intercalated, with dark grey shales, pyritic, hard,
- 5.9      Shales, dark grey, mottled with minute dark known organic fragments, common pyrite grains are grades into claystone-light brown, at the bottom, frequent pyritic grains.
- 437.0-445.9
- 2.3      Claystone, dark grey, mottled with light whitish grey, silica, sand fine grained, slightly micaceous, occasional few pyrite, medium hard and compact.
- 1.0      Claystone, dark grey pyritic, minute black organic fragments with few non-calcareous

materials, slightly micaceous and silty,  
medium hard and compact.

- 1.3      Claystone, dark grey, with black organic material, slightly calcareous and pyritic, medium hard.

Transitional zone.

441.6      PATALA BASE      -      LOCKHART LIMESTONE

- 3.2      Claystone, dark grey, mottled with white calcareous material, forams present not abundant, black organic material present, silty medium hard.

445.9-454.9

- 1.3      Claystone, same as the overlying unit.

Contact of LOCKHART LIMESTONE starts  
447.2 ft. Base of the Patala Formation -447.2

- 1.3      Limestone, light grey, to dark grey, black minute grains of organic material present, hard and massive, no bedding, calcite filling through irregular fractures. few forams present.

- 5.5      Claystone, dark grey mottled with calcareous light grey material with pyrite nodules 1/2" diameter, light brown fossils and organic material present, lamellibranchs shell impression prominent, horizontal jointed, slightly silty.

- 0.7      Limestone, light grey, hard and massive light brown staining common, lamellibranchs fossils present.

454.9-465.0

- 1.4      Limestone, light grey, with light brown crystallized forams, massive and hard, subhorizontal jointed, along the joints plain dark grey calcareous claystone present.

- 1.0      Claystone, dark grey, mottled with white forams, light brown inside the core surface, hard, horizontal jointed, slightly silty.

- 6.6      Limestone, light grey, brown crystallized forams scattered on the core surface, hard and massive, claystone, dark grey, mottled with

white forams on the core surface, but light brown inside it, highly calcareous and slightly irregularly intermingled with limestone, but more prominent along the joints plain in lenticular thin lens, nodular,

465.0-475.1	2.5	<u>Limestone</u> , same as overlying unit.
	1.0	<u>Claystone</u> , dark grey, mottled with white forams on the surface, highly fossiliferous and calcareous, medium hard, lamellibranch and light brown forams common horizontal jointed.
	6.3	<u>Limestone</u> , (same as above limestone) but more prominent claystone along the subhorizontal joints planes, calcite crystals common along the joint plains.
475.1-485.3	9.9	<u>Limestone</u> (same as the overlying unit) vertical fractured, more crystallized along the plains.
485.3-495.3	9.0	<u>Limestone</u> , (same as overlying unit)
495.3-505.4	10.1	<u>Limestone</u> , (same as overlying unit)
505.5-525.5	9.3	6.9 limestone (same as overlying unit) -----

#### BASE LOCKHART

#### 522.4 FT CONTACT TOP - HANGU FORMATION

	2.4	<u>Siltstone</u> , dark grey, slightly mottled with white calcareous material, common very fine grains of pyrite, slightly micaceous, hard compact and horizontal jointed.
525.5-537.7	10.2	<u>Siltstone</u> , (same as overlying unit) at the bottom of the core is broken.
535.7-545.7	8.9	<u>Sandstone</u> , grey fine grained, few big quartz subangular grains 1/32" of an inch and pink feldspar grains present slightly micaceous and calcareous, hard and jointed.
545.7-555.3	9.32.7	<u>Sandstone</u> , (same as the overlying unit) fine to medium grained.
	6.6	<u>Sandstone</u> , dark grey, fine grained, mottled with white silica sand grains, slightly

micaceous, hard horizontal jointed broken core.

- 1.5      Siltstone, dark grey, mottled with white free silica, slightly micaceous, 1/4" pyrite nodule present, free quartz, medium grained rounded grains with light brown organic material.
- 3.0      Bauxite, light grey, 1/4" of an inch diameter pisolite of bauxite more dark grey than the cementing material, 40% the volume occupied by the pisolites, core of the pisolite replaced by iron oxide, the cementing material claystone very hard and massive, the core of pisolite also occupied by pyrite, a thin film of chitinous material layered on the cementing material, horizontal jointed.
- 3.3      Bauxite, light brown, pisolites ranging 1/8 to 1/4 of an inch in diameter occupied the 30 to 40% of the total area, partially all the core of pisolites replaced by iron oxide and chitinous material, the cementing material greenish grey.
- 0.9      Bauxite, pisolites dark brown to light brown, 1/16 to 1/8 of an inch in diameter. 75% of the pisolites almost oxidized into iron oxides the cementing material silty, brown partially mottled with chitinous material, hard and massive no bedding.
- 565.3-575.3      1.6      Bauxite, (same as the overlying unit) at the bottom more mottled with white soapy material which zoned in the pisolites.
- 1.3      Bauxite 3 to 5% pisolites present, completely altered to white material some of light brown in color, the cementing material (brown) siltstone black grains, the bottom more lateritic.
- 5.4      Claystone, dark brown and violet with light greenish grey siltstone, original material later altered to this hematitic claystone, thin bedded, hard,
- 0.9      Claystone, Violet brown, with frequent yellowish brown specks, good parting making places 2 to 4 inches soapy touch at parting plain medium hard, no bedding.



575.3-582.6	3.8	<u>Claystone</u> , (same as the overlying unit)
	1.7	<u>Claystone</u> , dark brown, highly micaceous, soapy touch, brittle, not bedding, medium hard.
		----- Base of Hangu Formation to Zaluch Group -----
	1.3	<u>Claystone</u> , same as the overlying unit, two 2"-4" of an inch limestone, lenses, light grey, fine grained, hard, slightly micaceous, along it plain (contact) light greenish grey in color, brittle, no bedding.
582.6-588.4	1.3	<u>Limestone</u> , light grey, mottled with brownish and greenish color, fine grained, hard and compact embedded in claystone, dark brown, micaceous, brittle, and soft.
	0.7	<u>Claystone</u> , dark brown, soft micaceous, soapy touch, no bedding, silty.
		----- TOP ZALUCH (584.6) CONTACT -----
	3.6	<u>Limestone</u> , pink mottled with white specks, fine grained crystalline, fractured, broken core, clay thin band along the joint planes.
590.4-595.0	4	<u>Limestone</u> , pinkish brown, with white and dark brown specks, dense, fine grained, calcite crystals, subhorizontal jointed with vertical joints, thin bedded, long the joints plains claystone-dark brown mottled with irregular calcite streaks, white crystalline material, fossiliferous, broken core.

Log of Drill Hole No.4 - CDH-4  
 Topo sheet - 43 D/6  
 District - Khushab  
 Lat - 32/34/45 N  
 Long - 72/23/25 E

Depth	Core Recovery Ft	Description
0.00-340.0	0	SAKESAR LIMESTONE (NO CORE)
340.0-360.0	0	TOP NAMMAL FORMATION - SAKESAR BASE (NO CORE)
360.9-371.0	1.3	Limestone, dark grey fine grained, fossiliferous, medium bedded, hard and massive, occasional marl lenses cliff forming.
	7.7	Marl, dark grey, fossiliferous, pyritic,
	369.9	TOP PATALA FORMATION - NAMMAL FORMATION BASE
	1.0	<u>Shale</u> , grey, not well fissile, fossiliferous pyritic.
371.0-381.2	0.4	<u>Claystone</u> , grey, fossiliferous, pyritic.
	3.7	<u>Shale</u> , grey, not well fissile, fossiliferous, occasional organic resin.
	4.1	<u>Claystone</u> , grey, fossiliferous, pyritic hard.
	0.9	<u>Shale</u> , dark grey, not well fissile, occasional fossil.
381.2-391.1	7.5	<u>Shale</u> , grey, not well fissile, occasional fossils pyritic.
	2.4	<u>Claystone</u> , grey, calcareous, fossiliferous, frequent calcite veins silty, thin bedded.
391.1-396.3	0.5	<u>Claystone</u> , same as the overlying unit.
	1.3	<u>Marl</u> , grey, fossiliferous, silty, thin bedded hard.
	3.2	<u>Shale</u> , grey, not well fissile, occasional fossils pyritic.
396.3-398.3	2.1	<u>Shale</u> , same as the overlying unit.
398.5-404.3	0.1	<u>Claystone</u> , light grey, fossiliferous, hard and

		massive, pyritic hard.
	0.3	<u>Shale</u> , grey, hard, not well fissile, occasional fossils.
	0.3	<u>Shale</u> , grey, fossiliferous.
	3.1	<u>Shale</u> , dark grey, occasional pyritic coated forams nodules.
404.3-410.3	1.3	<u>Shale</u> , same as the overlying unit.
	0.9	<u>Claystone</u> , light grey, calcareous, fossiliferous, slightly silty and hard.
	2.6	<u>Claystone</u> , light grey, fossiliferous, frequent clay and pyritic nodules.
	1.2	<u>Shale</u> , dark grey, not well fissile, brittle, occasional pyritic grain.
410.3-418.3	5.6	<u>Shale</u> , dark grey, not well fissile, occasional pyritic grains.
	2.4	<u>Sandstone</u> , light grey, medium grained, moderately sorted, subrounded.
418.3-424.5	0.1	<u>Sandstone</u> , same as the overlying unit.
	0.3	<u>Shale</u> , grey, not well fissile, occasional calcareous lenses.
	0.3	<u>Claystone</u> , light grey, light brown, hard and massive.
	0.4	<u>Shale</u> , grey, not well fissile, occasional clay stone lenses.
	5.0	<u>Shale</u> , brownish black, brittle, at the occasional pyritic graining grades.
442.5-427.1	2.0	<u>Shale</u> , same as the overlying unit.
		0.3-0.7 inch Coal stringer, occasional pyritic nodules.
	0.3	<u>Claystone</u> , grey, calcareous, carbonaceous top. occasional clay and pyritic nodules.
427.1-436.3	4.0	<u>Shale</u> , light grey, not will fissile, occasional pyritic grains.

	5.2	<u>Claystone</u> , light grey, occasional shale, lenses.			
436.3-440.0	1.0	<u>Shale</u> , dark grey, not well fissile, occasional resin.			
	0.7	<u>Shale</u> , same as the overlying unit, calcareous.			
438		TOP LOCKHART LIMESTONE PATALA FORMATION BASE.			
	1.5	<u>Marl</u> , grey, grades to limestone in lower part.			
	0.1	<u>Shale</u> , dark grey, not well fissile, occasional pyritic coated fossils.			
440.0-450.0	1.3	<u>Shale</u> , same as the overlying unit, frequent fossils fragments.			
	0.3	<u>Claystone</u> , grey, calcareous, silty.			
	0.9	<u>Limestone</u> , light grey, fine grained hard and lenses, occasional clay lenses and black graining.			
	1.1	<u>Shale</u> , grey, fossiliferous.			
	0.6	<u>Shale</u> , dark grey, calcareous, not well fissile.			
	2.0	<u>Limestone</u> , light grey, crystallized, fine grained occasional thin calcite veins and pyritic grains.			
	1.0	<u>Nodular Limestone</u> , light grey to dark grey, fine grained medium bedded.			
	1.3	<u>Claystone</u> , grey, calcareous, frequent fossils impressions.			
	1.0	<u>Nodular limestone</u> , same as above			
450.0-460.1	9.4	<u>Nodular Limestone</u> , same as the overlying unit			
460.1-470.3	9.6	<u>Nodular Limestone</u> "       "       "			
470.3-480.4	9.3	<u>Nodular Limestone</u> "       "       "			
480.4-484.9	4.3	<u>Nodular Limestone</u> "       "       "			
484.9-495.5	10.1	<u>Nodular Limestone</u> "       "       "			

495.0-505.0	10.1	<u>Nodular Limestone</u> "       "       "
495.9		TOP HANGU FORMATION - LOCKHART BASE
	3.3	<u>Siltstone</u> , greenish grey, occasional pyritic grains, thin bedded, hard.
305.3-513.5	7.2	<u>Siltstone</u> , same as the overlying unit, slightly micaceous.
	1.0	<u>Bauxite</u> , dark greenish, gray, frequent pissolites and pyrite nodules, hard and massive.
513.5-521.3	3.6	<u>Laterite</u> , greenish grey, brown light brown, light brown, light gray concretions occasional pyrite and pissolites.
		HANGU FORMATION BASE
	4.1	<u>Claystone</u> , brown, micaceous, soft massive grades at the bottom, 4,3, at the base.
521.3-525.5	3.2	<u>Claystone</u> , same as the overlying unit.
526.5		ZALUCH GROUP TOP
	1.0	Limestone, very light grey, hard fine grained, this bedded cliff forming.

Log of Drill Hole No.5  
 Topo sheet - 43 D/6  
 District - Khushab  
 Lat - 32/35/15N  
 Long - 72/22/35E

Depth	Core Recovery (ft)	Description
0.5	00	No core (Eroded top of Sakesar Limestone)
5-11.4	5.6	<u>Limestone</u> , light brownish grey and light grey lenticular, grained, forams 1/16" diameter common but not abundant, bedding visible, rock jointed, with vertical and horizontal fractures, weathered to yellow, chalky, some calcite veins, generally vertical and rock porosity is confined to the numerous joints, 7" inches longest core.
11.4-14.4	2.0	<u>Limestone</u> , light grey with brownish tingle- light grey chert nodules of diameter 1/2" forams abundant as big as 1/8" diameter, sub-horizontal calcite filled marking original bedding, jointed, 5 inches longest core.
14.4-16.5	2.1	<u>Limestone</u> , same as above jointed 5 inches longest core.
16.5-19.3	2.6	<u>Limestone</u> , light grey with light brownish tingle, white irregular patches of light grey chert, many irregular fractures filled by calcite, abundant forams, 8 inches longest core.
19.3-23.9	4.3	<u>Limestone</u> , light grey, dense, fine grained, forams abundant, rock jointed, with irregular fractures, weather to light yellow. No chert nodules 11 ft longest core.
23.9-30.2	6.1	<u>Limestone</u> , light grey, dense, fine grained, forams 1/8" size abundant. (Rock sub-horizontal jointed), clay bands between joint plain, irregular fractures, calcite fillings.
30.2-34.8	4.4	<u>Limestone</u> , light grey, fine grained, dense forams less than 1/8" size abundant, rock horizontal-subhorizontal jointed, clay bands plain irregular fractures, particularly filled calcite.

34.8-41.0	6.0	<u>Limestone</u> , light grey with brownish tinge, dense and fine grained, forams abundant, sub-horizontal, jointed, joint plain weathered to light yellow, no chert nodules present.
41.0-48.3	7.0	<u>Limestone</u> , light grey with brownish tingle, dense fine grained, forams (crystallized) abundant, rock jointed with distinct irregular fracture - partially filled by calcite, weathered to chalky porous limestone.
48.3-58.3	9.9	<u>Limestone</u> , light grey dense and fine grained, rock jointed: the clay bands of light green, color between joint plain irregular fractures filled with calcite, highly fossiliferous (forams).
58.3-67.3	9.0	<u>Limestone</u> , medium grey with light brown tinge, dense, fine grained, forams 1/8" and greater than 1/8" abundant, rock irregularly fractured - light brown, its plain weathered to chalky limestone, 23" largest core.
67.3-77.3	9.8	<u>Limestone</u> , medium grey, dense and fine grained, fossil longer than 0.6" abundant, sub-horizontal jointed with vertical fracture filled by calcite, calcite irregular cavities common, rock weathered to chalky marl, full of fossils, 23" largest core.
77.3-87.3	8.0	<u>Limestone</u> , medium grey, dense, fine-grained, forams less than 1/8" abundant, porous and chalky with brownish tinge at the joint plain, irregular fractures without calcite crystals, 23" largest core.
87.3-97.5	10.0	<u>Limestone</u> , medium grey, dense and fine grained, Sub-horizontal jointed, the joint plain weathered to porous and chalky limestone with brownish tinge, fossil less than 1/8" common, rough small cavities common on the core surface, 26" the largest core, silty layers common.
	7.5	<u>Limestone</u> , is as above. <u>Limestone</u> , medium grey to grey with brownish tinge at the joints, highly fossiliferous, fossil looks white, dense, weathered to clayey and porous limestone.

Claystone, dark grey to light grey, mottled

with iron oxide, highly fossiliferous, fossils are more than the clay - look brown inside the core, looks white on core surface.

105.3-108.4

3.1

Claystone, medium grey to dirty white with tinge of iron oxide, porous and soft, highly fossiliferous, fossils more than clay, highly calcareous.

Limestone, light grey with tinge of iron oxide, highly fossiliferous, hard and dense.

Claystone, dark grey, highly fossiliferous,

Limestone, medium grey with tinge of iron oxide, fossiliferous, dense.

Claystone, dark grey, calcareous, highly fossiliferous and compact.

108.4-116.0

6.7

Claystone, medium grey, fossils light brown, calcareous material white on core surface, fossils abundant, highly calcareous, pyrite present, compact and hard.

0.3

Shales, grey calcareous, with pyrite grains, fossils not abundant.

0.5

Claystone, medium grey to light grey with light brown streaks of iron oxide, fossils brownish grey common, pyritic.

0.1

Shales, dark grey, fossils lighter in color, brown and reddish brown minute specks present, pyritic.

1.3

Claystone, medium grey with yellowish brown tinge, fossils abundant and of darker color, flashing minute grains of calcite, silty touch, 4" of an inch largest fossil.

0.5

Shales, dark grey to light grey weathered to brownish yellow, forams abundant.

1.4

Limestone, medium grey to light tinge with iron oxide forams abundant mostly crystallized, darker color, fractured, dense and fine grained.

0.2

Claystone, yellow brownish grey with purple tinge, weathered, forams abundant.



	1.7	<u>Limestone</u> , same as (1.4).
111.6-128.0	6.2	<u>Limestone</u> , light grey to white grey mottled with yellow and brownish yellow color, forams less than 1/8" abundant, vertically fractured weathered to clayey and chalky materials, lamellibranches fossil shells (1/2") present, porous.
	3.8	<u>Limestone</u> , light grey to white grey, with yellow tinge, weathered to clayey chalky limestone, slightly porous, forams, slightly darker than the limestone color abundant, vertically fractured core, 8" the largest core.
128.0-137.2	9.1	<u>Limestone</u> , light grey, with yellowish tinge, weathered to chalky white, slightly porous, forams less than 1/8" abundant, gastropods 1/2" fossil present, sub-horizontally jointed with irregular fractures with calcite filling, the 15" largest core.
137.2-141.3	3.2	<u>Limestone</u> , medium grey to light grey; prominent 1/10" calcite vertical veins common, forams common but not abundant, 2"-4" long gastropods fossils present, calcite crystals crystallized in small cavities of limestone, weathered to chalky limestone with yellowish brown tinge.
141.3-146.6	4.9	<u>Limestone</u> , medium grey, weathered to chalky limestone with brownish tinge black specks, fossils abundant, irregularly fractured, porous at joints plain, calcite crystals present at fracture plain.
	9.5	<u>Limestone</u> , medium grey to light grey brownish staining at the joints planes, weathered to chalky and slightly porous limestone, forams abundant, little darker but not so distinct on core surface, horizontal 1/8" calcite veins common.
156.5-161.5	4.5	<u>Limestone</u> , medium grey to light grey weathered to chalky limestone, yellowish brown at sub-horizontal joints, black specks surrounded by iron oxide common, forams present.
171.5-181.5	9.5	<u>Limestone</u> , light grey, weathered to chalky and dirty grey, forams less than 1/8" common, yellowish brown clay bands in the joint plain,

18" the largest core.

181.5-188.9	6.9	<u>Limestone</u> , medium grey to light grey, with brownish yellow iron staining weathered to chalky, dense and fine grained, brownish yellow at the joints plain, forams less than 1/8" common, 13" largest core.
188.9-198.5	9.0	<u>Limestone</u> , medium grey to light grey, weathered to chalky dense and fine grained, brownish yellow at joint plain, irregular fractured particularly filled by calcite, forams, slightly darker,
198.5-208.5	9.1	<u>Limestone</u> , medium grey to light grey weathered to clayey, yellowish white at joints plains, calcite vein abundant in fractures, forams common, 10" largest core.
208.5-218.5	9.6	<u>Limestone</u> , medium grey to light grey, weathered to chalky brown, forams 1/8" distinction not abundant calcite filling thought irregular cracks common.
218.5-225.1	5.9	<u>Limestone</u> , medium grey to light grey weathered to chalky with light brown staining, slightly porous and clayey, calcite crystals common, on fresh broken core given distinct cross sections of Nummulities, calcite fillings throughout irregular fracture, 5" the largest core.
225.1-232.4	7.0	<u>Limestone</u> , (same as above)
232.4-241.1	1.3	<u>Limestone</u> , (same as above)broken recovery, largest core.
	7.3	<u>Limestone</u> , grey to medium grey with yellow tinge, forams and Brachiopods 1/2" common and distinct, limestone grades into dark claystone (calcareous), 12" largest core.
241.2-250.0	0.1	<u>Marl</u> , dark grey, very fossiliferous with more than 50% forams, platy cleavage dip 5.
	8.1	<u>Limestone</u> , light grey, clayey, very fossiliferous with 30 or 40 percent, light grey forams less than 1/8 inch wide, the core evenly broken into 6 inch blocks by dark grey shale parting as much as 30 degrees, randomly oriented suggesting this a nodular, limestone of 6 inch nodules.

250.0-254.0	0.3	<u>Shale</u> , grey, pyritic plant lenses on bedding.
	0.4	<u>Limestone</u> , light grey, nodular, boundaries.
	0.3	<u>Shale</u> , grey, fissile, abundant tinge fossil <u>Shale</u> , and plant leaves both brown and black, on bedding.
	1.1	<u>Limestone</u> , light grey, clayey, dense, fine grained, lenticular, with irregular boundaries, no bedding, rock fracture in any direction, very sparse tinge fossil shell.
	1.1	<u>Shale</u> , grey with green tinge, very fissile, abundant fossil forams (?) brown and black plant fossil leaves on bedding.
	0.2	<u>Limestone</u> , light grey clayey, dense, fine grained, contain lineal brown marking, randomly oriented fossil plants, a nodule with irregular boundaries.
254.4-258.8	4.0	<u>Limestone and shale</u> , exactly like overlying run: light grey limestone with grey shale intercalation, the bedding curving around the limestone. The shale has abundant brown (resin) plants, some black (coaly), as well as abundant forams (?), limestone lenses becomes 50% forams (?) at base.
258.8-264.8	1.5	<u>Limestone Coquina</u> , light grey marly layers inclined between light lenses or nodules, plant fossil in marly layers, forams common to abundant.
		<u>Limestone. Coquina</u> , Light grey nearly 100% tests of forams, well sized, about 1/20 inch diameter, jointed, but otherwise rather non porous.
	2.4	<u>Limestone</u> , light grey to grey, with grey marly layers inclined between light grey lenses or nodules, some plant fossils in marly layers, forams common to abundant.
	1.2	<u>Limestone</u> , or marl stone, grey, very clayey, numerous white forams, light grey fossil distributed in sub-horizontal bedding plain.
	0.1	<u>Claystone</u> , grey, very limy, bedded abundant

fossil forams.

264.8-266.8	1.5	<u>Limestone</u> , light grey and grey abundant forams, poor bedding, clayey, core is in places.
266.8-276.8	0.8	<u>Limestone</u> , light grey fine grained, dense, irregular vertical joints, wavy, discontinuous paring of hair-thickness.
	4.8	<u>Sandstone and Limestone</u> , dark grey, very fine, sandstone (50%) irregularly inter-layered with light grey dense limestone, sandstone, clayey, fissile, and silt size toward the base, abundant white calcareous forams (1/8 inch) speckled appearance, the limestone, foraminiferal, very wavy boundaries, 16 alternation, bed, thickness averages 0.3 ft.
	1.0	<u>Limestone</u> , light grey, with a fair irregular layers of grey clayey laminated siltstone, dense and contains white forams 1/8 inch diameter.
		(Resistant, Massive Phase of Sakesar resumes below.
	3.3	<u>Limestone</u> , light grey, fine grained, dense, speckled throughout with 20% 1/8 inch forams lighter in color than rock, very few sub-horizontal silty partings.
276.8-383.2	6.2	<u>Limestone</u> , very light grey, nearly a coquina with more than 50% 1/8 inch forams, unbedded, appears weathered, inter-granular porosity, joint along which yellow clayey material,.
283.2-292.3	8.8	<u>Limestone</u> , nearly white, hard, but rotten weathered to chalky appearance, jointed and largest core one foot, clear calcite filling in vertical fractures, porous and absorbs water quickly, forams present, but not abundant, cliff forming, medium bedded.
292.3-309.3	9.3	<u>Limestone</u> , nearly white, porous, chalky, mostly badly fractured through one place 2 feet long, calcite-filled fractures, fossils abundant, but poorly preserved, and the forams, very small, no bedding orange stain on some joints.
302.3-309.3	5.7	<u>Limestone</u> , white chalky, porous, numerous, fine joints stained with little iron oxide,

fossils abundant, 6 inches longest core.

309.3-316.5	6.6	<u>Limestone</u> , white, chalky, harder than overlying limestone: core lengths greater than 6 inches, a little iron oxide along joint plain, fossiliferous.
316.5_320.5	10.2	<u>Limestone</u> , white abundant iron oxide staining in fracture throughout, fossiliferous fairly hard, but porous: weathered appearance, no size of bedding except for irregular iron stained sub-horizontal fractures, 1 foot core length average.
326.5_336.5	9.7	<u>Limestone</u> , nearly white, chalky, numerous iron stained joints, some irregular iron stained parting, forams abundant 1/32" diameter, bottom 2 feet wavy silty parting, contact with underlying very irregular and sharp. ..... Base Sakesar Limestone top Nammal Formation at 333.8 .....
	2.7	<u>Claystone and Limestone</u> , dark grey, sandy pyritic, fossiliferous claystone (55%) and light grey fossiliferous limestone, numerous finely layered but contain nodules of limestone around which the layering curves. The claystone contains fossils shale (clams ?) flattened on bedding plains, the same numerous white spots may be recrystallized forams, pyritic in 1/16 inch crystals.
336.5_346.5	1.0	<u>Limestone</u> , very light grey mottled with brownish iron oxide, wavy layers of dark grey clay, separated from underlying bed, iron staining at the base.
	8.1	<u>Limestone (Marl ?) and claystone</u> , very light grey clayey limestone (70%) in wavy layers and nodules as thick as 1 ft dark grey wavy laminated claystone with layers curling around the limestone nodules, medium, rounded, frosted sand grains, chitinous fossil or oolites of that size, pyrite crystal common.
	0.3	<u>Claystone</u> , dark grey, fissile, pyritic, flattened fossils on horizontal bedding.
346.5_356.5	0.3	<u>Claystone</u> , dark grey, fissile, with few quartz

crystals, pyritic horizontal bedding, fossils on bedding plain include megafossils and tiny ostracod (?), calcareous.

- 9.7      Limestone and claystone, alternations, verging 0.3 ft. of light grey limestone and dark grey claystone, to each other, typical marl, beds dip randomly as steeply as 20 degrees nodular marl, pyritic and fossiliferous; numerous white calcite filled tests about 1/16" recrystallized forams, or calcite filled phosphatic ostracods, considerable brown fossil material, in bottom 3 ft., the claystone abundant shiny resemble siltstone, no quartz the clay, crystals, mica or calcite.
- 356.5-366.5      10.0      Limestone, grey, clayey and dark grey claystone, similar to last unit: a nodular marl with clayey limestone, lenses or nodules separated by dark grey claystone, very irregular bedded dense, fine grained but visibly crystalline, little recognizable fissile material, calcite filled vertical fractures common, porosity claystone crystalize, contains abundant throughout, some nodules of 2" diameter with a finely crystalline radial structure.
- 366.5-373.9      7.1      Limestone and claystone, lenticularly interbedded, grey, fine grained, very dense and hard limestone nodules and pods separated by dark grey very calcareous hard claystone, core breaks at angles of as much as 50% along the steeply dipping claystone bedding, lime nodules probably average between 6 to 12 inches diameter, claystone microfossils.
- 373.9-383.5      2.6      Limestone and claystone, like overlying unit, a nodular marl.
- 1.2      Shale, dark grey fissile, quartz free, large pyritic crystals (1/8 inch), little fossil along bedding.
- 2.8      Claystone, light medium grey, very silty, very poorly bedded, homogenous, a single pieces of core.
- 2.4      Limestone and claystone, grey, hard, dense, fine grained pyritic limestone nodules 6 to 12 inches in diameter separated by 10% dark grey claystone layers dipping as much as 50%.

383.5-393.2            4.4        Limestone and claystone, fine grained, hard, dense, grey limestone (70%) in nodules or lenses 1 ft, thick, limestone pyrite, poorly preserved fossils and, shale layers dip randomly claystone, dark grey, silty, layered, microfossils.

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Top Patala Formation ? The following appears to be transition zone form marl to shale, but since shale predominates, it probably belongs to Patala/at 387.8 depth. Nammal formation thickness = 54".  
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0.6        Claystone, grey with slightly greenish coat, platy cleavage, but not fissile, abundant microfossil (white), contact above sharp but regular, contact below gradational, sugary recrystallized texture.

0.4        Claystone, grey, calcareous, core flecked by white fossil material, contains numerous 1 m fossil shells of phosphatic or chitinous material, poorly developed layering that tends to dip at low angles, quartz free, fine waxy appearance, some places recrystallized texture.

0.5        Claystone, dark medium grey, platy cleavage, very fossiliferous, contains a little pyrite.

0.5        Limestone, grey, very clayey: a marl that grades into overlying unit, pyrite crystals as large as 1/8 inch abundant, poorly bedded dense, hard.

393.2-402.3            2.9        Limestone, and claystone, grey dense clayey limestone lenses grading into quartz free dark grey claystone, unit flecked throughout by white lens-like fossils 1/8 inch long, layering poorly developed and tends to dip at low angles from horizontal.

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396.1        BOTTOM NAMMAL FORMATION "TRANSITIONAL ZONE"  
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5.8        Claystone, dark grey, fissile, quartz free,

forams disk-like with radial markings along bedding, very nearly a shale, pyrite brittle and tends to crumble though it makes good core, sides of the core lower half speckled with 1/16" long white spots disk shaped coiled forams about 3/32" diameter well preserved, mostly but not wholly lying flat on the bedding.

402.3-406.1	0.9	<u>Claystone</u> , dark grey, platy, brittle, quartz free, pyritic, abundant translucent forams.
	2.9	<u>Claystone</u> , dark grey mottled with 20% white calcareous patches, poorly bedded, numerous forams somewhat randomly oriented, pyritic, white limy patches irregular but tend to lengthened horizontally.
406.1-416.1	1.7	<u>Claystone</u> , dark medium grey mottled by white fossil material, quartz free sugary appearance due to recrystallized calcite or clay, good solid core one length.
	3.5	<u>Claystone</u> , dark grey, fissile, brittle, no fossil specks on side of core, quartz free pyrite, unfossiliferous.
	4.8	<u>Claystone</u> , grey, dark grey in appearance, mottled with white calcareous patches and fossils, very calcareous, almost unbedded, though the calcareous patches longer in the horizontal plains, solid core, the unit and other run in the Patala could easily be called "Marl" or even "Marlstone".
416.2-426.1	1.0	<u>Claystone</u> , dark grey, bottom of overlying unit becoming darker more clayey downward to grade into the fissile clay, abundant white fossil material inside of core. 1/8 inch forams, 1/2 poorly bedded with a few white streaks tending towards the horizontal.
	7.6	<u>Claystone</u> , dark grey, fissile, the order of 1/8 inch but not cleave on perfectly smooth place, pyritic, quartz free smooth texture, very brittle, unfossiliferous, contains a few forams toward the bottom, could shale, pyrite large (1/16") discrete crystals, some fine disseminations on fossil shells.
426.1-427.9	1.1	<u>Claystone</u> , dark grey, quartz free, core badly shattered and part may be caved and from



above.

427.9-437.9	0.1	<u>Claystone</u> , dark grey, fissile, nearly a shale, quartz free, forams abundant at top, common throughout, a few claims, finely disseminated pyrite replaced fossils at places bottom 3 inches becomes limy, grades to underlying unit.
	0.8	<u>Claystone</u> , dark grey, mottled with fine white fossil material, sandy fine quartz grains in pockets, unbedded.
	1.2	<u>Claystone</u> , dark grey, mottled with dark medium grey pockets of sandy clay, unbedded, sand pockets tend toward horizontal elongation.
	1.7	<u>Claystone</u> , dark grey, fissile, brittle, quartz free, unfossiliferous, tinge shiny crystals, probably pyrite scattered throughout.
437.9-447.9	4.3	<u>Claystone</u> , dark grey, fissile, brittle, quartz free, a little finely disseminated pyrite, unfossiliferous.
	0.8	<u>Claystone</u> , dark grey, mottled with light grey lenses and pockets of fine quartz sand and silt, poorly bedded, but sandy lenses elongate horizontally.
	1.8	<u>Sandstone</u> . Light and dark grey, mottled, fine grained, contains clay pebbles (light grey) at tops and sandstone lenses or pebbles at base, large pyrite concretions, irregular layering throughout.
	0.9	<u>Shale</u> , dark fissile, quartz free except for 2 sand lenses 1/2 inch thick near top, unfossiliferous,
447.9-452.4	2.3	<u>Shale</u> , or fissile claystone, dark grey, slightly silty, unfossiliferous, upper half contains numerous brown translucent specks of resin, but there recognizable plant fragments.
	2.1	<u>Sandstone</u> , light and dark grey mottled finely and irregularly layered clayey, one 1/8 inch lenses of coal, soft except for 4 inches at bottom of run, light grey, probably calcareous.
452.4-485.5	0.4	<u>Sandstone</u> , light grey mottled with black

grain, fine grained, unbedded.

1.9 Shale, dark grey, slightly silty touch-light grey, pyritic, unfossiliferous.

1.3 Claystone, dark grey, mottled with silty light grey specks, pyritic, forams visible, fossils shell are present.

4.3 Shale or fissile claystone, dark grey, gastropods fossils replaced by pyrite, 7 inch at bottom of run becomes silty with light grey staining.

458.5-469

0.3 Shale, dark grey, calcite crystals in weathered spots, calcareous, unfossiliferous and calcareous.

0.1 Claystone, light grey to dark grey, smooth surface, pyritic, unfossiliferous.

1.4 Shale, dark grey, unfossiliferous, grades to fissile claystone, hard.

460.3-470.4

6.0 Claystone, dark grey, silty, slightly calcareous (porous white irregular streaks), unfossiliferous, no pyrite.

0.3 Shale, dark grey, calcareous white streaks, unfossiliferous.

3.2 Claystone, dark grey, with light brown specks, forams common, lamellibranches shell impressions with light brown color that only confined to them, slightly calcareous - irregularly distributed, slightly calcareous.

470.4-480.5

1.9 Claystone, dark grey with light grey fossils impression: little fissile, lamellibranch 1/4" shell common, more fissile near the bottom

472.3 -----  
BASE OF PATALA FORMATION TOP OF LOCKHART  
LIMESTONE.  
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1.3 Limestone, medium grey to light-grey, dense, fine grained, slightly fossiliferous.

3.3 Claystone, dark grey to light grey with light brown spots, silty and calcareous, lamellibranches shells common, black and dark

at the bottom.

- |             |     |   |
|-------------|-----|---|
|             | 3.1 | <u>Limestone</u> , medium grey to light grey, forams dark grey abundant, clayey lenticular band making nodular limestone, fine grained, lenses, abundant calcite crystals.  |
| 480.5-490.7 | 9.8 | <u>Nodular limestone</u> , medium grey to dark grey, sub-horizontal jointed, core surface light grey, forams not abundant, calcite veins throughout irregular abundant fractures common, intercalated with irregular bands of mudstone, dark grey, abundant in forams, with in the dark brown background, 23" largest core, few pyrite grains, vertical crack.  |
| 490.7-500.4 | 9.5 | <u>Nodular limestone</u> , dark grey, light grey on core surface, sub-horizontal jointed, vertical cracks, along the joints plain claystone, highly fossiliferous (same as overlying limestone).  |
| 500.4-508.9 | 8.2 | <u>Nodular limestone</u> , dark grey, with black and dark brown patches, crystallized, fine grained, dense sub-horizontally pointed, claystone along the joints plains - percentage of claystone lenses than the above limestone.   |
|             | 0.3 | <u>Claystone</u> , dark grey, highly calcareous with lamellibranches shell.   |
| 508.9-518.8 | 9.7 | <u>Nodular limestone</u> , dark grey, crystallized, fine grained, hard, sub-horizontal jointed, claystone along the joint planes, few grains of pyrite, black grains scattered on the surface, fossils crystallized lighter in color of the rock, limestone grades into claystone-dark grey, highly fossiliferous-fossils look white on the core surface, irregular cracks clayey layers making elliptical shape, 5% percentage of claystone. |
|             | 0.2 | <u>Claystone</u> , dark grey, abundant forams, limy nodules of 1/2", forams white on the core surface.  |
| 518.8-528.9 | 9.5 | <u>Nodular limestone</u> , (same as above unit), percentage of claystone more than 5% limestone nodules 1/4 to 1" of sizes surrounded by claystone: white patchy appearance.  |
| 528.9-538.9 | 9.5 | <u>Nodular limestone</u> , (same as the above unit,   |

20% percentage of claystone.

538.9-548.9                      9.1                      Same as the overlying unit, the percentage of claystone in 10%. The contact is gradational, not sharp.

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BASE OF LOCKHART LIMESTONE - TOP HANGU  
FORMATION (548.0) feet.  
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0.9                      Sandstone, medium grey to dark grey fine grained, calcareous, mottled with white forams on the surface fossil, light brown on fresh surface.

548.9-558.9                      10.9                      Sandstone, fine grained, light grey to medium grey, more darker irregular layers making elliptical shapes surrounded white calcareous material in between, pyrite crystals present, forams light brown looks white on core surface slightly micaceous with yellowish brown tinge.

558.9-569.0                      9.9                      Sandstone, medium grained, light grey to dark grey; hard, black clay nodules and forams present; micaceous and slightly calcareous,

569.0-579.1                      4.5                      Sandstone, (same as above unit).

0.6                      Siltstone, dark grey, yellowish brown, red hematitic grains common, micaceous, slightly calcareous (1/8" fossil), compact and hard.

0.7                      Claystone lateritic, dark bluish green to dark brown bluish-green 1/2" nodules irregularly weathered to brown, slightly silty and shining glazing.

0.19                      Sandstone, bluish green, medium grained-rounded to subrounded grains, slightly micaceous, irregularly, brown green, black rounded patches present.

1.1                      Sandstone, greenish, white, more whitish at the bottom, medium grained, founded to subrounded with little black grains, friable black rounded specks 1/2" diameter, weathered to black.

2.0                      Sandstone, light bluish green medium grained-rounded to subrounded with little black grains, weathered to dark brown violet color-

mottled with thin irregular veins.

- |             |      |  |
|-------------|------|--|
| 579.1-588.5 | 0.1  | <u>Sandstone</u> , white, weathered to greenish and haematitic, medium grained rounded to subrounded, thin bedded, occasional accessory black grains.  |
|             | 0.5  | <u>Sandstone</u> , haematitic, weathered to limonite (yellowish brown), medium grained - rounded to subrounded grains, with some white free quartz patches slightly micaceous, hard and thin bedded.   |
|             | 0.5  | <u>Sandstone</u> , greenish white, medium grained - rounded to subrounded, hard, black grains abundant, weathered or grades to haematitic and clayey sandstone.  |
|             | 3.9  | <u>Sandstone</u> , greenish white, medium grained - rounded to subrounded, hard, black grains abundant, weathered or grades to haematitic and clayey sandstone.  |
|             | 3.9  | <u>Sandstone</u> , bluish grey, medium grained, micaceous, grades to haematitic clay with irregular bluish clay bands, weathered to limonitic patches hard.  |
|             | 8.5  | <u>Sandstone</u> , violet with irregular band of bluish white, medium grained - rounded to subrounded, hematite weathered to limonite - yellowish brown, sandstone grades to whitish greenish sandstone making irregular zones, highly micaceous, thin bands of clay wavy structure, hard. |
| 588.5-598.6 | 10.1 | <u>Sandstone</u> , same as overlying unit.   |
| 598.6-608.9 | 1.1  | <u>Sandstone</u> , greenish white, medium grained rounded to subrounded grains, hard slightly micaceous, irregular grading to hematitic sandstone bands, light grey making wavy structure.   |
|             | 8.2  | <u>Sandstone</u> , hematitic, purple uniform in color, weathered to yellowish brown iron oxide (limonite), medium grained, micaceous, mottled with very minute white specks on the surface, friable and pours with very thin clayey (dark brown) bands.                                    |
| 608.9-617.5 | 2.9  | <u>Sandstone</u> , (same as the overlying unit)  |

	5.7	<u>Claystone</u> , violet grey, silty, slightly micaceous with red tinge.
617.5-625.5	4.5	<u>Claystone</u> , yellowish grey, silty and little micaceous, weathered to spongy texture - porous with white brown patches.
	1.3	<u>Claystone</u> , (same as next to the overlying unit).

Log of Drill Hole No.6 CDH-6  
 Topo Sheet - 43 D/6  
 District - Khushab  
 Lat - 32/34/35N  
 Long - 72/16/0E

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0.00-272.0	0	<u>Sakesar Limestone</u> (No Core).
272.0-282.6	8.5	<u>Limestone</u> dirty white to yellowish brown fine grained, medium bedded, weathered porous, fractured, cliff forming.
282.6-284.0	1.3	<u>Limestone</u> , same as the overlying unit.
284.0-294.0	8.0	<u>Limestone</u> , same as the overlying unit.
		BASE SAKESAR LIMESTONE TOP NAMMAL FORMATION
	0.4	<u>Limestone</u> , light grey, medium bedded occasional marl, fine grained, stringers, fractured, jointed.
294.0-304.0	8.0	<u>Limestone</u> , same as the overlying unit.
	1.5	<u>Marl</u> , grey, fossiliferous pyritic.
304.0-311.0	2.5	<u>Marl</u> (same as the overlying unit).
	4.5	<u>Marl</u> , grey, fossiliferous, pyritic, silty at the base.
311.0-321.0	9.9	<u>Marl</u> , same as the overlying unit.
321.0-331.0	1.7	<u>Marl</u> , same as the overlying unit.
	1.9	<u>Limestone</u> , light grey, fossiliferous, pyritic.
	3.7	<u>Marl</u> , light bluish grey to grey, frequent pyritic nodules.
331.0-339.0	7.5	<u>Marl</u> , same as in the overlying unit.
339.0-346.0	3.1	<u>Marl</u> , same as the overlying unit.
	2.3	<u>Marl</u> , grey to light grey fine grained, fossiliferous pyritic.
346.0-353.0	5.0	<u>Marl</u> , same as the overlying unit, 8 inches

thick grey shale at top.

353.0

TOP PATALA FORMATION NAMMAL FORMATION BASE.

353.0-361.0

- 1.9 Shale, greenish grey, not well fissile, frequent pyritic nodules and fossil fragments.
- 6.0 Shale, dark grey, well fissile, papery calcareous, marly & silty at the top, fossiliferous surface, highly calcareous at few horizon pyritic, brown frequent grey clay nodules.
- 1.7 Shale, dark grey, not well fissile, fossiliferous, pyritic.

361.0-371.0

- 1.0 Shale same as the overlying unit.
- 3.6 Marl, grey, fossiliferous, silty.
- 2.1 Shale, greenish grey, well fissile, pyritic.
- 2.3 Shale, grey, not well fissile, pyritic, frequent pyritic nodules and fossil fragment.

371.0-381.0

- 10.0 Shale, same as the overlying unit, silt occasional clay nodules at the base, grading to siltstone in lower part.

381.0-391.0

- 10.0 Shale, dark grey, well fissile, papery, calcareous.

391.0-401.0

- 1.0 Marl, grey to light grey, fossiliferous, frequent pyritic nodules.
- 5.5 Shale, dark grey to black, carbonaceous, not well fissile, frequent coal stringers and pyritic nodules.
- 2.6 Sandstone, light grey, coarse to medium grained, moderately sorted, subangular to subrounded, occasional Coal stringers.

401.0-411.0

- 1.9 Sandstone, same as the overlying unit.
- 3.6 Sandstone, white, medium grained, rounded to subrounded, friable, steaks.
- 4.3 Sandstone, same as the overlying unit, occasional Coal stringers and pyritic nodules.

411.0-417.0

- 0 No Core, occasional Coal cutting with sand.



417.0-421.0	0.3	<u>Sandstone</u> same as the overlying unit.
	3.7	<u>Sandstone</u> , same as overlying unit (3.6).
421.0-427.0	0.9	<u>Sandstone</u> , same the overlying unit.
427.0-437.0	6.5	<u>Sandstone</u> , same as overlying unit.
437.0-447.0	8.9	<u>Sandstone</u> same as overlying unit.
447.0-452.9	4.9	<u>Sandstone</u> , same as the overlying unit.
452.9-454.1	0.0	<u>No core</u> , occasional Coal cuttings with sand through water return.
454.1-459.1	3.3	<u>Sandstone</u> , same as the overlying unit.

Log of Drill Hole No.7 CDH-7  
 Topo Sheet - 43 D/6  
 District - Khushab  
 Lat - 32/34/10N  
 Long - 72/16/5E

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0 - 300.00	0	<u>Top Sakesar</u> Limestone (No Core).
300.0-310.0	10.0	<u>Limestone</u> , dirty white, stained with light yellowish brown, Prominent along the joints, porous, common, Calcite crystals fine grained chalky in appearance, vertically fractured, Cliff forming.
310.0-320.4	8.8	<u>Limestone</u> , same as the overlying unit.  Transitional Zone starts
	0.8	<u>Limestone</u> , bluish grey to dark grey, occasional, marl fossiliferous, pyritic.
320.4-328.5	8.0	<u>Limestone</u> , same as the overlying unit.
328.5-338.5	1.3	Same as the above.
		TOP NAMMAL FORMATION
	8.7	<u>Marl</u> , grey to light grey, mottled with white microforams on the core surface, occasional pyritic grains.
338.5-348.5	10.0	<u>Marl</u> , same as the overlying unit.
348.5-358.5	8.6	<u>Marl</u> , same as above, but more close to structure of nodular limestone.
358.5-367.9	8.7	<u>Marl</u> , same as the overlying unit.
		TRANSITIONAL ZONE.
	0.7	<u>Marl</u> , dark grey, uniform in color, fossil fragment light brown, pyritic.
367.9-377.9	9.7	<u>Marl</u> , grey to medium grey, highly fossiliferous, mottled with microforams on core surface, forams light brown inside core forams preserved, common fossil fragments, pyritic horizontal jointed, no resemblance to

nodular limestone.

PATALA SHALE STARTS

	0.3	<u>Mudstone</u> , dark grey, pyritic, fossils well preserve, fossils common, regular parting 1/2" in thickness, upper and lower portion fossiliferous and close to marl.
377.9-382.0	4.1	<u>Mudstone</u> , same as the overlying unit.
382.0-382.3	0.3	<u>Mudstone</u> , same as the above.
382.3-385.9	3.6	<u>Mudstone</u> , grey, mottled with white forams, highly pyritic, lamellibranchs fossils 1/4" common occasional clay nodules 1" in dia.
385.9-392.0	1.3	<u>Mudstone</u> , same as above.
	4.3	<u>Marl</u> , light grey, mottled with white microforams, highly fossiliferous, pyritic hard.
	0.5	<u>Mudstone</u> , same as above.
392.0-392.3	0.3	<u>Mudstone</u> , same as above, abundant micro forams.
492.3-402.3	6.0	<u>Mudstone</u> , same as above, more pyritic and fossiliferous.
	1.6	<u>Limestone</u> , light grey, fossiliferous, pyritic, hard.
	1.3	<u>Mudstone</u> , same as above.
402.3-407.6	5.1	<u>Mudstone</u> , black, mottled with white microforams, more fossiliferous at the lower part.
407.6-417.6	6.0	<u>Mudstone</u> , black, same as above.
	4.0	<u>Sandstone</u> , light grey, medium grained, highly calcareous, pyritic thin bedded, occasional thin shale lenses.
417.6-427.0	9.4	<u>Mudstone</u> , black, pyritic, interbedded with light grey sandstone, highly pyritic and calcareous at the lower part.
427.0-435.7	1.1	<u>Mudstone</u> , same as the lower part of the overlying unit.

	5.3	<u>Sandstone</u> , light grey, clay stringers mottled with irregular grey, medium grained, sugary texture, pyritic, hard.
	0.9	<u>Coal</u> , black one lenticular lens of 1" pyritic, lower 3" organic material, brownish black.
	0.3	<u>Coal-Black</u> .
435.7-437.5	1.5	<u>Sandstone</u> , light grey, medium grained mottled with dark grey, pyritic grains, carbonaceous at the upper part.
437.5-4440.0	0.5	<u>Coal</u> , black, no pyrite.

Log of Drill Hole No.9      CDH - 9  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/39/45N  
 Long - 72/33/25E

<u>Depth</u> (FT)	<u>Core Recovery</u> (Ft)	<u>Description</u>
0 - 340.0	0	<u>Limestone</u> (Sakesar Limestone) No Core.
340.0-345.9		TOP NAMMAL FORMATION
	3.4	<u>Shale</u> , black and pyritic.
	2.5	<u>Marl</u> , grey, occasional pyritic grains.
351.6-361.6	10.0	<u>Limestone</u> , grey to light grey, nodular, mottled with frequent lenses of marl.
361.6-371.6	10.0	<u>Limestone</u> , same as the overlying unit.
371.6-381.6	10.0	<u>Marl</u> , grey, highly fossiliferous, common Calcite crystals.
381.6-391.6	10.0	<u>Marl</u> , same as overlying unit.
391.6-401.6	0.6	<u>Marl</u> , same as overlying unit.
	392.0	TOP PATALA FORMATION
	3.4	<u>Claystone</u> , grey, to dark grey, slightly calcareous, fossiliferous.
	3.7	<u>Marl</u> , grey fine grained and hard at places, occasional lenses of fossiliferous shale.
	2.3	<u>Claystone</u> , dark grey.
401.6-411.6	10.0	<u>Claystone</u> , grey to black.
411.6-421.6	9.7	<u>Claystone</u> , it appears name as above, frequent pyritic grains and carbonaceous material.
	0.3	<u>Coal</u> mixed with 20% clay and is pyritic.
421.6-423.6	0.7	<u>Claystone</u> , same as overlying unit.
	0.10	<u>Coal</u> , same as above.
	0.4	<u>Claystone</u> , dark grey, sticky, highly

carbonaceous.

423.6-428.7	5.1	<u>Claystone</u> , same as overlying unit.
428.7-431.0	2.3	<u>Claystone</u> , same as overlying unit.
431.0-435.9	1.3	<u>Claystone</u> , same as overlying unit.
	3.5	<u>Claystone</u> , dark-grey, hard occasional few coal stringers.
435.9-445.9	2.6	<u>Claystone</u> , dark-grey, grades into shales, occasional clay nodules.
	2.3	<u>Siltstone</u> , dark-grey grades into shale and coarse sandstone.

Log of Drill Hole No.10      CDH - 10  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/40/05N  
 Long - 72/31/55E

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (ft)	<u>Description</u>
0-21.0	21.0	No Core
		CHORGALI FORMATION
21.0-26.9	1.9	<u>Marl</u> , white to yellowish-white, fossiliferous.
26.9-36.0	2.9	<u>Limestone</u> , white, fossiliferous, hard and compact, thin bedded.
	1.2	<u>Marl</u> , same as overlying unit.
36.0-37.10	1.9	<u>Marl</u> , same as above.
37.10-46.5	3.0	<u>Limestone</u> , white, coarse grained, fossiliferous, thin bedded bluish-grey, grades to marl.
46.5-56.5	10.0	<u>Marl</u> , same as overlying unit.
56.5-61.0	4.5	<u>Limestone</u> , yellowish-white, occasional lenses of marl.
61.0-71.0	10.0	<u>Limestone</u> , grey, fossiliferous, occasional calcite veins and clay nodules.
71.0-81.0	10.0	<u>Limestone</u> , grey, fine grained, crystalline, fossiliferous occasional big clay nodules.
81.0-91.0	10.0	<u>Limestone</u> , same as above.
91.0-101.0	10.0	<u>Limestone</u> , same as above.
101.0-111.0	10.0	<u>Limestone</u> , light grey, coarse-grained, calcite veins thin bedded.
111.0-116.0	6.0	<u>Limestone</u> , same as above, occasional marl.
116.0-126.0	10.0	<u>Limestone</u> , same as above.
126.0-136.0	10.2	<u>Limestone</u> , same as above.
136.2-125.11	9.4	<u>Limestone</u> , light grey, fine grained

		crystalline, fossiliferous, occasional marl nodules.
145.11-147.6	2.0	<u>Marl</u> , same as above.
147.6-157.6	0.3	<u>Marl</u> , grey, highly fossiliferous.
	0.9	<u>Marl</u> , same as above.
	0.6	<u>Marl</u> , grey, grades to shale.
	0.3	<u>Marl</u> , grey, fossiliferous.
	0.6	<u>Marl</u> , grey.
	2.4	<u>Marl</u> , light grayish-green, fossiliferous.
	1.7	<u>Limestone</u> , light brownish grey, coarse grained, marly fossiliferous.
	1.3	<u>Limestone</u> , same as above.
	1.5	<u>Limestone</u> same as above.
157.6-167.10	1.2	<u>Limestone</u> , brownish-grey, coarse-grained, fossiliferous.
	0.9	<u>Limestone</u> , brownish grey, coarse-grained, hard and massive.
	0.2	<u>Limestone</u> , grey, fossiliferous.
	7.11	<u>Limestone</u> , same as overlying unit.
167.10-177.10	4.9	<u>Limestone</u> , interbedded with marl lenses.
	0.5	<u>Limestone</u> , same as above.
	4.6	<u>Limestone</u> , same as overlying unit.
	0.5	<u>Marlstone</u> , grey.
177.10-184.10	1.6	<u>Limestone</u> , light grey, coarse grained, marly.
	6.4	<u>Limestone</u> , same as above, occasional thin lenses of marl.
184.10-194.10	10.0	<u>Limestone</u> , same as above, fossiliferous at the base.
194.10-204.10	10.0	<u>Limestone</u> , dirty grey, highly fossiliferous and marly.



204.10-213.4		<u>Limestone</u> , grey, fossiliferous, marly and occasional marly nodules.
213.4-223.4	10.0	<u>Limestone</u> , grey, fine grained, fossiliferous, marly at top and bottom, thin bedded.
223.4-233.4	10.0	<u>Limestone</u> , same as overlying unit.
233.4-243.4	10.0	<u>Limestone</u> , same as overlying unit.
243.4-253.4	10.0	<u>Limestone</u> , dirty grey, highly fossiliferous, marly and nodular.
253.4-263.4	10.0	<u>Limestone</u> , same as above.
263.4-270.3	6.9	<u>Shale</u> , dark-grey, marly, <u>Limestone</u> , light grey, highly fossiliferous and marly.
270.3-280.3	10.0	<u>Limestone</u> , same as above, marly in lower part.
290.3-300.3	10.0	<u>Limestone</u> , same as overlying unit.
300.3-310.3	10.0	<u>Limestone</u> , same as overlying unit.
310.3-320.3	10.0	<u>Limestone</u> , same as overlying unit.
	4.3	<u>Limestone</u> light grey, medium to fine grained, fossiliferous, medium bedded.
320.3-330.3	10.0	<u>Limestone</u> , same as overlying unit.
	1.5	<u>Limestone</u> , same as overlying unit.
	2.11	<u>Limestone</u> , same as overlying unit.
330.3-340.3	10.0	<u>Marl</u> , dirty grey, hard and compact.
340.3-349.3	3.4	<u>Marl</u> , same as overlying unit.
	4.8	<u>Shale</u> , dark grey, marly and pyritic.
	1.5	<u>Marl</u> , same as overlying unit.
349.3-359.4	5.3	<u>Marl</u> , same as overlying unit,
	2.8	<u>Marl</u> , same as above.
359.4-367.9	8.5	<u>Marl</u> , grey, fossiliferous,
367.9-377.2		<u>Marl</u> , same as above.

# UPPER TOP PATALA FORMATION

377.2-387.2		<u>Marl</u> , grades to shale.
387.2-394.1	4.10	<u>Shale</u> , dark grey.
	2.0	<u>Shale</u> , dark grey, and marly.
394.1-402.3	8.2	<u>Shale</u> , dark grey, occasional fossiliferous.
402.3-411.10	0.7	<u>Shale</u> , same as overlying unit.
	4.3	<u>Shale</u> , same as overlying unit.
	0.8	<u>Marl</u> , dark-grey.
	0.5	<u>Shale</u> , grey, slight marly.
	2.8	<u>Shale</u> , dark grey, coal stringers and pyritic nodules.
411.10-421.0	2.6	<u>Shale</u> , same as above.
	2.9	<u>Coal</u> , dirty black.
	2.5	<u>Claystone</u> , dark-grey, sticky, friable, and fissile.
	1.6	<u>Claystone</u> , same as overlying unit.
	1.10	<u>Claystone</u> , dark grey, hard compact.
421.0-431.0	5.9	<u>Claystone</u> , dark grey, fissile, friable and pyritic.
	4.2	<u>Claystone</u> , same as above.
431.0-432.0	1.0	--
432.0-442.0	3.7	<u>Claystone</u> , grey, more darker near the bottom, hard and compact, fossiliferous.
	6.3	<u>Marl</u> , light grey, hard, pyritic and highly fossiliferous.
442.0-452.0	2.1	<u>Marl</u> , same as overlying unit.
	1.3	<u>Marl</u> , dark grey, highly fossiliferous.

# UPPER TOP LOCKHART LIMESTONE

6.3	<u>Limestone</u> , light grey, occasional marl lenses,
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nodular.

452.0-460.0	8.0	<u>Limestone</u> , same as above.
460.0-470.1	10.0	<u>Limestone</u> , light grey, fine grained, compact, nodular bedded.
470.1-479.3	8.6	<u>Marl</u> , dark grey to light grey, highly fossiliferous.
479.3-489.3	5.0	<u>Marl</u> , same as above.
	1.0	<u>Limestone</u> , grey, fine grained, highly fossiliferous.
	4.0	<u>Marl</u> , same as overlying unit.
489.3-499.3	9.8	<u>Marl</u> , same as overlying unit.
499.3-508.0	3.0	<u>Marl</u> , same as above.
UPPER TOP HANGU FORMATION		
	6.7	<u>Sandstone</u> , light grey, medium grained, moderately sorted, subrounded and micaceous, medium bedded.
508.0-516.0	5.5	<u>Sandstone</u> , same as overlying unit.
	1.3	<u>Laterite</u> dark to light grey, hard, occasional hematitic concretions.
	0.3	<u>Laterite</u> , greenish-grey, weathers, light brown, occasional pisolites, lateritic.
	0.6	<u>Laterite</u> , same as above.
	1.7	<u>Sandstone</u> , greenish grey, mottled with hematitic color, hard, coarse grained, micaceous.
	0.5	<u>Sandstone</u> , violet, medium grained hard and compact.
516.0-528.0	10.0	<u>Sandstone</u> , same as above.
528.0-538.0	8.0	<u>Sandstone</u> , same as above.
	2.0	<u>Sandstone</u> , light greenish grey, coarse-grained, moderately, sorted, subrounded, micaceous, occasional pyritic grains.

Drill Hole No.11 CDH - 11  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/39/25N  
 Long - 72/34/30E

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0.00-320.1	0	SAKESAR LIMESTONE (No Core)
		TOP NAMMAL FORMATION
320.1-329.9	6.8	<u>Marl</u> , light grey, fossiliferous.
	3.0	<u>Mudstone</u> , grey, occasional pyritic nodules.
329.9-339.1	1.9	<u>Mudstone</u> , same as overlying unit.
	7.3	<u>Marl</u> , light grey, fossiliferous.
339.1-348.5	9.4	<u>Marl</u> , same as the overlying unit, occasional clay lenses at joints plains.
348.5-358.5	10.0	<u>Marl</u> , same as overlying unit,.
358.5-368.5	10.0	<u>Marl</u> , same as overlying unit.
		TOP PATALA FORMATION
368.5-378.5	10.0	<u>Mudstone</u> , grey, fossiliferous.
378.5-385.5	7.0	<u>Mudstone</u> , same as overlying unit.
385.5-404.5	1.8	<u>Mudstone</u> , grey, slightly carbonaceous.
	0.1	<u>Coal</u> , black, occasional stringers of sand.
	0.5	<u>Mudstone</u> , grey, carbonaceous, hard, silty at base.
	6.6	<u>Mudstone</u> , grey, frequent lenses of siltstone.
404.5-409.9	5.4	<u>Shale</u> , grey, not well fissile, occasional clay nodules.
409.5-420.5	7.1	<u>Shale</u> , as overlying unit.
	416.6	TOP LOCKHART LIMESTONE
	3.5	<u>Nodular Limestone</u> , light grey to dark grey,

highly fossiliferous.

420.5-430.5

8.8

Nodular Limestone, light grey to grey,  
fossiliferous.

Log of Drill Hole No.12  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/36/40N  
 Long - 72/34/40E

CDH - 12

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0.00-315.5	0.0	SAKESAR LIMESTONE (No Core)
		TOP NAMMAL FORMATION
315.5-523.3	7.8	<u>Limestone</u> , light grey, fine grained, fossiliferous grades to marl in lower part of unit.
323.3-333.3	10.0	<u>Limestone</u> , same as the overlying unit, frequent marl lenses and pyritic grains.
333.3-343.3	9.9	<u>Limestone</u> , same as the overlying unit.
343.3-353.3	2.5	<u>Limestone</u> , same as overlying unit.
	3.0	<u>Marl</u> , grey, fossiliferous.
	348.8	TOP PATALA FORMATION
	5.4	<u>Mudstone</u> , dark grey, occasional fossils and clay nodules.
353.3-363.3	8.6	<u>Mudstone</u> , dark grey, occasional fossils.
363.3-372.7	9.4	<u>Mudstone</u> , dark grey, occasional clay nodules and silty.
372.7-382.7	10.0	<u>Mudstone</u> , same as above, occasional clay, nodules.
382.7-392.7	10.0	<u>Shale</u> , grey, occasional pyritic grains and clay nodules.
392.7-492.7	3.7	<u>Marl</u> , grey, fossiliferous, frequent shale lenses.
	396.4	LOCKHART LIMESTONE
	6.3	<u>Limestone</u> , grey, fine grained, fossiliferous, occasional marl lenses.
402.7-412.7	10.0	<u>Limestone</u> , same as overlying unit.

Log of Drill Hole No.13  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/36/55N  
 Long - 72/32/15E

CDH - 13

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0.00-325.1	0	SAKESAR LIMESTONE (No Core)
325.1-332.3	7.0	<u>Limestone</u> , whitish, grey, fine grained, fossiliferous, occasional calcite veins and clay lenses, medium bedded, cliff forming.
332.3-342.3	10.0	<u>Limestone</u> , same as the overlying unit.
342.3-350.7	0	No core.
350.7-360.7	10.0	<u>Limestone</u> , same as the overlying unit.
360.7-371.0	1.9	<u>Limestone</u> , same as overlying unit.
		TOP NAMMAL FORMATION
	8.4	<u>Limestone</u> , bluish grey, fine grained, occasional lenses, of marl bedded.
371.0-381.0	9.8	<u>Marl</u> , bluish grey, fossiliferous.
381.0-391.0	10.0	<u>Marl</u> , same as overlying unit, grades nodular limestone in lower part of unit.
391.0-396.4	1.3	<u>Marl</u> , same as overlying unit.
	1.2	<u>Shale</u> , dark grey, not well fissile, grades to fossiliferous marl in lower part of unit.
	1.7	<u>Marl</u> , grey, pyritic, fossiliferous, hard.
	1.2	<u>Marl</u> , grey, fossiliferous.
395.4-401.9	4.0	<u>Marl</u> , light grey, fossiliferous, occasional pyritic grains.
401.9-411.9	10.0	<u>Marl</u> , same as overlying unit.
411.9-415.0	3.1	<u>Marl</u> , same as overlying unit, dark grey, and fossiliferous at lower part of unit.
415.0-425.0	10.0	<u>Marl</u> , same as overlying unit.

425.0-431.4	3.4	<u>Marl</u> , same as overlying unit.
	3.0	<u>Marl</u> , grey, fossiliferous pyritic.
431.4-439.0	5.7	<u>Marl</u> , same as overlying unit.
	1.5	<u>Mudstone</u> , grey, calcareous, fossiliferous.
439.0-441.0	2.0	<u>Mudstone</u> , same as overlying unit.
441.0-444.4	3.4	<u>Marl</u> , grey, fossiliferous and pyritic.



Log of Drill Hole No.15      CDH - 15  
Topo Sheet - 43 D/10  
District - Khushab  
Lat - 32/39/15N  
Long - 72/30/30E  
Completed 20 March 1964  
Logged by S. H. Shah.

Ft.

0 - 100	No record.
100 - 378.3	Sakesar Limestone.
378.3-448.0	Nammal Formation.
448-483.5	Patala Formation with 1.8 carbonaceous shale.
483.5-492.5	Patala Formation.
492.5-497.5	Khairabad Limestone.

Log of Drill Hole No.17      CDH - 17  
 Topo Sheet - 43 D/10  
 District - Khushab  
 Lat - 32/36/40N  
 Long - 72/25/05N

<u>Depth</u> (Ft)	<u>Core</u> <u>Recovery</u> (Ft)	<u>Description</u>
0.00-316.3	316.3	SAKESAR LIMESTONE (No Core)
316.3-326.3	10.0	Limestone, whitish grey, fossiliferous, chalky, weathered, medium hard.
326.3-329.0	1.0	Limestone, same as above.
		NAMMAL FORMATION STARTS
	1.6	Limestone, bluish grey, horizontally jointed
329.0-332.0	2.5	Limestone, sand as above.
332.0-342.0	9.3	Limestone, same as the overlying unit. Marl, light grey, fossiliferous, hard.
342.0-345.3	3.3	Marl, same as the overlying unit.
345.3-355.0	9.7	Marl, same as the above.
355.0-365.6	9.0	Limestone, light grey, nodular, fossiliferous grey marl intercalated.
365.6-373.6	10.0	Limestone, same as above.
373.6-377.6	4.0	Limestone, same as above.
377.6-380.6	3.0	Limestone, same as above.
380.6-390.6	10.0	Limestone, light grey, nodular, fossiliferous pyritic.
390.6-400.0	2.3	Limestone, same as above.
	7.1	Marl, grey highly fossiliferous,
400.0-406.0	6.0	Mudstone, grey, fossiliferous, pyritic,
406.0-416.0		PATALA FORMATION STARTS
	2.4	Mudstone, same as above.

416.0-423.0	5.0	Limestone, light grey, nodular, fossiliferous, pyritic.
	2.6	Mudstone, grey, fossiliferous Calcareous.
	0.7	Mudstone, same as above.
	3.0	Limestone, light grey, nodular, fossiliferous.
	3.1	Mudstone, grey, fossiliferous.

**Borehole logs from PUNJMIN lease areas**

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Drill hole ID: PJ-1  
Location (m): 9376166N, 3166247E  
Date of commencement: 12.4.80  
Date of completion: 1.5.80

Elevation 2915

ft

0-8	Alluvium
8-97	Chorgali Formation
97-300	Sakesar Limestone
300-400	Nammal Formation
400-453	Patala Formation
453-454.5	Coal
454.5-477	Patala Formation
477	Lockhart Limestone (top)

Drillhole ID: PJ-2  
Location (m): 9379366 N, 3166704 E Elevation 2890  
Date of commencement: 2.6.80  
Date of completion: 17.7.80

ft

0-4	Alluvium
4-98	Chorgali Formation
98-288	Sakesar Limestone
288-398	Nammal Formation
398-453.08	Patala Formation
453.08-453.37	Coal
453.37-453.96	Rock
453.96-455.48	Coal
455.48-456.29	Rock
456.29-456.62	Coal
456.62-478	Patala Formation
478	Lockhart Limestone (top)

Drill hole ID: PJ-3  
Location (m): 9408719 N, 3169127 E      Elevation 2715  
Date of commencement: 9.8.80  
Date of completion: 22.8.80

ft

0-8	Alluvium
8-98	Chorgali Formation
98-298	Sakesar Limestone
298-408	Nammal Formation
408-462.75	Patala Formation
462.75-463.08	Coal
463-08-468.50	Rock
468.50-468.67	Coal
468.67-478	Patala Formation
478	Lockhart Limestone (top)

Drill ID: PJ-4  
Location (m): 9407347 N, 3169379 E ELEVATION 2720  
Date of commencement: 1.9.80  
Date of completion: 12.9.80

ft

0-12	Alluvium
12-100	Chorgali Formation
100-300	Sakesar Limestone
300-408	Nammal Formation
408-468.25	Patala Formation
468.25-468.58	Coal
468.58-469.00	Rock
469.00-469.33	Coal
469.33-473.67	Rock
473.67-474.58	Coal
474.58-478.00	Patala Formation
478.00	Lockhart Limestone (top)



Drill ID: PJ-5  
Location (m): 9400855 N, 3165186 E ELEVATION 2950  
Date of commencement: 1.2.82  
Date of completion: 10.2.82

ft

0 - 115	Chorgali Formation
115 - 320	Sakesar Limestone
320 - 430	Nammal Formation
430 - 468	Patala Formation
468.83 - 482	Coal
468.83 - 482	Patala Formation
482	Lockhart Limestone (Top)

Drill ID: PJ-6  
Location (m): 9396832 N, 3168981 E ELEVATION 2710  
Date of commencement: 26.8.83  
Date of completion: 14.9.83

ft

0 - 8	Alluvium
8 - 100	Chorgali Formation
100 - 298	Sakesar Limestone
298 - 410	Nammal Formation
410 - 451	Patala Formation
451.0 - 451.08	Coal
451.08 - 452.00	Rock
452.00 - 452.17	Coal
452.17 - 453.50	Rock
453.50 - 453.83	Coal
453.83 - 462.00	Patala Formation
462	Lockhart Limestone (Top)

Drill ID: PJ-7

Location (m): 9376943 N, 3167390 E ELEVATION 2810

Date of commencement:

Date of completion:

ft

0 -6	Alluvium
6-45	Chorgali Formation
45 - 308	Sakesar Limestone
308 - 418	Nammal Formation
418 - 448	Patala Formation
448 - 448.25	Coal
448.25 - 451.00	Rock
451.00 - 451.25	Coal
451.25 - 452.50	Rock
452.50 - 453.00	Coal
453.00 - 468	Patala Formation
468	Lockhart Limestone (Top)

Drill ID: PJ-8

Location (m): 9370405 N, 3167664 E ELEVATION 2770

Date of commencement: 08.5.84

Date of completion: 01.6.84

ft

0 - 8	Alluvium
8 - 88	Chorgali Formation
88 - 270	Sakesar Limestone
270 - 405	Nammal Formation
405 - 495.5	Patala Formation
445.5 - 447.00	Coal
447.00 - 465	Patala Formation
465	Lockhart Limestone (Top)

Drill ID: PJ-9  
Location (m): 9372966 N, 3167930 E ELEVATION  
Date of commencement: 19.6.84  
Date of completion: 09.7.84

ft

0 - 8	Alluvium
8 - 80	Chorgali Formation
80-298	Sakesar Limestone
298 - 412	Nammal Formation
412 - 448.83	Patala Formation
448.83 - 449.67	Coal
449.67 - 451.00	Rock
451.00 - 451.50	Coal
451.50 - 452.08	Rock
452.08 - 452.5	Coal
452.5 - 458	Patala Formation
458	Lockhart Limestone.

Drill ID: PJ-10  
Location (m): 9375252 N, 3167756 E      ELEVATION  
Date of commencement: 12.8.84  
Date of completion: 05.9.84

ft

0 - 8	Alluvium
8 - 98	Chorgali Formation
98 - 270	Sakesar Limestone
270 - 416	Nammal Formation
416 - 449	Patala Formation
449.0 - 449.50	Coal
449.50 - 450.50	Rock
450.50 - 450.75	Coal
450.75 - 460.00	Patala Formation
460.00	Lockhart Limestone (Top)

Drill ID: PJ-11  
Location (m): 9382618 N, 3166284 E ELEVATION  
Date of commencement: 26.10.84  
Date of completion: 05.12.84

ft

0 - 11	Alluvium
11 - 89	Chorgali Formation
89 - 272	Sakesar Limestone
272 - 415	Nammal Formation
415 - 457.67	Patala Formation
457.67 - 458.00	Coal
458.00 - 458.17	Rock
458.17 - 459.17	Coal
459.17 - 460.42	Rock
460.42 - 461.42	Coal
461.92 - 468	Patala Formation
466	Lockhart Limestone

Drill ID: PJ-12  
 Location (m): 9385310 N, 3166293 E      ELEVATION  
 Date of commencement: 19.2.85  
 Date of completion: 17.3.85

ft

0 - 15	Alluvium
15 - 116	Chorgali Formation
116 - 303	Sakesar Limestone
303 - 419	Nammal Formation
419 - 469	Patala Formation
469.00 - 469.33	Coal
469.33 - 470.33	Rock
470.33 - 471.33	Coal
471.33 - 473.33	Rock
473.33 - 473.75	Coal
473.75 - 480.00	Patala Formation
480	Lockhart Limestone



Drill ID: PJ-13  
Location (m): 9379824 N, 3166064 E ELEVATION  
Date of commencement: 21.3.85  
Date of completion: 10.4.85

ft

0 - 10	Alluvium
10 - 108	Chorgali Formation
108 - 300	Sakesar Limestone
300 - 417	Nammal Formation
417 - 457.75	Patala Formation
457.25 - 457.42	Coal
457.42 - 458.00	Rock
458.00 - 458.50	Coal
458.50 - 461.00	Rock
461.00 - 461.25	Coal
461.25 - 468.00	Patala Formation
468.00	Lockhart Limestone (Top)

Drill ID: PJ-14  
Location (m): 9368577 N, 3169301 E ELEVATION 2600  
Date of commencement: 27.4.85  
Date of completion: 12.5.85

ft

0 - 4	Alluvium
4 - 90	Chorgali Formation
90 - 265	Sakesar Limestone
265 - 375	Nammal Formation
375 - 425	Patala Formation
425.00 - 426.25	Coal
426.25 - 438.00	Patala Formation
438.00	Lockhart Limestone (Top)

Drill ID: PJ-15  
Location (m): 9371686 N, 3169150 E ELEVATION 2650  
Date of commencement: 08.8.85  
Date of completion: 24.8.85

ft

0 - 12	Alluvium
12 - 78	Chorgali Formation
78 - 276	Sakesar Limestone
276 - 396	Nammal Formation
396 - 441	Patala Formation
441.00 - 442.00	Coal
442.00 - 458.00	Patala Formation
458.00	Lockhart Limestone (Top)

Drill ID: PJ-16  
Location (m): 9386133 N, 3168410 E ELEVATION 2905  
Date of commencement: 21.9.85  
Date of completion: 31.10.85

ft

0 - 5	Alluvium
5 - 108	Chorgali Formation
108 - 320	Sakesar Limestone
320 - 429	Nammal Formation
429 - 478.42	Patala Formation
478.42 - 479.08	Coal
479.08 - 479.50	Rock
479.50 - 480.00	Coal
480.00 - 481.50	Rock
481.50 - 482.50	Coal
482.50 - 488.00	Patala Formation
488.00	Lockhart Limestone (Top)

Drill ID: PJ-17  
Location (m): 9394454 N, 3167344 E      ELEVATION 2882  
Date of commencement: 22.11.85  
Date of completion: 12.12.85

ft

0 - 118	Chorgali Formation
118 - 329	Sakesar Limestone
329 - 447.75	Nammal Formation
447.75 - 478.50	Patala Formation
478.50 - 478.75	Coal
478.75 - 479.50	Rock
479.50 - 480.08	Coal
480.08 - 481.50	Rock
481.50 - 481.92	Coal
481.92 - 490.00	Patala Formation
490.00	Lockhart limestone (Top)

Drill ID: PJ-19  
Location (m): 9401632 N, 3168231 E ELEVATION 2775  
Date of commencement: 07.3.86  
Date of completion: 04.5.86

ft

0 - 90	Chorgali Formation
90 - 266	Sakesar Limestone
266 - 397	Nammal Formation
397 - 443.33	Patala Formation
443.67 - 413.67	Coal
443.76 - 448.92	Rock
448.92 - 449.42	Coal
449.42 - 445.50	Patala Formation
455.50	Lockhart Limestone (Top)

Drill ID: PJ-20

Location (m): 9386545 N, 3168533 E ELEVATION 2790

Date of commencement: 16.10.86

Date of completion: 14.11.86

ft

0 - 88	Chorgali Formation
88 - 279	Sakesar Limestone
279 - 429	Nammal Formation
429 - 464.17	Patala Formation
464.17 - 464.42	Coal
464.42 - 465.75	Rock
465.75 - 465.83	Coal
465.83 - 466.08	Coal
466.08 - 471.50	Patala Formation
471.50	Lockhart Limestone (Top)

Drill ID: PJ-21  
Location (m): 9372783 N, 3167024 E ELEVATION 2800  
Date of commencement: 22.6.86  
Date of completion: 05.7.86

ft

0 - 90	Chorgali Formation
90 - 273	Sakesar Limestone
273 - 397	Nammal Formation
397 - 444.42	Patala Formation
444.42 - 444.75	Carbonaceous shale
444.75 - 445.92	Rock
445.92 - 447.42	Coal
447.42 - 448.42	Rock
448.42 - 448.92	Carbonaceous shale
448.92 - 449.08	Coal
449.08 - 468.00	Patala Formation
468.00	Lockhart Limestone (Top)



Drill ID: D-PJ-1  
Location: Dandot  
Date of commencement:  
Date of completion:

Lat - 32/09/40/N  
Long - 72/57/20/E

ft

0 - 90	Alluvium
90 - 242	Sakesar Limestone
242 - 347	Nammal Formation
347 - 363.58	Patala Formation
363.58 - 365.83	Coal
365.83 - TD	

Drill ID: D-PJ-2  
Location: Dandot  
Date of commencement:  
Date of completion:

Lat - 32/39/40/N  
Long - 73/57/10/E

ft

0 - 245	Sakesar Limestone and Nammal Formation
245 - 282.66	Patala Formation
282.66 - 285.25	Coal
285.25 - 316.00	Patala Formation
316.00	TD

# LOG OF PJD-12

Drilled by: PUNJMIN

Location: Lat. 32/44/35N, Long. 72/50/15E, North of Dalelpur.

Logged by: M. Anwar, Geological Survey of Pakistan

Date Logged: 10-23 January, 1988

From - To (ft)	Core Recov.	Description
0.0 - 200.0		Non coring.
200.0 - 450.0		Sandstone, light olive grey, medium grained, Kamli Formation.
450.0 - 538.0		Chorgali Formation.
538.0 - 628.0		Sakesar Limestone.
628.0 - 631.4		Marl, greenish grey, fossiliferous, with thin layers of greenish grey, Nammal Formation.
631.4 - 633.4		Shale, greenish grey (5Y 6/1), fissile, fossiliferous.
633.4 - 638.0		Limestone, light olive grey (5Y 6/1), fossiliferous, marl along the nodules.
638.0 - 646.5		Limestone, yellowish grey (5Y 8/1), fossiliferous, thin marly layers along the nodules.
646.5 - 648.0		Marl, with angular pieces of limestone (brecciated), light grey (N4), fractured.
648.0 - 658.0		Marl, light olive grey (5Y 6/1), brecciated, fossiliferous (less).
658.0 - 668.0	5.0	Limestone, light grey (N7), marl of medium grey along the nodules, fractured.
668.0 - 678.0	5.0	Limestone, light grey (N7), highly fractured, fossiliferous.
678.0 - 685.0	5.2	Limestone, light grey (N7), fractured, iron stained, fossiliferous, the limestone is iron stained with dusky yellow (5Y 6/4) thin calcite veins, less fissile.

685.0 - 688.0	1.6	Limestone, same as above.
688.0 - 698.0	5.3	Same as above.
698.0 - 708.0	9.0	Limestone, light grey (N7), fossiliferous, thin calcite veins, iron stained, fractured in the first part.
708.0 - 718.0	10.0	
708.0 - 711.0		Limestone, light olive grey (5Y 6/1), brecciated, pyrite grains.
721.0 - 714.5		Limestone, light olive grey (5Y 6/1), with marly layer of medium grey (N5) at places, pyrite grains more in marly places, fossiliferous.
714.5 - 718.0		Limestone, medium dark grey (N4), fossiliferous, iron stained, pyrite grains.
718.0 - 728.0	10.0	
714.5 - 725.0		limestone, light grey (N5), with marly layers of medium dark grey (N4), fossiliferous.
725.0 - 728.0		Marl, medium bluish grey (5 B/1), with Limestone of light grey pieces, fossiliferous, pyrite increases in marl.
728.0 - 738.0	9.9	
728.0 - 724.68		Limestone, light grey (N7), fossiliferous.
724.68- 733.6		Marl, light olive grey (5Y 6/1), fossiliferous, pyrite grains with limestone at pieces subrounded to rounded.

Contact of Patala Formation at 729.6

733.6 - 734.2		Shale, medium dark grey (N4), pyrite in dissemination, specks.
734.2 - 735.0		Marl, medium dark grey (N4), calcareous, pyritic, rare fossils.
735.0 - 735.2		Limestone, medium grey (N5), pyritic.
735.2 - 736.3		Marl, medium grey (N5), pyrite specks and grains, fossil shells.
736.3 - 738.0		Marl, medium grey to medium light grey (N5 to

N6).

738.0 - 748.0	4.5	
738.0 - 741.0		Shale, dark grey (N3), pyrite nodules 0.25 to 0.5 inches thick, sticky.
741.0 - 742.5		Limestone, light grey (N4), fossiliferous, thin calcite veins, pyrite specks and grains.
742.0 - 748.0	0.0	
748.0 - 752.0	3.6	
748.0 - 749.8		Marl, medium dark grey to medium grey (N4 - N5), fossiliferous.
749.8 - 750.1		Limestone, medium grey (N5).
750.1 - 750.5		Marl, medium grey (N5)
750.5 - 751.0		Limestone, medium grey (N5), fossiliferous.
751.0 - 751.7		Marl, medium grey (N5), with limestone pieces, fossiliferous.
751.7 - 752.0	0.0	
752.0 - 752.3		Limestone, light grey (N7), fossiliferous.
752.3 - 753.1		Marl, medium grey (N5), fossiliferous, sandy.
753.1 - 753.8		Marl, medium dark grey, fossil shells.
753.8 - 755.5		Shale, medium dark grey, fossiliferous, sandy.

Base of Patala Formation, top of Permian?

755.5 - 756.5		Clay, mottled with light bluish grey, maroon, sandy.
756.5 - 757.5		Sandstone, light grey, medium grained, with light maroon clay shades.
757.5 - 758.9		Sandstone, light greenish grey, medium grained, soft, friable.
758.9 - 761.0		Sandstone, medium grey, with light maroon clay shades, medium grained, soft.
761.0 - 761.5		Clay, light bluish grey, mottled with light

	maroon, sandy.
761.5 - 765.3	Clay, pale brown (5YR 5/2), sandy.
765.3 - 770.6	Sandstone, loose, grey, friable, light brownish grey (5YR 6/1).
770.6 - 773.6	Clay, Grayish red (5R 4/2), sandy, somewhat hard.
773.6 - 775.6	Clay, blackish red (5R 2/2), hard.
775.6 - 777.2	Clay, pale brown (5Yr 5/2), sandy.
772.2 - 774.2	Clay, same as above.
774.2 - 775.0	Clay, brownish grey (5YR 4/1), with calcareous concretions, sandy.
775.0 - 776.0	Sandstone, light brownish grey (5YR 6/1), with pale red clay (5R 6/2).
776.0 - 777.2	Clay, pale brownish (5YR 5/2).

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. *WH-1*

Area : *WAHALI (G) 43 H/1*

Date of start: *14-11-85*

Location (Coordinates): *42800N 17700E*

Date of completion: *28-11-85*

Ground Elevation: *2500 feet*

Logged by: *SHABIR MUSSAIN, GEOLOGIST*

Drilling Agency: *J. V. C. C*

Type of rig: *Longyear - 38*

Scale: *1"=100'*

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	<i>Sakasa Limestone</i>		<i>Light to dark grey medium grained limestone - fossiliferous cherty and contains khaki and green colored matrix bands.</i>	<i>70%</i> ↑			
83	<i>Nammal Formation</i>		<i>Cream colored nodular limestone - mainly belemnite highly fossiliferous.</i>	<i>Non Coring</i> ↓		<i>100%</i>	
177	<i>Patala Form</i>		<i>Dark green, black calcarenaceous shales.</i>	<i>99%</i>	<i>NA</i>	<i>70%</i>	<i>Bottom of hole at 203 feet. No coal seam encountered.</i>
200 203	<i>Warcha Sandstone</i>		<i>Coarse grained sandstone containing specks of green pyrite.</i>				

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. WH-2

Area : WAHALI(S) 43 1/2

Date of start: 1-12-1985

Location(Coordinates): 43°00'N 103°00'E

Date of completion: 22-12-1985

Ground Elevation: 2610 feet

Logged by: SHA331R HUSSAIN, GEOLOGIST

Drilling Agency: I. V. C. C

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Sakiesai Limestone		Light grey medium to coarse grained cherty limestone with calcrete veins. fossiliferous with intercalations of greenish and black marls				
99'						95%	
	Nonimal Formation		Light cream colored nodular limestone with interbedded marls, contains microfossils				
205'							
	Patafa Formation		Green to black carbonaceous fossiliferous shales - contains coal 1-1"	88%	11.2	80%	Coal seam 239'-6" = 1-1" 240-7" = 1-1"
259'	Waicha Sandstone		Red bauxitic chrys indurated by calcareous sandstone				Bottom of hole at 259-7"
			Coal Seam = 1-1"				



# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. WH-3

Area : WAHALI (G) 43 H/1

Date of start: 30-12-85

Location (Coordinates): 42300 N 17150 E

Date of completion: 18-1-86

Ground Elevation: 2570 feet.

Logged by: SHABIR HUSSAIN, GEOLOGIST

Drilling Agency: I.V.C.C.

Type of rig: R.O.C.

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Sakesai Limestone		Greyish calcareous medium to coarse grained limestone fossiliferous - contains brachiopods and greenish marts towards base.				
80'	Nammal Formation		Light cream colour limestone nodular behaviour - mixed with marts. conglutinated appearance.	Non rec.		90%	
194'	Patala Form.		carbonaceous shales.	85%			
207'	Warcha sandstone		coarse grained calcareous sandstone containing specks of quartz, calcite & pyrite.	81%	ND	70%	Bottom of hole at 211-10'. No coal seam encountered
211-10'							

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. WH-4

Area : WAHALI (G) 43H/1

Date of start: 23-1-86

Location (Coordinates): 42950N 10000E

Date of completion: 7-2-86

Ground Elevation: 2610 feet

Logged by: SHABIR HUSSAIN, GEOLOGIST

Drilling Agency: I. V. C. C.

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Sakesar Limestone		Dark grey limestone, contains chert nodules, massive, cataclastic, fossiliferous.	Non Coring		95%	
100'	Narnial formation		Light grey nodular limestone, intercalated with yellowish marls. towards base becomes quite soft, fossiliferous.				
196'	Patala formation		Greenish carbonaceous shale, contains coal 1'-2"	98%	NA	80%	Coal seam 221'-1" 1" 222'-2" 1" 223'-2"
230' 241'-4"	Warcha sandstone		Coarse grained sandstone impregnated with quartz, + calcite specks.  Coal seam = 1'-2"				Bottom of Hole at 241'-4"

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. *WH-5*  
Area : *WAHALI (G)* Date of start: *22-1-86*  
Location (Coordinates): *43300N 18400E* Date of completion: *14-3-86*  
Ground Elevation: *2600 feet* Logged by: *SHABRIR HUSSAIN, GEOLOGIST*  
Drilling Agency: *I. V. C. C.*  
Type of rig: *Longyear-38* Scale: *1"=100'*

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	<i>Sakesar Limestone</i>		<i>Coarse grained grey limestone massive, cherty and fossiliferous. contains fossils towards base.</i>				
70'							
	<i>Nammal Formation</i>		<i>Cream, white nodular limestone, towards the middle of formation becomes mostly black carbonaceous shales also interbedded</i>	<i>Non Coring</i>		<i>100%</i>	
189'							
	<i>Patala Formation</i>		<i>Black carbonaceous shales. Three coal seams separated from each other by sandstone.</i>	<i>98%</i>	<i>NA</i>	<i>89%</i>	<i>Coal seam 221'-1" = 4" 221'-11" = 6" 222'-6" = 3" 222'-9" = 3" 223'-6" = 2" 223'-1" = 2"</i>
240' 242'-4"	<i>Wazha Sandstone</i>		<i>Coarse grained yellowish calcareous sandstone.</i>				<i>Bottom of hole at 242'-4"</i>
			<i>Coal seam = 9"</i>				

# Bore Hole Log

Project: Coal Exploration Project  
 Area : WAHALI (G) 434/1  
 Location (Coordinates): 43200N 17970E  
 Ground Elevation: 2595'  
 Drilling Agency: PUNJNIN  
 Type of rig: Longyear-34

Bore Hole No. WH-6  
 Date of start: 28-7-86  
 Date of completion: 21-10-86  
 Logged by: AYUB ASGHAR, GEOLOGIST  
 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
10'	Atlixial		Mixture of clay & silt.				
106'	Sakesau Limestone		Dark grey in colour, coarse grained, impregnations of chert, calcareous, fossiliferous. Greenish and khaki marls towards base.	98%	NA	100%	
168'	Nammal Formation		White, creamish nodular limestone, medium to fine grained, intercalated with yellow marls.				
206'	Patala Formation		Green to black carbonaceous shales splintery & friable. contains no coal seam.	95%	80	90%	
245'	Warcha sandstone		Cream coloured coarse grained sandstone.				Bottom of hole at 245' No coal seam en- countered

# Bore Hole Log

Project: Coal Exploration Project  
 Area : WAHALI (G) 434/  
 Location (Coordinates): 42700 N 17100 E  
 Ground Elevation: 2565 feet  
 Drilling Agency: PUNJMIN  
 Type of rig: Longyear - 34

Bore Hole No. UN-7  
 Date of start: 30-10-86  
 Date of completion: 6-11-86  
 Logged by: AYUB ASGHAR, GEOLOGIST  
 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Cord Rec. %	Core Dia.	Water Loss %	Remarks
0	Sakesar Limestone		Grey calcareous cherty limestone with greenish, cherty matrix.	98%			
40'					NQ	100%	
	Nammal Formation		cream coloured nodular massive limestone, fossiliferous	95%			
129'							
	Patala Formation		Green to black carbonaceous shales containing coal.	97%	80	85%	Coal seam 153-8" 154-9" = 1'-1"
	Red clays/sandstone		Red bauxitic clays underlain by coarse grained cream color sandstone.	95%	80	95%	Bottom of hole at 188
			coal seam 1'-1"				

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. 60A - 1

Area : NALLA (A-1) 43D/14

Date of start: 11-10-87

Location (Coordinates): 104060N 350155E

Date of completion: 25-10-87

Ground Elevation: 2450 feet

Logged by: Ayub Asghar, Geologist

Drilling Agency: PUNJIN

Type of rig: Longyear - 34

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Alluvium		Silty loams mixed with sand	95% Non Coring		20%	
90'	Kamrial Formation		Dark brown sandstone with red clay matrix base				
130'	Chargali Formation		White, creamish limestone with intercalation of units of greenish, reddish color.	95%	NA	60%	
208'	Sakesar Limestone		Light grey fractured limestone with chert concretions, greenish, Greenish shales towards base.	90%	NA	90%	
319'	Naminal Formation		White, soft, chalky list containing intercalations of yellow, red, fractured to certain extent, interbedding of black shales	95%	NA	70%	
476'	Patala Formation		Black carbonaceous shale, with coal & Patala.	90%	BA	80%	
525'	Locharat Limestone		Detritic clays marking the transition between shales and limestone. Very limestone				
532'							Bottom of the hole 532 feet. 13' shale & seam and 30' Patala encountered

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. WA-2

Area : WAULA, (A-1) 43 2/4

Date of start: 9/11/87

Location (Coordinates): 39250N, 80250E

Date of completion: 19/11/87

Ground Elevation: 2425'

Logged by: Ayub Asghar, Geologist

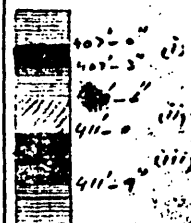
Drilling Agency: Punjmin

Type of rig: Longyear-34

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
	Alluvium	m m	Silty loam and becomes more sandy in lower portions, mixed with gritty material	100 Non coring	4"	10-15%	
150'	Fakir	o o o	Light grey to white cherty limestone with greenish cherts at base				
206'	Limestone	o o o					
	Nammal Formation	o o o	White chalky limestone, interbedding of black shales, fractured and highly fossiliferous	98-100%	NQ	50-100%	
379'-6"							
427'-6"	Patala Formation	o o o	Black carbonaceous shales, friable, mixed with silty material, contain coal part				
430'	Loekhat Limestone	o o o	Dark grey hard limestone, mixed with shales, marking transitional zone				

Detail of coal seam



ii) coal  
iii) good quality part  
iv) coal

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. WA-3

Area : WALIKA (A-1) 430/4

Date of start: 23-7-1987

Location (Coordinates): 1038800N, 3502750E

Date of completion: 19-9-1987

Ground Elevation: 2450 feet

Logged by: Ayub Asghar, Geologist

Drilling Agency: PUNJMIN.

Type of rig: LONGYEAR-34

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Alluvium		silt, clay mixed with sand and pebbles.	100%			
90'	Kamli Formation		Dark coal, coarse grained sandstone containing angular pebbles.	100%		5%	
190'	Chogali Formation		Dark, marly limestone containing greenish shales				
217'-6"	Sakesar Limestone		Hard, crystalline limestone with chert concretions, highly fossiliferous, towards base contains greenish, grayish shales	98%	NA	70%	
390'	Nammal Formation		Soft, nodular limestone mixed with mudstone				
468'	Patala Formation		Black carbonaceous shale, coarsely bedded.	99%	34	10%	
515'	Lockhart Limestone		Hard gray limestone with shales, Transitional zone.				
518'			Coal seam, mixed with Pyrite & sand.				

491'-0" Coal  
491'-6" Soil  
501'-0" Patala  
504'-0" Soil  
Coal seam, mixed with Pyrite and other carbonaceous materials.  
Bottom of the hole at 518 feet.



# Bore Hole Log

Project: Coal Exploration Project  
 Area : Mudhwa (E) 432/10  
 Location (Coordinates): 29500N, 59400E  
 Ground Elevation: 2825 feet  
 Drilling Agency: P.I.D.C.  
 Type of rig: Longyear-44

Bore Hole No. MW-1  
 Date of start: 25-10-85  
 Date of completion: 6-11-85  
 Logged by: Saeed Akhtar,  
 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0						5%	
85'	Chargali Formation		White limestone inter-bedded with marls				
325'	Sakesai Limestone		Light gray cherty limestone with greenish-khaki shales interbedded towards base parts of limestone	Non Coring		90%	
490'	Namnal Formation		Cream, off-white nodular limestone with marls - Greenish black shales interbedded			85%	
582'	Patala Formation		Black carbonaceous shales with sandy layers - No coal seam present	98%	NR	80-90%	
585'	Lockhart Limestone		Hard gray limestone - marks the Transitional zone				

Bottom of hole at 585 feet. No coal seam encountered.

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. MW-2

Area : Mudhwal (E) 432/10

Date of start: 13-11-85

Location (Coordinates): 30800N, 60850E

Date of completion: 15-12-85

Ground Elevation: 2975 feet

Logged by: Saeed Akhtar,

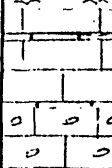
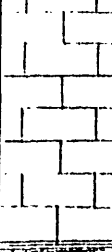
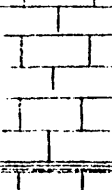

Drilling Agency: P. I. D. C

Type of rig: Longyear-44. Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
5'	Chorga Formation		Off-white, soft limestone alternating with shales in the central portion - becomes nodular in lower portions	95%		10%	
61'	Sakesar Limestone		off-white to light grey hard, cherty limestone fossiliferous - interbedded with khaki shales.	non-sing		70-90%	
318'	Hammal Formation		Cream coloured marly limestone, nodular and interbedded with black shales.				
475'	Patala Formation		Green to black carbonaceous shales, splintery, sandy layers interbedded. No coal seam present	95%		80%	
590' 592'	Lockhart Limestone		Grey limestone - marks the transitional zone.				Bottom of hole at 592 feet. No coal seam encountered

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. *MB-3*  
 Area : *Miyahwal (E) 43 D/10* Date of start: *20-12-85*  
 Location (Coordinates): *30900 N, 50900 E* Date of completion: *31-12-85*  
 Ground Elevation: *2900 feet* Logged by: *Naeed Akhtar,*  
 Drilling Agency: *P.I.D.C*  
 Type of rig: *Longyear-44* Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
75'	<i>Atankwal Chargali Formation</i>		<i>Cray with pebbles off-white limestone</i>	<i>95%</i>		<i>5%</i>	
305'	<i>Pakesal Limestone</i>		<i>Coarse grained grey limestone containing chert. fossiliferous</i>	<i>Non Core</i>		<i>80-90%</i>	
469'	<i>Nammal Formation</i>		<i>White, soft massive limestone with interbedding of black shales.</i>		<i>NQ</i>	<i>85%</i>	
551' 556'	<i>Patala Formation</i>		<i>Green-black carbonac- eous shales.</i>	<i>95%</i>		<i>80%</i>	
							<i>Bottom of the hole at 556 feet</i>

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. KB-1

Area : KHABAKKI(D) 43 D/6

Date of start: 25-6-85

Location (Coordinates): 22200 N 43700 E

Date of completion: 27-7-85

Ground Elevation: 2685 feet

Logged by: Saeed Akhtar, Asst. Geol.

Drilling Agency: P. I. D. C.

Type of rig: Longyear-44.

3000' 100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
5'	Accretion		Thin, clay matrix with pebbles			5%	
315'	Sakesai Limestone		off-white limestone with yellowish matrix, calcareous medium to coarse grained cherty, towards base inter- bedded with greenish shales and yellowish matrix - highly fossiliferous and fractured.	Non Coring		95%	
470'	Nammal Formation		Limestone with yellowish calcareous matrix, nodular, highly fossiliferous, inter- bedded with matrix and black calcareous shales			90%	
570'	Patala Formation		Greenish black shales - interbedded with sandstone also contains pyrite. No traces of coal	98%	NA	90%	
629'	Lockhart Limestone		Greyish, nodular, matrix limestone.	95%		85%	Bottom of hole at 629 feet. No coal seam encountered

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. KB-2

Area : KHABAKKI(D) 43D/8

Date of start: 28-7-85

Location (Coordinates): 22400N 42700E

Date of completion: 2-8-85

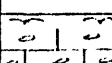
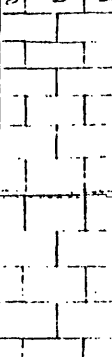
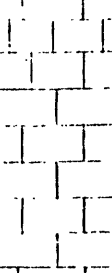


Ground Elevation: 2700 feet

Logged by: Saeed Akhlaq, AssH. Geo 109/85

Drilling Agency: P. I. D. C

Type of rig: Longyear-44

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	ALLUVIUM		Mixture of clay & boulders			10%	
292'	Sakeshi Limestone		Off. white limestone with yellow & tan colored marls, chert nodules, interbedded with green shales - fossiliferous	Non Coreing		95%	
469'	Nammal Formation		Limestone of light grey to white color - sandy lime- stone and become chalky towards base, highly fossiliferous.			90%	
570'	Patala Formation		Fossiliferous, mostly limestone of grey color - Greenish black pyrite shales. interbedded with sandstone & traces of coal	98%	NR	90%	
	Lockhart Limestone		Dark grey calcareous nodular massive limestone				

Bottom of hole at  
570 feet - No coal  
seam encountered

# Bore Hole Log

Project: Coal Exploration Project  
 Area : KHABAKKI (D) 430/6  
 Location (Coordinates):  
 Ground Elevation: 2800 feet  
 Drilling Agency: P. I. D. C  
 Type of rig: Longyear-44

Bore Hole No. KS-3 (7)  
 Date of start: 15-8-85  
 Date of completion: 19-8-85  
 Logged by: Saeed Akhtar, Asstt. Geol. Eng.

Scale: 1:1000

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
4"	Atterbury		off. white hard limestone with intercalations of marls become light yellow and interbedded with thin beds of marls - fossiliferous.	50%		75%	
248'	Sakaval Limestone			Non Coring			
432'	Naimal Formation		White, soft, fossiliferous limestone with intercalations of yellowish marls - becomes chalky and interbedded with grey marls			70%	
526'	Patala Formation		Blue-green shales, carbonaceous, sandstone with carbonated material - contains thin coal. also contain plastic clays	78%	NA	80%	
	Lockhart Limestone		Nodular grey limestone.				

Patala Coal  
 499' to 501' = 2'-6"

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. KS-4 (8)

Area : KHABBAKI (D) 43D/6

Date of start: 13-9-85

Location (Coordinates): 2370 N 40750 E

Date of completion: 23-9-85

Ground Elevation: 2900 feet

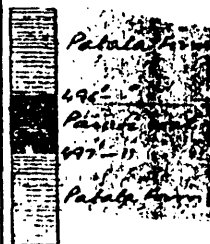
Logged by: Saeed Akhtar, Asstt. Geol.

Drilling Agency: P. I. D. C.

Type of rig: Longyear-44

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Sakesar Limestone		Dark grey hard fossiliferous limestone, interbedded with greenish shales and marls.	98%	1 1/2"	75%	
248'	Nammal Formation		White, chalky, soft, nodular marly limestone, interbedded with thin black calcareous shales.	98%	1 1/2"	90%	
420'	Patala Formation		Black carbonaceous shales interbedded with sandstone. contains Patala (inferior quality coal).	98%	1 1/2"	85%	
521' 526'	Lockhart Limestone		Grey, marly limestone.				



# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. KB-5 (9)

Area : KHABBAKI (D) 43D/6

Date of start: 6-10-1985

Location (Coordinates): 23750N 37600E

Date of completion: 11-10-1985

Ground Elevation: 2850 feet

Logged by: Saeed Akhtar, Asst. Geol.

Drilling Agency: P. I. D. C.

Type of rig: Longyear-44

SADAM HAD

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Alluvium		Mixture of clay & pebbles	95%			
257'	Sakaeai Limestone		Light grey massive limestone, cherty and fossiliferous, interbedded with greenish shales	Non coring		95%	
439'	Nammal Formation		White, soft, nodular limestone, interbedded of yellow marl.			92%	
543'	Patala Formation		Black carbonaceous shale containing sandy layers. No coal seam is present.	100%	NA	80-90%	
546'	Lockhart Limestone		Dark grey coarse grained limestone				Bottom of hole at 546 feet. No coal seam encountered.



# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. JR-1

Area : JHAMRAH(B) 430/10

Date of start: 8-10-85

Location (Coordinates): 1033700N, 3475300E

Date of completion: 3-11-85

Ground Elevation: 2710 feet

Logged by: Shabbir Hussain,

Drilling Agency: I. V. C. C

Type of rig: Longyear-38

Scale: 22480'

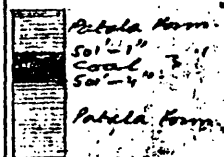
Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Alluvium		Silt, clay and gritty material			10-15%	
80'	Kansli Formation		Dark brown, micaceous sandstone, coarse grained and massive			60%	
103'	Chorgali Formation		Cream coloured, dolomitic nodular limestone, alternating bands of green & yellow marls			65%	
293'	Sakesar limestone		Light off-white hard <sup>cherty</sup> massive limestone, rich in fossils, thin bands of green, marl, shales interbedded, highly fractured		Non Coring	80-90%	
553'	Nammal Formation		White, soft, nodular, marly limestone, becomes cherty interbedded with greenish, black shales, fossiliferous			80%	
677'	Patala Formation		Black, greenish, micaceous shales with thin bands of sandstone	100%	NR	70%	
715'	Lockhart Limestone		Grey, hard limestone containing fossils				

Patala Form.  
698'-700'  
Coal = 1.0  
694'-695'  
Patala Form.  
Bottom of hole at  
717'-3"

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. JR-2  
 Area : JHANIRAH(B) 433/10 Date of start: 24-12-85  
 Location(Coordinates): 1033500N, 3471400E Date of completion: 3-2-86  
 Ground Elevation: 2600 feet Logged by: Shahbaz Hussain, Geologist  
 Drilling Agency: I.V.C.C.  
 Type of rig: Longyear-124 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Chargali Formation		Cream colored, fine grained massive limestone, interbedded with green, medium grained somewhat fractured	100%		60%	
75'	Sakesal Limestone		Light grey hard limestone becomes off white and contains a number of microfossils. Bluish marly limestone, cherty towards upper section, fractured, calcareous along fracture.	Non Coring		75%	
295'	Nammal Formation		Grey to white and some- times cream colored limestone. Chalky and interbedded with dark grey calcareous shales - fossiliferous, fractured.			85%	
480'	Pabla Formation		Black carbonaceous shales with white grey sandstone very thin coal seams.	100%	NA	75%	
514' 524'±5"	Lockhart Limestone		Dark grey nodular massive limestone.				



Bottom of hole at  
524'±5"

504'

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. JA-3  
 Area : JHANIKAH (B) 43D/10 Date of start: 27-11-86  
 Location (Coordinates): 183540N, 346930E Date of completion: 9-12-86  
 Ground Elevation: 2650 feet Logged by: Ayub Asghar, Geologist  
 Drilling Agency: PUNJMIN  
 Type of rig: Longyear-34 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Alluvium & Chargali Formation		Clay and silt creamy limestone, intercalated with marls also containing greenish marls & shales in an alternating manner, fractured to a certain extent.	100% None Core		25%	
198'	Sakesar Limestone		Coarse grained grey cherty limestone with bands of greenish & khaki shale, highly fractured, massive bands at base.	90% 98%	80	50% 90%	
348'	Mominat Formation		Soft, white nodular limestone containing marls, fossils: bryozoans and moderately fractured	95%		75%	
484'	Pakala Formation		Greenish, black fibrous shales, containing pyrite.	98%		70%	
511' 530'	Lockhart Limestone		Grey hard limestone.				Bottom of hole at 530 feet. No coal seam encountered.

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. JC-4

Area : JHANNI (B) 43 D/10

Date of start: 27-2-87

Location (Coordinates): 1035230N, 3474010E

Date of completion: 29-3-87

Ground Elevation: 2660 feet

Logged by: Ayub Asghar, Geologist

Drilling Agency: PUNJAB

Type of rig: Longyear - 34

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Alluvium		Loamy soil with pebbles	100%			
70'	Kamial Formation		Dark red coarse grained bedded sandstone, clayey behaviour towards base	100%		70%	
186'	Chargali Formation		Cream coloured limestone with greenish, marlous shales inter bedded	100%	NQ	75%	
256'	Sakeer Formation		Grey, off-white cherty limestone containing greenish shales towards base, contains abundant microfossils, highly fractured, massive towards base	100%	BQ	90%	
518'	Nammal Formation		Soft, white, nodular limestone interbedded with mass of yellow colour and greenish shales, fractured behaviour	78%	BQ	55%	
644'	Potaba Formation		Black carbonaceous shales with thin sand layers	93%	BR	75%	
683' 686'	Lachhri limestone		Hard, grey limestone transitional zone				Bottom of hole at 686 feet. No coal seam encountered

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. JR-5  
 Area : JHANIRAH (B) 432/15 Date of start: 16-6-1987  
 Location (Coordinates): 1036400N, 3475300E Date of completion: 2-7-1987.  
 Ground Elevation: 2650 feet Logged by: Ayub Asghar, Geologist  
 Drilling Agency: PUNJMIN.  
 Type of rig: Longyear-34. Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
55'	Alluvium		Silty clay with sand.	100		20%	
	Kamrial Formation		Dark brown coarse grained sandstone	Non coring		25%	
358'				95%		50%	
438'	Changai Formation		White to cream lime- stone with muds.	99%		70%	
	Sakriah Formation		Gray to white limestone mixed with shale, fossiliferous, towards base contains black shales.	82% 75%		95%	
696'	Kamrial Formation		White soft limestone ms. (or, mostly interbedded) with black shales.	78%		70%	
818'	Patala Formation		Black calcareous shales with white limestone	75%		85%	
858' 860'	Local limestone		Hard dark green limestone				Bottom of hole at 860 feet. No coal immediately encountered.

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. JR-6  
 Area : JHANIRAN (B) 430/10 Date of start: 6-5-87  
 Location (Coordinates): 1037200 N, 3473700 E Date of completion: 21-5-87  
 Ground Elevation: 2610 feet Logged by: Alyub Asghar, Geologist  
 Drilling Agency: PUNJNIN.  
 Type of rig: Longyear-34 Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0'	Alluvium		Silt & clay mixed with sand	100		10%	
35'	Kamrial Formation		Dark red coarse grained sandstone with maroon clays, sandstone contains angular pebbles.	Non Core		20%	
212'	Chargali Formation		White limestone contain- ing layers of khaki- green shales, moderately fractured	95%		60%	
307'	Sakesar Limestone		Light grey cherty limestone, well bedded, becomes massive towards base, highly fractured, towards base greenish, khaki shales.	95%	80	90%	
569'	Nammal Formation		White soft, nodular limestone with thin black calcareous shales	1			
645'	Patala Formation		Black carbonaceous shales interbedded with sandy layers.	90%		80%	
734' 738'	Lockhart Limestone		Grey limestone mixed with shales, transition- al zone				Bottom of hole at 738'. No coal seam encountered

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. JR-8

Area : JHAMIRAH (B) 43D/10

Date of start: 7-1-87

Location (Coordinates): 1035600N, 3470500E

Date of completion: 24-1-87

Ground Elevation: 2600 feet

Logged by: Ayub Asghar, Geologist

Drilling Agency: Punjmin

Type of rig: Longyear-34

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
0	Chargali Formation		White dolomitic limestone with marls.	100%		50%	
85	Sakesar Limestone		white to grey cherty limestone interbedded with greenish marls	75%	80	85%	
325	Nammal Formation		white, soft, chalky appearance, nodular limestone, containing black shale.			90%	
465	Patala Formation		black carbonaceous shale, contains coal + pyrite	98%		90%	
500 512	Lockhart Limestone		Hard grey limestone				

Bottom of hole at 512 feet. Found a poor quality. Alternating layers of coal and sandy material. Also impregnated with pyrite.

?

488'-489'-9"  
488'-9" to 489'-6"

9"7

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. *N16-1*

Area : *MAGHAL*

Date of start: *15-6-85*

Location (Coordinates): *50090N, 94400E*

Date of completion: *24-7-85*

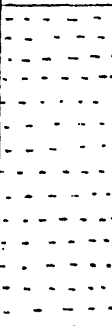
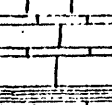
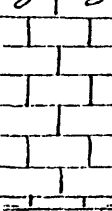
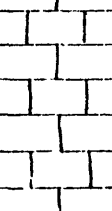


Ground Elevation: *2486 feet 43 2/4*

Logged by: *Shabbir Hussain, Geologist*

Drilling Agency: *I. V. C. C.*

Type of rig: *Longy car - 38*

Scale: *1"=100'*

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
<i>15'</i>	<i>Alluvium</i>	<i>m m</i>	<i>Dark brown sandy loam.</i>				
<i>245'</i>	<i>Kamial Formation</i>		<i>Dark brown and maroon coloured Coarse grained sandstone -</i>			<i>10%</i>	
<i>332'</i>	<i>Chorgali Formation</i>		<i>cream coloured marly limestone with alter- nating maroon marls, flaggy, fractured</i>	<i>Not coming</i>	<i>4"</i>		
<i>485'</i>	<i>Sakasa Limestone</i>		<i>Light grey cherty limestone, fractured and fossiliferous, becomes massive in lower portions, greenish shales at base.</i>			<i>100%</i>	
<i>645'</i>	<i>Nammal Formation</i>		<i>Light grey, creamish marly limestone, nodular appearance, fractured and fossiliferous</i>				
<i>701'</i>	<i>Patala Formation</i>		<i>Dark green carbonaceous shales with Patala and pyritic nodules, calcareous.</i>			<i>80%</i>	<i>Parti coal.</i>
	<i>Lockhart Limestone</i>				<i>NQ</i>		<i>685' - 682' 10" = 2' 10"</i> <i>coal</i> <i>682' 10" - 682' 10" = 10"</i>



# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. MG-2

Area : MAGHAL

Date of start: 27-7-85

Location (Coordinates): 38350N, 97200E  
430/14

Date of completion: 6-8-85

Ground Elevation: 2435 feet

Logged by: Shabbir Hussain, Geologist.

Drilling Agency: I.V.C.C.

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Cord Rec. %	Core Dia.	Water Loss %	Remarks
136'	Alluvium		Silty clay loamy soil mixed with gritty materials, dark brown clay in basal parts.	100		15%	
207'	Chorgali Formation		cream coloured marly l-st intercalated with maroon & yellow coloured marls & shales, fractured.				
391'	Sakesai Limestone		Light grey limestone, nodular, massive with chert in upper parts, highly fractured and lower contact with Nammal formation is marked by grey greenish shales and marls, highly fractured.	Non Coring	4"	70-80%	
490'	Nammal Formation		White limestone interbedded with marl of light grey to bluish color, argillaceous l-st, lower contact transitional, fractured & fossiliferous.				
541'-8"	Patala Formation		Dark greenish shales, carbonaceous, interbedded with l-st, contains coal seams.		NQ	60%	Coal seam 523'-6" to 525'-1" = 19"
543'-8"	Lockhart Limestone		Grey to light grey l-st with minor marls.				Parti 526'-6" to 527'-1" = 6" 531'-4" to 533'-6" = 24" Bottom of hole at 543'-8"

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. MB-3

Area : NAGHAL

Date of start: 12-8-85

Location (Coordinates): 41500N, 95850E

Date of completion: 11-9-85


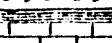
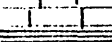

Ground Elevation: 2530 feet 430/14

Logged by: Shabbir Hussain, Geologist

Drilling Agency: I. V. C. C.

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
65'	Alluvium	~ ~	Brownish silty loamy material mixed with grits.	100		10%	
420'	Kamlial Formation		Dark brown coarse grained layered sandstone mixed with angular pebbles, maroon shales & clays in basal part.	Non coring	4"	50- 80%	
440'	Iskeja Limestone		Light grey cherty limestone				
451'	Naminal Formation		Whitish with marls.				
509'-11"	Patala Formation		Dark green carbonaceous shales with bands of i.s.t containing coal seams.		NQ		Coal seam 494'-0" to 495'-2" = 14"  Bottom of hole at 509'-11".

# Bore Hole Log

Project:Coal Exploration Project

Bore Hole No. *MG-4*

Area : MAGHAL

Date of start: 14-9-85

Location(Coordinates): 41300 N, 97900 E

Date of completion: 23-10-85

Ground Elevation: 2440. feet <sup>43 D/14</sup>

Logged by: *Sirabbir Hussain, Geologist.*

Drilling Agency: I. V. C. C

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
130'	Alluvium		yellow to brown clays mixed with sand and silt.			10%	
230'	Kamliel Formation		Dark brown coarse grained sandstone with maroon clays.				
380'	Sakasa Limestone		Light grey nodular l.st. with chert nodules in upper part, highly fractured and fossiliferous mixed with marls, marked by greenish shales at base.	Non string	4"	80-90%	
475'	Nammal Formation		White to cream coloured limestone mixed with marls, calcareous shales in middle part, fractured.				
544'	Patala Formation		Dark green carbonaceous shales, mixed with pyrite and thin bands of l.st. No coal seam present.	93%	N2		Bottom of No. 1 546'-10". No coal seam encountered.
546'-10"	Lockhart Limestone		Light grey l.st. mixed with marls.				

# Bore Hole Log

Project: Coal Exploration Project Bore Hole No. *MG-5*  
Area : *MAGHAL* Date of start: *1-11-85*  
Location (Coordinates): *41250 N, 92250 E* Date of completion: *21-11-85*  
Ground Elevation: *2555 feet* Logged by: *Shabbir Hussain, Geologist*  
Drilling Agency: *I. V. C. C.*  
Type of rig: *Longyear-38* Scale: *1"=100'*

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
<i>40'</i>	<i>Alluvium</i>		<i>yellow to brown clays and silts.</i>	<i>100</i>		<i>10%</i>	
<i>210'</i>	<i>Sakesar Limestone</i>		<i>light gray bluish limestone, with cherty nodules, highly fossiliferous, fractured, base marked by greenish shales.</i>	<i>Non coring</i>		<i>90%</i>	
<i>330'</i>	<i>Nammal Formation</i>		<i>Cream coloured micaceous limestone, soft and mixed with mails of yellowish colour, fractured nature, interbedded with calcareous shales.</i>	<i>1</i>			
<i>380'</i>	<i>Patala Formation</i>		<i>Dark green carbonaceous shales with sandy bands. No coal seam.</i>	<i>98%</i>	<i>NA</i>		<i>No coal seam present.</i>
<i>386'</i>	<i>Lochhart Limestone</i>		<i>light grey argillaceous limestone.</i>				<i>Bottom of hole at 386 feet.</i>

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. 113-6

Area : MAGHAL

Date of start: 24-11-85

Location (Coordinates): 39700N, 95150E

Date of completion: 7-2-86

Ground Elevation: 2435 feet. 430/14

Logged by: Shahabir Hussain, Geologist

Drilling Agency: I. V. C. C.

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
95'	Alluvium	m m m m m m	yellow to light brown clays mixed with sand and silt.	100		10%	
475'	Kamlial Formation		Dark brown coarse grained sandstone, with maroon coloured shales and clays at base.	Nm coreing	4"	80-90%	
475'	Chargal Formation		Green coloured l.s. with marls.				
484'	Sakesar Limestone		White l.s. interbedded with marls of light grey to bluish colour, argillaceous l.s., highly fractured and fossiliferous.				
606'	Nammal Formation		light grey limestone, nodular, massive with chert in upper parts - (cherty appearance) highly fractured and lower contact consists of - contain dominantly shales.				
818'							
850'-4"	Patala Formation		Dark green sandstone shales - contain coal.	97%	NR	80%	Coal seam
855'	Lockhart Limestone						829'-10" to 831'-4" = 18" and 836'-0" to 837'-8" = 12" Bottom of hole at 855 feet.

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. 113-7

Area : MASHAL

Date of start: 17-12-86

Location (Coordinates): 49800N, 96750E

Date of completion: 29-3-87

Ground Elevation: 2425 feet <sup>432/14</sup>

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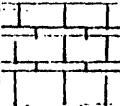
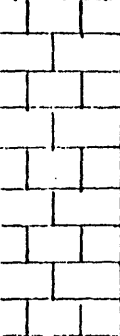
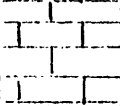
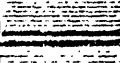
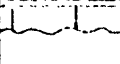
Ayub Asghar, Geologist

Drilling Agency: PUNJMIN

Saeed Akhtar, Asst. Geologist

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
136'	Alluvium	n n n n n n	yellowish clays mixed with sand and silt.	Non coreing		10%	
207'	Chargali Formation		cream to white mainly limestone, interbedded with marl and yellow marls and flaggy limestones.				
439'	Sakesar Limestone		light gray to bluish coloured limestone nodular behaviour, mixed with minor marls, massive in lower portions, fractured & fossiliferous.	97%	NQ	80-90%	
509'	Nammal Formation		limestone of white to gray colour mixed with marls, fractured nature.				
550'	Pakla Formation		dark green carbonaceous shale with thin sandy bands contains Pakla coal.	73%	BQ		Pakla Coal 542'-5" = 16" 543'-9" = 16" and 546'-0" = 5" 546'-5" = 5"
675'-10"	Lochard Limestone		light gray nodular limestone.				

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. MG-8

Area : MAGHAL

Date of start: 15-4-87

Location (Coordinates): 49750 N, 98850 E

Date of completion: 18-5-87

Ground Elevation: 2490 feet <sup>430/14</sup>

Logged by: Sajeeb Akhtar, Asstt. Geol. Engg.

Drilling Agency: PUNJMIN

Type of rig: Longyear-38

Scale: 1"=100'

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
166'	Alluvium		yellow brown silty loam, sand dominating mixed with gritty material.	100% non coring	4"	10%	
239'	Chorgali Formation		cream to light grey limestone with alternating marls, flaggy, sparsely fractured.				
386'	Sakras Limestone		Light grey coarse grained limestone, becomes massive towards base, highly fractured.	95%	NQ	90%	
431'	Nammal Formation		Light grey marly limestone, interbedded with marls.				
461.8'	Patala Formation		Dark green carbonaceous shales, alternating layers of marls.	91%	BQ	80%	
475'	Lockhail Limestone		Light grey medium to marly limestone.				

Details of Parate

452-7	(i)
453-10	(ii)
454-2	(iii)
455-4	(iv)
456-8	(v)
457-10	(vi)
458-11	(vii)
459-12	(viii)

# Bore Hole Log

Project: Coal Exploration Project

Bore Hole No. *MG-9*

Area : *MAGHAL*

Date of start: *10-6-87*

Location (Coordinates): *1039300N 349780E*

Date of completion: *25-10-87*

Ground Elevation: *2410 feet*

Logged by: *Ayub Asghar, Geologist*  
*Saeed Akhtar, ASH Geologist*

Drilling Agency: *PUNJIN*

Scale: *1"=100'*

Type of rig: *Longyear-18*

Depth (in feet)	Formation	Legend	Lithologic Description	Core Rec. %	Core Dia.	Water Loss %	Remarks
	<i>Alluvium</i>		<i>Silty clay mixed with sand and gravel material</i>	<i>2 in dia</i>		<i>10%</i>	
<i>150'</i>							
	<i>Kamrial Formation</i>		<i>Dark brown to red, dark sandstone containing angular pebbles, interbedded with red clayey material.</i>	<i>100%</i>	<i>NA</i>	<i>20%</i>	
<i>550'</i>							
	<i>Chargu Formation</i>		<i>White to cream limestone with wavy interbedding</i>	<i>75%</i>	<i>NA</i>	<i>70%</i>	
<i>590'</i>							
	<i>Sakasar Limestone</i>		<i>Greyish cherty limestone highly fractured. Greenish shale towards base</i>				
<i>670'</i>							
	<i>Naminal Formation</i>		<i>White, soft chunky ls., fractured with interbedding of greenish shale.</i>	<i>75%</i>	<i>32</i>	<i>100%</i>	
<i>820'</i>							

*Continued sheet - 2*



## APPENDIX III

### DATA POINT LOCATION MAPS AND PROPOSED DRILLING AREAS FOR THE SALT RANGE

	Page
Four maps.....	In back pocket
Code and source for data points.	

## CODE AND SOURCE FOR DATA POINTS

The following is a list of prefixes that are used on the data point location maps to identify data from different sources. All data points that have the common a prefix are from the same source which is listed below.

### Sheet 3

O- .....Warwick and Shakoor field observations, Appendix I  
S- .....Warwick and Shakoor measured sections, Appendix I  
CDH-.....GSP boreholes form the 1960's, Appendix II  
CSR-.....Shah measured sections, Appendix II and Shah (1980)  
IS-.....Coal thickness data from Shah (1980)  
WS-.....Measured sections from Wynne (1878), section number  
          refers to page number from Wynne (1878)  
KB-.....PUNJMIN boreholes, Appendix II

### Sheet 4

O- .....Warwick and Shakoor field observations, Appendix I  
S- .....Warwick and Shakoor measured sections, Appendix I  
CDH-.....GSP boreholes form the 1960's, Appendix II  
CSR-.....Shah measured sections, Appendix II and Shah (1980)  
IS-.....Coal thickness data from Shah (1980)  
WS-.....Measured sections from Wynne (1878), section number  
          refers to page number from Wynne (1878)  
MA-.....Measured sections by Akhtar (1985)  
JR-.....PUNJMIN boreholes, Appendix II  
PJ-.....PUNJMIN boreholes, Appendix II

### Sheet 5

O- .....Warwick and Shakoor field observations, Appendix I  
S- .....Warwick and Shakoor measured sections, Appendix I  
WS-.....Measured sections from Wynne (1878), section number  
          refers to page number from Wynne (1878)  
ESR-.....Mashhadi and Shakoor measured sections, Appendix II  
MA-.....Measured sections by Akhtar (1985)  
D-.....Javed and Hussain measured sections, Appendix II  
G-.....Javed and Hussain measured sections, Appendix II  
M-.....Javed and Hussain measured sections, Appendix II  
W-.....Javed and Hussain measured sections, Appendix II  
DL-.....GSP coal thickness data from Alam et al (in press)  
DT-.....GSP coal thickness data 1987-88 field season, Alam et  
          al (in preparation)  
GSP-.....GSP boreholes, Alam et al (in press)  
WH-.....PUNJMIN boreholes, Appendix II  
WA-.....PUNJMIN boreholes, Appendix II  
MG-.....PUNJMIN boreholes, Appendix II  
GEE-.....Borehole reported by Gee (1938, p. 301)

Sheet 6

O- .....Warwick and Shakoor field observations, Appendix I  
S- .....Warwick and Shakoor measured sections, Appendix I  
WS-.....Measured sections from Wynne (1878), section number  
          refers to page number from Wynne (1878)  
ESR-.....Mashhadi and Shakoor measured sections, Appendix II  
LTS-.....Measured section from LaTouche (1894)  
LTM-.....Mine coal thickness data from LaTouche (1894)  
LTD-.....Drift coal thickness data from LaTouche (1894)  
LTGSD-....Government drift coal thickness data from LaTouche  
          (1984)  
MN-.....Warwick and Shakoor mine thickness data, Appendix I

**APPENDIX IV**

**PALEOCENE COAL AND CARBONACEOUS SHALE  
THICKNESS MAPS FOR  
THE SALT RANGE**

**Six maps..... In back pocket**