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Nature, origin and mode of occurrence of Hangu-Kachai area coal, district Kohat, NWFP, Pakistan: A preliminary study

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ABSTRACT: *Coal showings are known from the Hangu Formation of Paleocene age in the Hangu-Kachai area, northwest of Kohat. The Hangu Formation is well developed in this area and is comprised of quartzitic sandstone with minor intercalations of shale. The coal seam is developed near the upper contact of the Hangu Formation with the overlying Lockhart Limestone. Preliminary exploratory drilling of the Hangu Formation in the area have revealed the presence of coal. The coal is dull to shinning black and ranges from high volatile B to C bituminous in rank. The Hangu area coal occurs in the form of discontinous stringers and lenses and is less than 2 metres thick.*

The average analytical results on as recieved basis indicate, the coal bed contains 0.52% moisture, 14.2% ash, 4.2% sulphur, 53% fixed carbon and 32.64% volatile matter. Based on the average BTU/lb and fixed carbon content of the Hangu-Kachai coal samples collected from the field, with minor exception of variation in colour, the Hangu coal is analogous to the known coals of the Balochistan and the Salt Range areas. On the basis of its stratigraphic position, mode of origin and structure, the Hangu-Kachai coal is comparable with the Makarwal coal of the Surghar Range. Detailed exploratory studies are proposed to evaluate the nature and extent of the Hangu-Kachai area coal.

INTRODUCTION

Coal is regarded as one of the vital energy resource for the economic development of a country. In Pakistan, where there is an increasing demand for sustainable energy resources, coal exploration, so far, has mainly been restricted to the Balochistan, Sindh and Punjab provinces. Recently, the severe on-going energy crisis in the country, the goverment and the power generation sector has shown keen interest for a reappraisal of all the indigenous energy resources including coal and its utilization for electric power generation. Therefore, the Paleocene strata of northern Pakistan, particularly in the province of NWFP, which did not receive much attention in the past, is turning out to be geologically promising in-terms of coal prospects. The detail investigation combined with subsurface drilling programme of the Paleocene strata seem to hold a potential for substantial coal discovery.

The Paleocene strata is exposed along the western margin of the Kohat Plateau, in the hanging wall of the Main Boundary Thrust

(MBT). The MBT marks the northern margin of the Kohat Plateau and brings the Mesozoic and Paleocene strata over the Miocene molasse sediments (Abbasi & McElroy, 1991; Meissner et al., 1974). The thickest section of the Paleocene rocks in the Kohat-Potwar plateau is around the study area (Fig. 1) where it is about 1400 metres thick (Meissner & Rehman, 1973). The Paleocene strata here, is tightly folded into a number of east plunging folds and has also been deformed by a number of thrust faults (Fig. 1). The Paleocene succession is comprised of clastic and non-clastic facies. The Hangu Formation represents the clastic facies of the Paleocene strata and is also a host for coal deposits from this area. The coal occurs in the

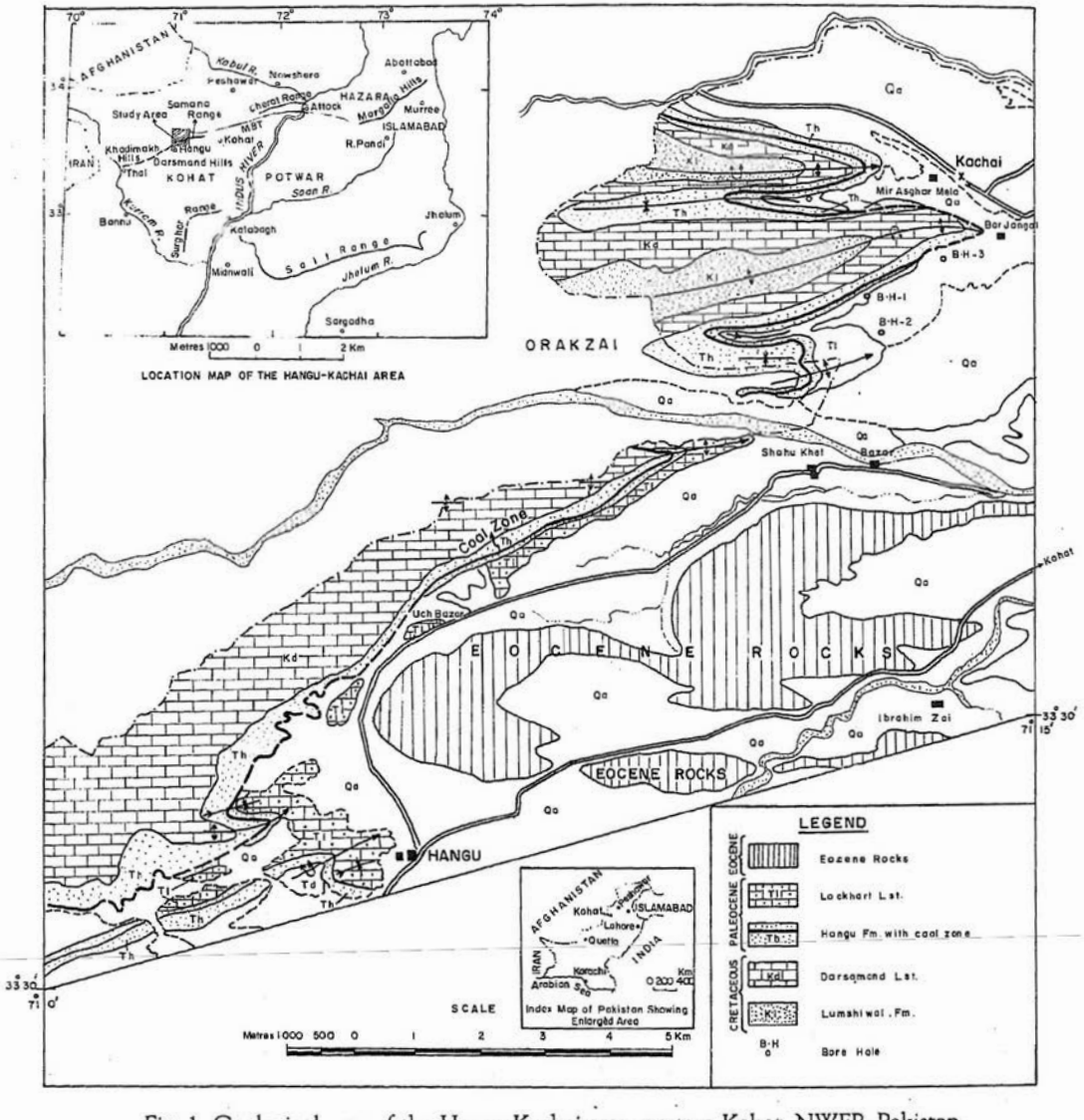

Fig. 1. Geological map of the Hangu-Kachai area, western Kohat, NWFP, Pakistan.

form of lenses and is located in the argillaceous facies in the upper part of the formation. The thickness of the seam is variable and is distributed over a large area around the Hangu and in Samana Range (Fig. 1). The present study deals with the description and the genesis of coal in Hangu-Kachai area of Kohat.

The study area is located about 25 Km northwest of the Kohat city (lat. 33° 30′ to 33° 40′ N and long. 71° to 71° 15′ E). The area was first mapped on 1:250,000 scale by a joint USGS-GSP working group (Meissner et al., 1974, 1975). Fatmi (1973) measured and described several stratigraphic sections and established the stratigraphic relationships of the Mesozoic and Tertiary strata in the area (Fig. 2).

DESCRIPTION OF THE HANGU FORMATION

The Hangu Formation of Paleocene age (Shah, 1980) is widely distributed in northern Pakistan. Regionally, the formation is exposed in a large area of the Salt Range, Surghar Range, Attock-Cherat Ranges, Hangu and Samana Ranges in the Kohat and in the Hazara areas. In the study area, the Hangu Formation unconformably underlies the Paleocene Lockhart Limestone (Fig. 2). At its type locality, the formation is comprised of light gray to reddish brown quartzose sandstone. The sandstone is fine to medium grained, predominantly cemented by silica and contains trace fossils. Gradded bedding, low-angle cross bedding and trough cross bedding are the common sedimentary structures. At places, tabular and herringbone cross bedding are also present. In Makarwal area (Danilchik & Shah, 1987) the lower contact of the formation lies at the base of the lateritic bed . The base of the formation in the Hangu area is marked by a 1-2 m thick laterite beds. The unit above the laterite beds is medium to coarse-grained, pebbly, quartzose sandstone. The coal seam ranging in thickness from < 1 m to 2 m is present near the upper contact (~ 5-7 m) of the formation with the overlying Lockhart Formation in the study area.

The thickness of the formation is variable from south to north. At Hangu, the maximum thickness of the formation is about 105 m, whereas, it is reportedly 1 m thick at Mastura river in the north (Khan et al., 1988).

The quartzose sandstone of the Hangu Formation is generally well sorted, mature, clean and cross-bedded. On the basis of its lithology and sedimentary structures the formation is interpreted as deposited in a high energy, marginal marine depositional environment. This interpretation is supported by relatively good textural and compositional maturity of the sandstone. In such environments, the role of wind in achieving maturity of the sediments, is widely documented from the study of modern environments. Sands brought to the coastal area can become highly quartzose (90-95% Quartz) by enrichment from local coastal sediments (Cleary & Condolly, 1971). The formation of coal is indicative of luxurient organic growth under hot and humid climatic conditions normally present in the coastal swamps.

DESCRIPTION OF COAL

The coal of the Hangu area is dull to shinning black in colour and ranges from high volatile B to C bituminous in rank (Landis et al., 1971), with occasional disseminated pyrite grains. The thickness of the seam varies from half a metre to 2 metres, and it is in the form of lenses and stringers. Three bore holes were drilled by the Geological Survey of Pakistan to determine the subsurface trend, thickness, depth and lateral extent of the coal seam in the Hangu-Kachai area (Fig. 3). In bore hole 1, the coal seam is located at a depth of 138 metres and is 0.8 m thick. The coal bearing shales are 1.8 m and

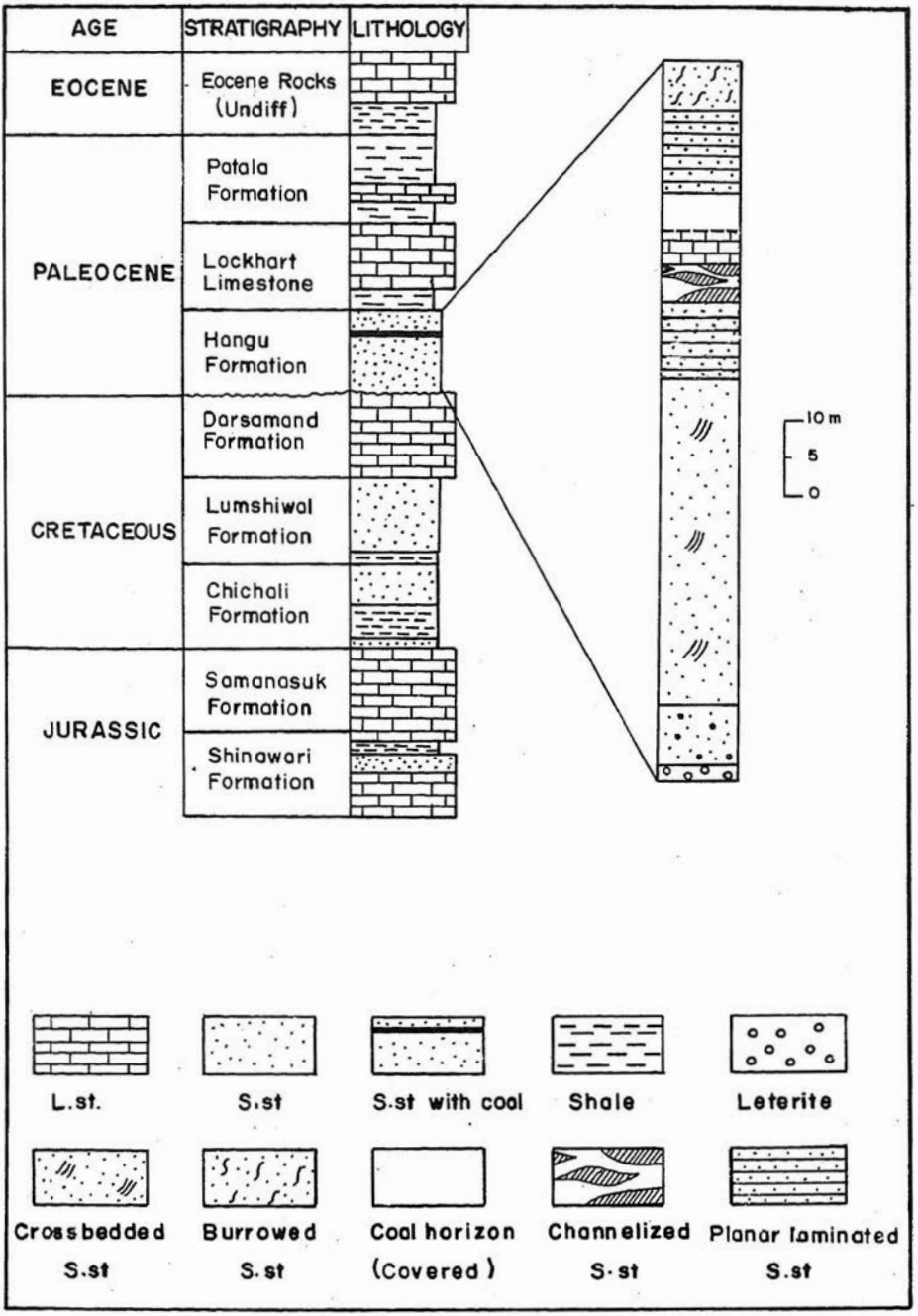

Fig. 2. Stratigraphy of the Hangu area, western Kohat and measured stratigraphic section of the Hangu Formation in Fort Lockhart area.

1.5 m thick in the bore hole 2 and 3, and appear at a depth of 160 and 220 m, respectively (Fig. 3).

The Hangu coal ranks from lignite to sub-bituminous with more than 50% fixed carbon and the heating value BTU/lb exceeding 13,000 (7228 K cal/Kg) (Table 1). The preliminary chemical analyses indicate that inspite of slightly higher sulphur content these coal can still be used for industrial and domestic purposes.

DISCUSSION

The major coal fields of Pakistan are Paleocene in age, mostly confined to the Indus Basin, the only exception being the coal fields of Balochistan that are located in Eocene strata (Table 2). The lack of age correlation within these two belts is believed to be the result of the Paleocene fragmentation of the Tethyan sea when some parts of it became emerged (Haq, 1984). Shallow marine and near shore sedimentation during the Paleogene times concurrent with the development of isolated lagoonal and lacustrine conditions favoured the coal formation in parts of the Indus Basin. The coal beds formed in such depositional environments tend to be more linear and laterally extensive. This predictive depositional model is well in conformity with the coal fields in the Sind province.

Coal from different areas of Pakistan generally rank from lignite to sub-bituminous (Table 2). These coals are friable, with a relatively high content of ash and sulphur and an average heating value in the range of 6000-12900BTU/lb. These coals are characterized by marked physical and chemical variations, both within individual and from one coal field to another (Ahmed, 1986). The coal of Makarwal area (Surghar Range) is located in the carbonaceous shale deposits of the Paleocene Hangu Formation and has similar physical and chemical properties as that of the Hangu coal. The comparison of analytical data from various coal fields of Pakistan (Table 2) indicates that the lowest rank coals (lignite to sub-bituminous) are from Sind Province while the highest rank coals occur in Balochistan, Punjab and N.W.F.P. (Warwick & Javed, 1990). The Balochistan and Hangu coals have relatively higher fixed carbon content and heating value than most of the other coals of Pakistan. In both of these areas, evidence of extensive tectonic activities in the form of intense folding and faulting are believed to have attributed to enhancing the maturity of these coals.

The coal deposits of Pakistan are relatively younger in age and are poorer in grade because of the short span of putrefaction and particular environments these were deposited in (Ahmed, 1986). The trace elements analyses indicate that Pakistani coals have similar ranges as coals of comparable rank in the United States (Warwick & Javed, 1990). Lignite to sub-bituminous coals of Paleocene to Eocene age are found in many parts of the continental interior in the United States. These include an extensive area of essentially flat-lying beds in north Dakota, Colorado, Wyoming and Montana (Ward, 1984). Extensive deposits of low rank coal occur in Tertiary strata of the Gippsland Basin in eastern Victoria (Australia), central Europe and in India (Ward, 1984).

CONCLUSION

The present study shows that a single, 0.5 to 2 m thick, laterally discontinous, coal seam is present in the upper part of the Hangu Formation. The preliminary results indicate that the coal from this area could be economically viable, if the major influencing parameters such as, the physical setting of the coal deposit is properly investigated. To achieve this objective, a detail study of the entire coal horizon is in progress and the data obtained through this effort will subsequently be presented.

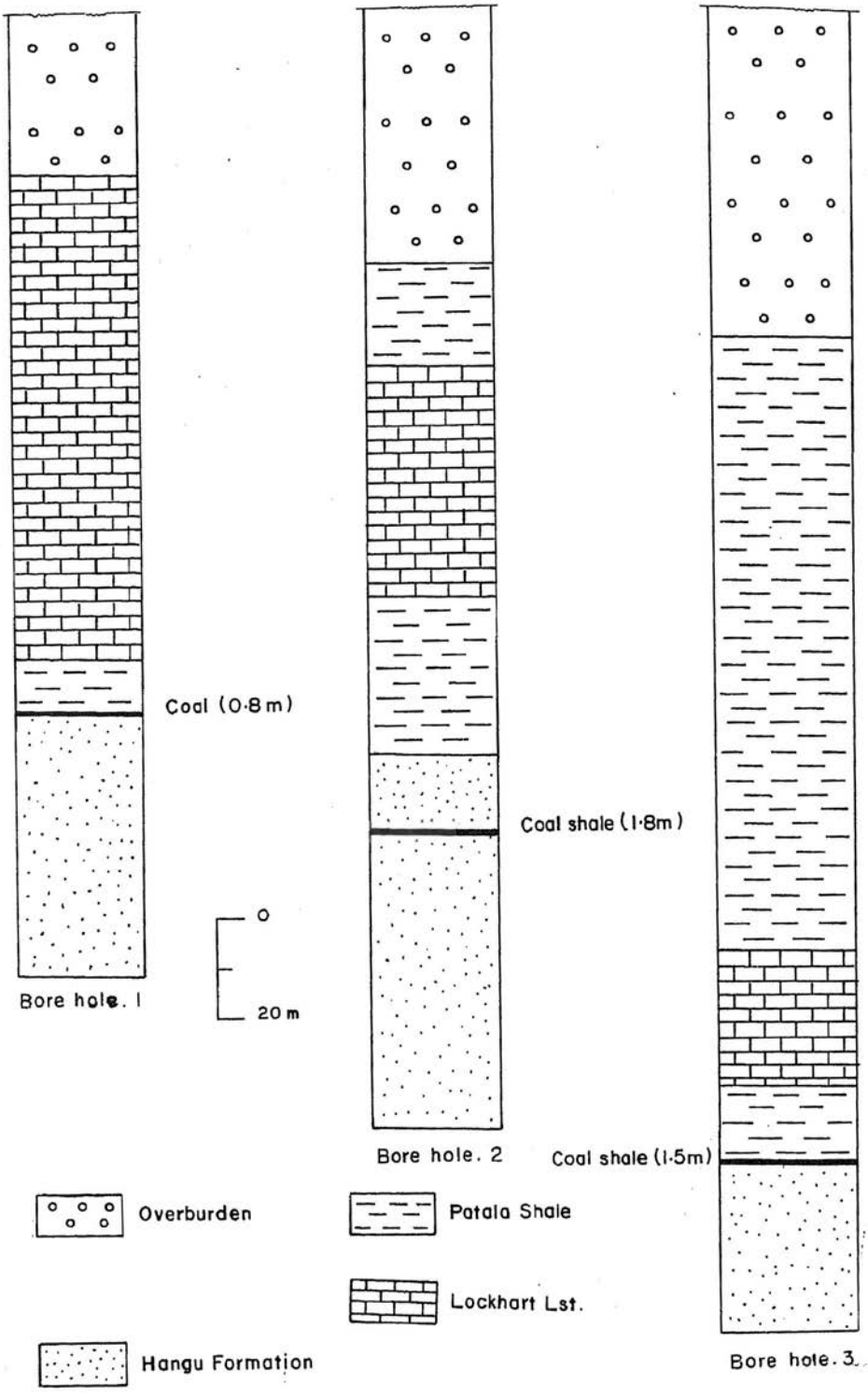

Fig. 3. Stratigraphic column of bore hole from the Hangu-Kachai area. Location of bore-holes is marked on Figure. 1.

TABLE 1. PROXIMATE ANALYSES OF HANGU COAL* (ON AS RECEIVED BASIS)

No.	Sample No.	Moisture %	Ash %	Volatile matter %	Fixed carbon %	Air dry loss %	Total sulphur %	Sp. Gravity (Appt)	Heating value (BTU/lb)
1.	HC. 1-90	0.70	14.65	32.50	52.24	7.97	4.51	0.98	12828
	Dry	—	14.66	32.73	52.67	4.54	—	—	12918
	Dry ash-free	—	—	38.35	61.65	5.32	—	—	15138
2.	HC. 2-90	0.17	13.20	36.14	50.49	0.27	3.53	0.90	13362
	Dry	—	13.22	36.20	50.58	—	3.54	—	13385
	Dry ash-free	—	—	41.72	58.28	—	4.07	—	15424
3.	HC. 3-90	0.16	14.71	29.28	55.85	3.87	4.54	0.90	13148
	Dry	—	14.73	29.33	55.94	—	4.55	—	13169
	Dry ash-free	—	—	34.39	65.61	—	5.33	—	15444

* Analysis performed at the Geological Survey of Pakistan

TABLE 2. COMPARATIVE ANALYTICAL DATA OF THE VARIOUS COAL FIELDS OF PAKISTAN

Name of Coal Field	Age	Formation	Fixed carbon %	Moisture %	Ash %	Total sulphur %	Volatile matter %	BTU/ Lb. %
Hangu Coal	Paleocene	Hangu Fm.	53	0.30	14.9	4.2	30.0	12,918
Attock Cherat Coal	—do—	—do—	52.90	7.1	9.3	3.5	22.0	9,386
Makerwal	—do—	—do—	40.25	5.54	11.19	5.14	43.1	11,237
Salt Range	—do—	Patala Fm.	34.58	7.59	24.29	5.58	33.39	9,115
Sindh	—do—	Bara	25.23	28.46	6.12	4.78	27.98	6,680
Balochistan	Eocene	Ghazij	58.10	9.62	13.59	4.99	40.29	9,816

(After Ahmad et al. 1986, Kazmi et al. 1990 and Hussain et al. 1990)

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