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Review of Tertiary coal fields of lower Indus plain in Pakistan and adjacent areas of Gujrat and Rajasthan states in India

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ABSTRACT: *This paper discusses possible occurences of lignite in a large area of Lower Indus Plain, especially in the desert areas of Thar Parker district and extending over to areas of Gujrat and Rajasthan states in India. Review of available geologic publications, drilling data and projections from known coal fields of southern Sindh in Pakistan and Gujrat and Rajasthan States in Western India, including reports of coal intercepted by oil and water drilling companies in these areas and a recent discovery of 12 to 13 meter thick lignitie coal seam just south of Chachro in Thar Parker , now reasonably substantiate the idea that Thar Parker desert is underlain by vast resources of unexplored coal deposits.*

INTRODUCTION

The location of Tertiary coal fields of Lower Indus Plain and Tahar Parker desert in Pakistan, and Rajasthan and Gujrat States in India, occurs in a structural depression between the fold and thrust belt of central Pakistan to the west and the Precambrian shield and Creto Eocene Tertiary Deccan flood basalts to the east. All the known occurrences of lignite in Lower Indus Plain are in the subsurface, but on the Indian side in Rajasthan and Gujrat coal has been reported to be near the bedrock. The confirmed coal occurences in the Lower Indus Plain (Fig.1) were discovered during 1986 by COALREAP drilling project (SanFilipo et al., 1988; Landis et al., 1988; Durrani & Warwick, 1990). Most of the coal in Rajhastan and Gujrat States on the Indian side is being mined from the bedrock areas, as compared to Lower Indus coal fields where coal has been encountered in the subsurface conditions only. Expanded coal exploration and coal utilization on the Indian side may not have any geologic significance, as compared to the Lower Indus including Thar Parker. But higher coal exploration activity on the Indian side is easy to understand, because bedrock areas generally tend to be more populated compared to desert areas, hence chances of mineral wealth discoveries and its development generally increase when water-well drilling for villages or quarrying activities for the extraction of building stone are carried out. A close examination of known Tertiary coalfields (Fig.1) in Lower Indus Plain and areas of Gujrat and Rajhastan States indicates that potential for subsurface coal deposits can be extrapolated from known coal fields and occurrences in these areas up or down dip to almost everywhere the Tertiary rocks are present. This observation can further be substantiated through the mud log data of Khorewah field in District Badin in Southern Sindh , where Union Texas of Pakistan drilled an exploratory hole (co-ordinates 24° 44' 56.5" N, and 68° 29' 26.373" E) for oil in June, 1988. Coal has been reported to occur at about 10m depth. Geological Survey of Pakistan (GSP) in collaboration with the U.S. Geological Survey (USGS) has prepared a detailed plan to further investigate the area by drilling a shallow drill hole to further confirm the existance , seam thickness and characteristics of the above reported coal. All these field indications, drilling and mud log data suggest that in Lower Indus Plain, Tertiary rocks are the source rocks for the coal deposition. Therefore, in any future coal exploration program in Lower Indus Plain including Thar Desert, it is important to precisely locate the Lower Tertiary rocks at shallow depths, which are yet not erroded away, to allow an economical coal drilling exploration programme.

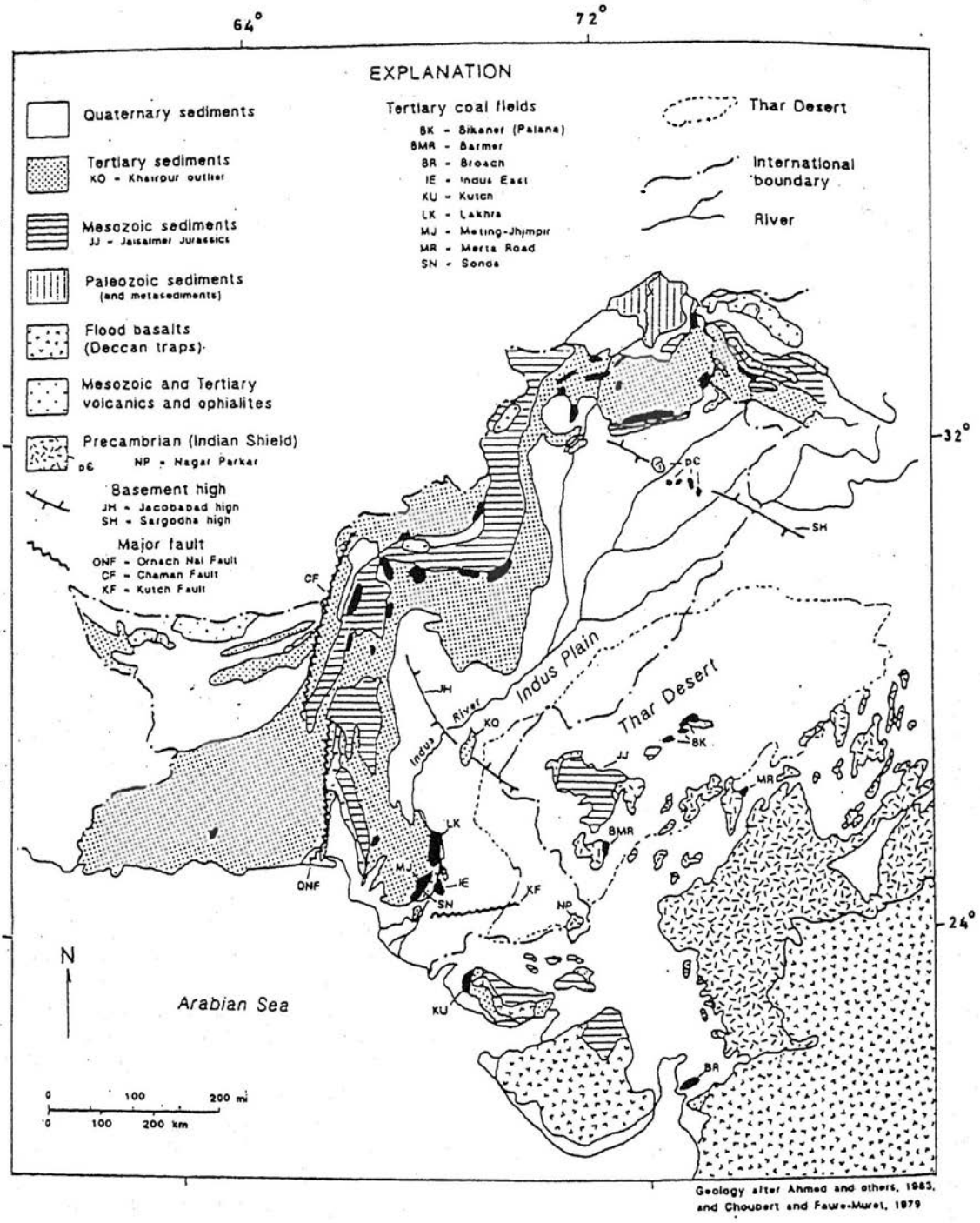

Fig. 1. General geology and location of Tertiary coal fields, Pakistan and west-central India, south of the Himalayan front (after Ahmed et al., 1986).

COAL FIELDS OF LOWER INDUS PLAIN

i. Lakhra: Lignite A to sub-bituminous C; 200 sq.km.
ii. Sonda-Thatta: Lignite A to sub-bituminous C; 650 sq.km.
iii. Meting-Jhimpir: Lignite A to sub-bituminous C;90 sq.km.

(Source= Energy Year Book, 1986)

The coal deposits in Lower Indus Plain (Fig.1) are located in two stratigraphic horizons; the Bara Formation which is encountered at depths from 90 to 245m is of Middle Paleocene age. Thirty centimeter thick coal beds found at depth of 20 to 45m in the upper horizon are associated with the Sonhari Member of the Laki Formation of Early Eocene age. The Sohnari Member consists of siltstones, shales, sandstones, coal, and carbonaceous shale, and is lithologically very similar to the Bara Formation. Both the Sohnari Member and the Bara Formation are near marine, fresh to brackish-water deposits (Ahmed et al., 1986) . The coal from the Lakhra and Sonda fields, in the thicker coal seams of Bara Formation has the following characteristics: the Sonda coal is lower in sulfur (2.6%) and ash (15.4%) as compared to Lakhra coal where sulfur is 5.5%, and ash 19.1%, on as-received basis. On the avarage the coal from the Lakhra and Sonda fields contain 28.4% moisture, 27.9% voltatiles, 25.2% fixed carbon, about 18.3% ash, 4.7% sulfur on as-received basis. Average calorific values for Lakhra coal samples is about 3,660 Kcal/kg, and that of Sonda/ Jherruck about 3,870 Kcal/kg on as-received basis. The coal in Meting- Jhimpir area (Fig.1) is in the Sonhari Member at the base of Laki Formation, Which according to Ahmed et. al. (1986) consists mainly of sandstone and lateritic clay. Meting-Jhimpir coal has the following characteristics : 31.6% moisture, 29.6% volatile matter, 28.15% fixed carbon, 12.5% ash and about 4.0% of sulfur (on as-received basis). Average calorific values for this coal samples is about 4000 Kcal/kg on as- received basis (Kazmi et al., 1990). Only one coal seam in the Sonhari Member and which is generally thin, lenticular and varying in thickness from 0.3 to 1.0m is being presently mined in Meting-Jhimpir area (Kazmi et al., 1990). The coals from these areas have a strong tendency to spontaneous combustion, which makes it difficult for storage and transportation. The Sonda coal seams are thinner (average 2.4m) (Hussain, 1986) compared with those of the Lakhra area which averages about 5m thick, (range 0.2cm to 5.6 m). The Sonda coal is comparably deeper than the coal in Lakhra field (SanFilipo & Khan et al., 1990).

COAL RESOURCES OF LAKHRA/ SONDA/METING-JHIMPIR

The total estimated coal resources by reliability categeory for Lakhra and Sonda, as estimated by Schweinfurth and Hussain (1988) and for Meting-Jhimpir (Kazmi et al., 1990) are summarized in (Table 1).

COAL FIELDS OF GUJRAT STATE, INDIA

Coal was being sporadically mined in the Kutch District of Gujrat well before Wynne conducted his coal survey of 1867-1869 in Gujrat area (Wynne & Fedden, 1872). The coal occurrences reported by Wynne and Fedden were all thin lenticular beds assigned to the Upper Jurassic, but recently placed in the Lower Cretaceous (Biswas, 1971; Anand-Prakash, 1985). After the discovery of several lignite beds upto 10m thick in the northwest part of Kutch (Fig.1) and occuring between 8 and 58 meters depth, the Mesozoic coals

TABLE 1. SUMMARY OF COAL RESOURCES (IN MILLION TONNES) IN LAKHRA, SONDA AND METING-JHIMPIR AREAS IN SOUTHEREN SINDH

Coal field	Measured/Indicated	Inferred	Hypothetical	Total
Lakhra	540	510	30	1,080
Sonda	500	2,500	680	3,700
Meting-Jhimpir	53	108	NA	161

lost their economic significance because of the discovery of thick Tertiary coals in this area (Gowrisankaran et al., 1987).

The largest Tertiary coal deposits in this area, the Panadhro field, has been strip mined since early eighties from Eocene rocks which are generally thought to be equivalent to the Laki Formation of Sindh (Gowrisankaran et al., 1987). Biswas (1965) proposed revised nomenclature for Tertiary of Kutch, but mostly the nomenclature of Sindh is prefered by many Indian geoscientists. A comparison of the stratigraphic nomenclature of Sindh with further revision suggested by Biswas (1971) is shown in Fig.2. Correlation between the coal-bearing intervals of Sindh and Kutch area as shown in Figure 2 can be questionable, because, the thickest coal beds in Kutch are generally thought to be basal Laki (Sonhari Member) equivalents , which are relatively thin in Sindh , While the thin Paleocene coal beds of Kutch are thought to be middle RaniKot (Bara Formation) equivalents ,which are thick in Sindh. The Eocene age, as that of Laki sequence assigned to the Nardi Formation is based mostly on the presence of *Assilina granulosa,* which occurs near the middle of the formation , well above the coal (Biswas, 1965). Therefore, it is possible that the coal-bearing Lower Naredi Formation is actually correlative with the Paleocene upper Bara Formation. Fredrickson (1989) suggests that the Sonhari beds may also be of Paleocene age, based on his study on Palynomorphs. However, additional work is clearly required for a comprehensive correlation of the coal beds of Kutch with those of Sindh.

Several beds of lignite from 3 to 8 meter thick were discovered by oil and gas drilling in the Broach District of Gujrat (Venkatappaya, 1971), about 400 km south of Kutch (Fig.1). At the Jhagadia field of Broach, 700 tons of coal per day are being mined from a 5 meter bed which lies at depths of about 25 to 150m in the Upper Eocene Tarakeshwar Formation (Fig.2) (Gowrisankaran et al., 1987).

The Mesozoic and Cenozoic sedimentary rocks of Kutch generally dip gently to the south from the basement high at Nagar Parkar. Updip projections to southern Thar from Kutch are somewhat complicated by the active Kutch fault zone (Fig.1).

COAL FIELDS OF RAJASTHAN STATE, INDIA

In Rajasthan State of India coal was encountered in 1896 at Palana, near Bikaner (Fig.1). Mining activities, which had started in 1898 in this area, came to a halt in 1966 due to an extensive mine fire (Gowrisankaran et al., 1987). From 1950 to 1967, more than 400 bore holes were drilled, and a surface mine was being planned. A single lignite bed of 4 to 18 meter thickness, occurring at depths of 40 t0 87 meter, in the Laki equivalent of Palana was reported (Gowrisankaran et al., 1987).

The lignite at Palana is described as "*brown to brownish grey colour resembling that of peat... very light (with) marcasite and stringers of resin in... it.*" (Dutta, 1971); "*woody to peaty material, disintegrating rapidly on exposure*" (Brown & Dey, 1975,). High moisture content ranging from 45 percent, and drying to 17 percent on as-received basis has been reported by (Dutta, 1971).

The Palana and Kutch, coals show wide variations, but seem to range from the lignite B (soft brown coal) to subbituminous A range(Brown & Dey, 1975; Bhowmick and Roychaudhri, 1982). The Palana Formation is composed of sandstone, claystone, laterite, and lignite (Kholsa, 1973), and can be inferred from Shrivastava (1971) to be at least 100m thick, and is reported to be directly underlain by the Upper Protorozoic to Cambrian Jodhpur (Vindhyan) Formation at Palana.

Several other coal fields in the Bikaner district (all within 75 km of Palana) have been identified by government of Rajasthan drilling programs. At Gurka there is a zone of lignite with a typical cumulative coal thickness of up to 27m, and a single bed of 72m recorded in one drill hole (Gowriskaran et al., 1987). A 41m coal bed has been reported from Barsingsar in the Bikaner district. Other Tertiary coal field of Rajasthan are shown in Figure 1. At Barmer there are three 5-15m zones of lignite at depths of 55-120m. At Merta Road there are several coal fields eith a 7-8m lignite bed at depth

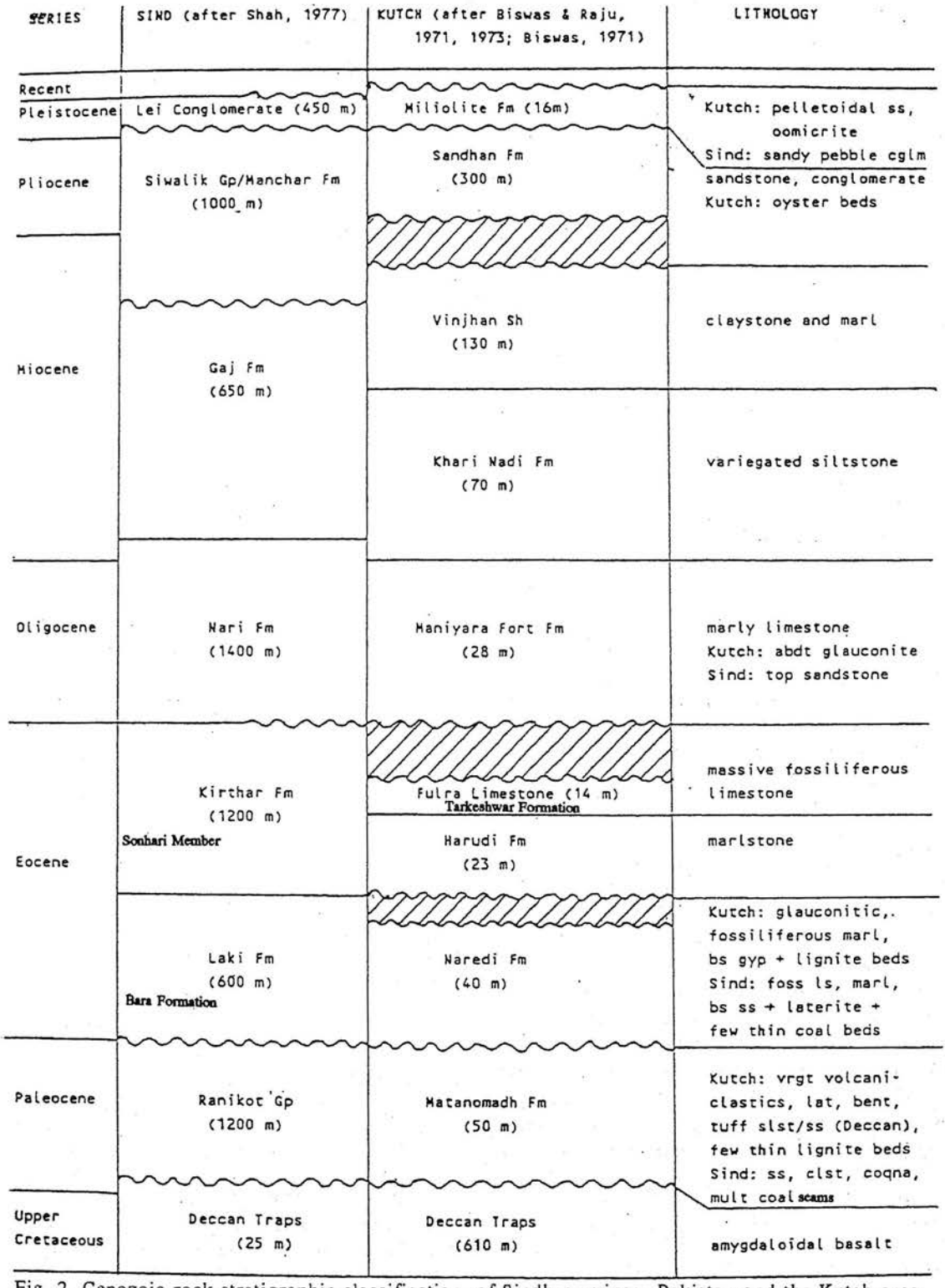

Fig. 2. Cenozoic rock stratigraphic classification of Sindh province, Pakistan and the Kutch area of India. abdt =abundant; ss = sandstone; ls = limestone; gyp = gypsum; cglm = conglomerate; vrgt = variegated; slst = siltstone; mult = multiple; clst = claystone; lat = laterite; bent = bentonite.

of 65-150 meters (Gowrisankaran et al., 1987).

CONCLUSIONS AND RECOMMENDATIONS

A wide variety of subsurface geological data is now available for a comprehensive understanding of Tertiary coal deposition in the Indus Plain. Discovery of about 17 meter thick coal seam south of Chachro in Thar Parker, in a water drill hole by SAZDA (Sindh Arid Zone Development Authority) in 1990 , and more recent discovery of 12 to 13 meter thick coal seam at Dhakla in Thar Parker Desert by the Geological Survey Of Pakistan, further substantiate the coal deposit potential in the Tertiary rocks in the Lower Indus Plain parhicularly in the Thar Parker Desert. Literature review of coal deposits in Gujrat and Rajasthan (India) indicates the similarity of depositional conditions and, especially, of the Tertiary rocks which are bounded to the east by the Indian shield. However, due to a large data gap in Thar Desert area and part of lower Indus plain, at present it would not be possible to correlate the known coal seams with those of the Gujrat and Rajasthan coal fields to the east. But prliminary reports suggest that lignitic (soft brown) coal discovered at Dhaklo by the Geological Survey of Pakistan has strong resembence with the lignite at Palana (Rajhastan) as described descriptions suggested by (Dutta, 1971). However, it would be ideal if geophysical surveys, including resistivity, magnetics, or shallow seismic are conducted in the intervening areas. Investigations would provide the information on bedrock topography and also help to locate where the coal bearing rocks are shallowest for drilling purposes in the areas overlain by sand dunes. It may also help to understand the geometry of the coal seams and its extension in the Tertiary rocks in the reviewed areas.

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