

ON THE GEOLOGY AND CORRELATION OF COAL SEAMS OF PENCH-KANHAN—UPPER TAWA VALLEY COALFIELD, DISTRICT CHHINDWARA, MADHYA PRADESH

H. S. PAREEK

202 E, West End Road, Meerut Cantt. (U.P.)

ABSTRACT

The Satpura Gondwana basin has not drawn as much attention during the recent years, as other basins have from coal geologists for systematic mapping and coal seam correlation. Hence scattered information only is available for parts of coalfields of this basin. The geology of the Pench, Kanhan and Upper Tawa valley coalfields is presented in this paper, which also brings out the coal seams and their correlation in these areas. As all major Gondwana basins have been named after their principal drainage, the term Pench-Kanhan-Tawa valley basin is preferred to Satpura Gondwana basin.

The Lower Gondwana formations of the coalfield include the Talchirs, Barakars and Moturs, while separated exposures of the Upper Gondwanas occur in the Pench valley region. The Talchirs are in faulted contact with the Barakars in the northern portion of the coalfield. Faulting is common in the sedimentaries.

Three coal seams numbered as I, II and III from the top and of thicknesses 1.22-8.53 m., 0.60-1.82 m., and 0.60-2.13 m. respectively, occur within the Barakars. The seam characteristics have been presented. A thin seam, named as Leader, persistently appears following as a younger seam over each of the seams II and III. In the Pench valley region the Leader has coalesced with the respective seams in certain areas. In seam I, a tonstein band appearing microscopically as sandy carbonaceous kaolinitic mudstone grades laterally into shale and siltstone.

INTRODUCTION

AS is well-known, the major Gondwana coalfields of India are restricted to the fresh-water basins named as the Damodar valley, Mahanadi valley, Wardha-Godavari valley, and Satpura Gondwana basins. The attention of coal geologists that has been drawn is of a lesser significance with respect to the Satpura Gondwana basin, possibly because the coal seams are of comparatively lesser thickness, and the areas are under-developed with problems of means of communication.

The Satpura Gondwana basin includes "the hilly region of Hoshangabad, northern Chhindwara and north-east Betul. In it lie the Mahadeva hills around Pachmarhi

(22°28':78°26')" (Fox, 1934). The limits may be taken as from Mohpani (22°45':78°50') on the north to Pathakhera (22°6':78°10') on the south, and from Sirgora (22°12':78°50') in the east to Sonada (22°16':77°47') in the west. The coalfields included in this basin are Mohpani (22°45':78°50') in the extreme north, Pench valley and Kanhan valley in the east, and Pathakhera, Dulhara (22°10':78°1'), Shahpur (Tawa) (22°10':77°54'), and Sonada from east to west on the west. The present knowledge on their geology exists due to Blanford (1882), Jones (1887), and Fox (1934).

Of these coalfields, the Tawa valley area is undeveloped, while the Pench valley has been explored and worked out to an extent greater than that of the Kanhan valley. The Gondwanas occur as a small patch near Sirgora, and form a continuous strip from Dighawani (22°12':78°49') in the east to Nonkharak (22°11'30":78°10') in the west, being affected by faults at places. This tract stretching for 63 km. with a width of 8 to 10 km. is traversed by the rivers Pench, Kanhan and Tanbia (Upper Tawa). These coal-bearing areas represent the Pench-Kanhan-Upper Tawa valley Coalfield, and this paper presents its geology, and occurrence and correlation of coal seams, as studied by the author.

GEOLOGY OF THE COALFIELD

All the major basins of Gondwana deposition owe nomenclature to their principal drainage system, and hence the Pench-Kanhan-Tawa valley basin is preferable to Satpura Gondwana basin. The Pench valley, Kanhan valley and Upper Tawa valley areas cannot be demarcated sharply from one another and have accordingly been described as the Pench-Kanhan-Upper Tawa valley coalfield (Pareek, 1969a). The geological sequence of the rock formations in the coalfield is as follows.

Recent	Alluvium
Upper Cretaceous	Lava flows (Deccan Trap) and dykes of dolerite, sometimes Olivine-bearing.
.....Unconformity.....	
Upper Gondwana	Jabalpur Stage: Clays, massive sandstones, often gritty, and Carbonaceous shales in the Sirgora area.
.....Unconformity.....	
Lower Gondwana	Motur Stage: Yellowish sandstones, mottled red, buff, yellow and green clays, often with calcareous nodules. Red clays diminish westwards being practically absent in the Upper Tawa valley.....450-610 metres. Barakar Stage: Medium to coarse-grained sandstones, shales, carbonaceous shales and three interbedded coal seams.....120-130 metres. Talchir Stage: Greyish, greenish to olive-green shales, claystone, fine-grained sandstones with undecomposed felspar, and boulder bed.
.....Unconformity.....	
Archaeon	Metamorphics: Granites, often porphyritic, hornblende gneiss, schists and amphibolites.

The Kanhan valley exposes the full sequence of rock formations in the coalfield. The boundary between the sedimentaries and metamorphics is faulted and so also of the Talchirs and Barakars. The exact thickness of the Talchirs is difficult to be ascertained since they rest unconformably on irregular surface of the basement rocks and are in faulted contact with the overlying Barakars. A total of 1000 m. of the Lower Gondwana strata reducing in thickness westwards exists in the coalfield. The Barakars grade into the Moturs at some places, while they are in faulted contact at others. Scattered outcrops of the Upper Gondwana occur in the Pench valley region and their typical sequence is in the area around Sirgora.

The Deccan Trap covers most of the Pench valley region, concealing the Gondwanas specially in the eastern portion of the coalfield. The trap exposures also occur due south of Barkui (22°11': 78°42'), and from its east towards Dighawami and Sirgora. Scattered exposures also appear all round Chandameta (22°11'30": 78°44'). Dykes of dolerite are also spread throughout the area. Most of the Pench-Kanhan-Upper Tawa area is, therefore, covered by the Talchirs, Moturs and the Deccan Trap.

Text-figure 1 shows the geological map of the area covered. The general strike of the sedimentaries is ENE-WSW, and the dips are northerly, varying from 5° to 15°. Strike faulting is quite common and the fault zone is marked by silicification. The Gondwana patch near Sirgora owes its preservation due to two parallel strike faults. The patch of Talchirs near Chhinda (22°12': 78°51') has its southern side in faulted contact with the traps and the northern side with the Barakars and the traps, as seen in the Pench. A tributary of the Pench has meandered along the strike faults, before joining the Pench. A small patch of Barakars is also preserved in between the Moturs. An ENE-WSW fault also dislocates the Barakars, west of Jamkunda, where the Talchirs are in direct faulted contact with the Moturs. This can be considered as the arbitrary boundary for demarcating the coal-bearing areas of the Pench and Kanhan valleys.

A number of strike and dip faults exist in the Kanhan valley region. One strike fault stretches for a distance of 24 km., being affected by a dolerite dyke in the Ghorawari Khurd (22°11': 78°15') area and by a NNE-SSW fault near Damua (22°12': 78°28'). Faults are also very common within the traps.

DESCRIPTION OF THE ROCK FORMATIONS

Talchirs: The surface soil concealing the Talchirs below is marked by a greyish to greenish colour of the fragments and splinters of the Talchir shales. It is only along the railway cuttings, nalas, and river sections that the Talchirs are well-exposed. The rocks include greyish and khaki-greyish shales, greenish sandstones, boulder bed, and greenish to olive-green claystone, characterized by spheroidal weathering (Pareek, 1968). Varves so common in other coalfields (Ghosh, 1962; Pareek, 1965) are not of any conspicuous occurrence. No well-preserved plant fossils were available.

Barakars: The sequence exhibited is shale, carbonaceous shale and sandstone grading from fine to coarse-grained; shale, siltstone, and shaly sandstone; shale, carbonaceous shale, shaly coal and coal. The sandstones exposed in the river valley sections are massive although bedded, and exhibit big

pot holes. They are interbedded with micaceous sandstones and comprise angular quartz grains, altered feldspars and limonitic stains. The shales are greyish, occasionally grading into carbonaceous shales. The Barakars contain three interbedded economically workable coal seams. Leaf impressions typical of the age are common in the shales. Fossil woods belonging mostly to the *Dadoxylon* group are found at places.

Moturs: These form the Barren Measures of the coalfield and are different in lithological composition from those of any other basin in that they include coarse-grained to gritty yellowish sandstones, shaly beds and mottled clays of yellow, green, and red colours, most commonly, and associated with calcareous nodules. The sandstones have undecomposed feldspars and clayey concretions. The clays are non-plastic. No plant fossils have been recorded, but fossil wood has been reported near the base of *Moturs* in the Kanhan valley area (PAREEK, 1969b).

COAL SEAMS AND THEIR CORRELATION

Coal seams do not outcrop in the area, as is so commonly noticeable in other coalfields specially the Jharia coalfield, and hence their knowledge is based on the underground workings. Text-figure 2 shows the locations of different working collieries, while text-figure 3 records the nature of underground strata, as revealed by bore hole logs and mine workings in different important collieries of the coalfield. The principal producing collieries are the Rakhikol, Kalichhapar, Damua, Ghorawari group, and Datla West in the Kanhan valley, and Eklehra, Chandameta, and Rawanwara in the Pench valley. In the Pench valley, a continuous spread of coal measures exists eastwards from Barkui to the Pench, the most actively exploited area being between Barkui and Rawanwara and the strip eastwards from Eklehra.

Three coal seams numbered as I, II and III from the top exist in the Pench valley. In the Dighawani area, three coal seams occur in 4.70 m. of strata in the River Pench (Blanford, 1882). In the nala east of Sirgora, and in the Mandlajob to the west of Haranbhata ($22^{\circ}12':78^{\circ}55'$), two coal seams up to a depth of 18 m. have been proved by drilling by private companies. The Dighawani seams correspond

to seam I, while the two seams of Sirgora are a correlate with seams I and II.

One thick seam numbered as I is being actively worked in the Kanhan valley area. Two thin seams numbered as II and III are being worked in the Ghorawari area. A seam of similar thickness has been encountered in the drill holes at Rakhikol. Two seams below seam I are recorded to exist in the different parts of the valley. Three workable seams I, II and III thus occur in this area. The thick seam outcropping at Tandsi (Upper Tawa valley) correlates to seam I (PAREEK, 1966).

A thin seam is traceable above each of the seams II and III at different localities and is named as Leader to II or to III. It serves as an indicator horizon, and has coalesced with seam II in the Rawanwara area, and seam III in the North Chandameta area.

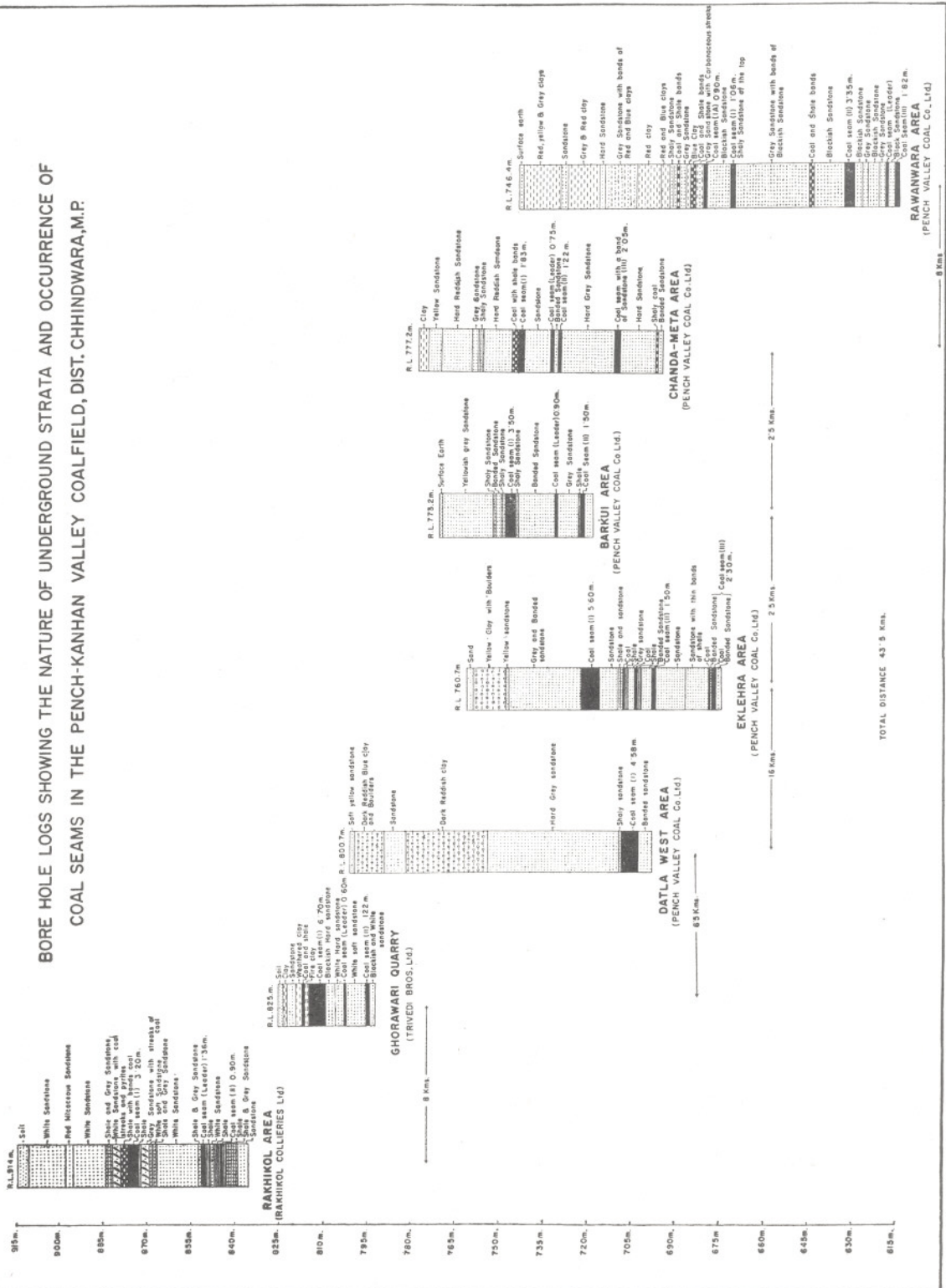
Text-figure 4 shows the diagrammatic sketch of the behaviour of the coal seams in the coalfield. Seam I has an upper shaly section and a lower of good coal. Its maximum thickness is 8.50 m. in the Sirgora area of Pench valley, and 7.30 m. in the Rakhikol area of Kanhan valley. The workable section is 3.65 m. in Rakhikol and 5.80 m. in Sirgora. This seam is seen to persist in thickness in the Kanhan valley area, and is of thinned appearance in the Pench valley area till it has again thickened in the Sirgora area. Its thickness is 2.42 m. in Chandameta, 1.22 m. in East Dongar Chickli, and 1.36 m. in Rawanwara areas.

Seam II has a thickness of 0.60 m. in Rakhikol, thickening to 0.98 m. in Datla, 1.35 m. in Eklehra, 1.82 m. in East Dongar Chickli and 3.40 m. in Rawanwara, where the Leader has coalesced with the seam, and 1.28 m. in the Sirgora area on eventual thinning and splitting of the Leader and seam II.

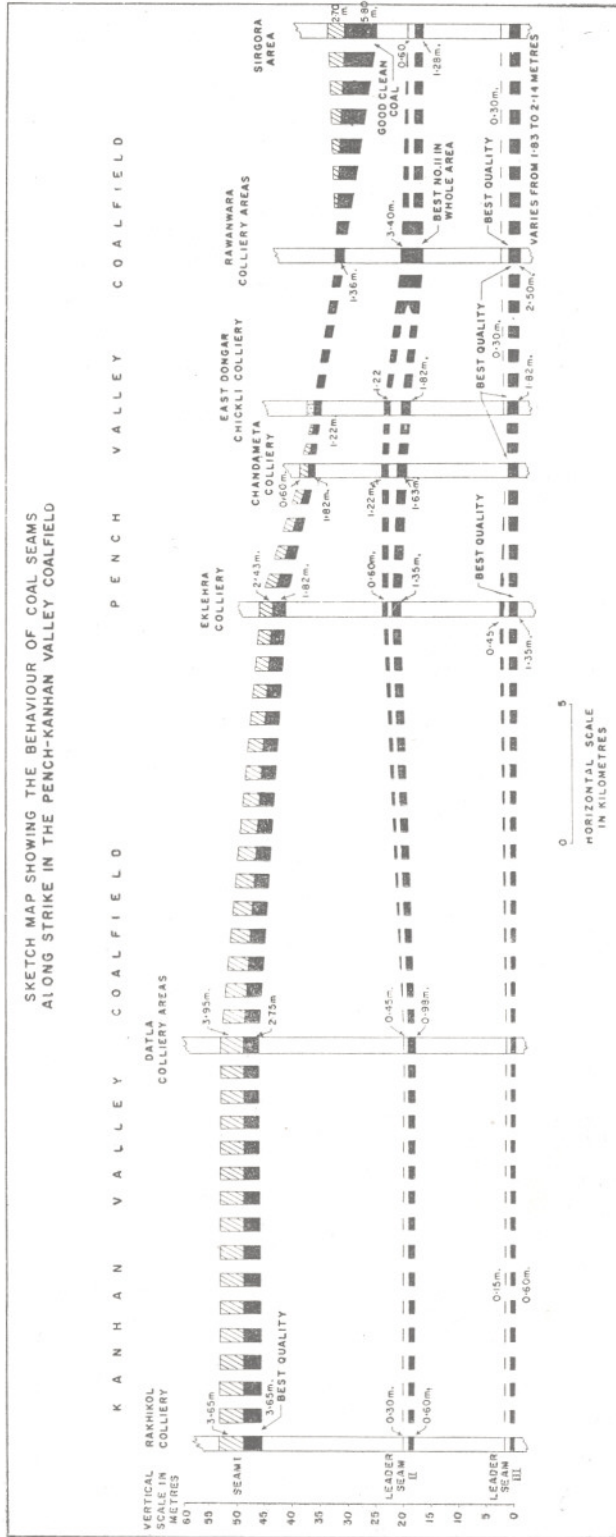
Seam III has a thickness of 0.60 m. in the Kanhan valley, and has thickened to 1.35 m. at Eklehra, 2.44 m. at North Chandameta, where it has coalesced with its Leader, and 2.50 m. at Rawanwara. In the Sirgora area, the seam thickness varies from 1.83 to 2.14 m. This seam is of best quality in the North Chandameta, Rawanwara and Sirgora areas. Similarly enough, seam II is the best in the whole area at Rawanwara.

The top part of the Tandsi seam exposed in the Tanbia valley of the Upper Tawa

BORE HOLE LOGS SHOWING THE NATURE OF UNDERGROUND STRATA AND OCCURRENCE OF COAL SEAMS IN THE PENCH-KANHAN VALLEY COALFIELD, DIST. CHHINDWARA, M.P.



TEXT-FIG. 3



TEXT-FIG. 4 — Sketch map showing the behaviour of coal seams along strike in the PENCH-KANHAN VALLEY COALFIELD.

valley area, has been eroded away leaving a thickness of 5.25 m. Grey shale and carbonaceous shale are still noticeable in the upper portion of the existing seam, while good coal forms the scarp face of the valley and represents the bottom portion of the seam. The physical make-up of the seam is characteristic of seam I, with which it correlates. The Pench-Kanhan-Upper Tawa valley coalfield forming a more or less continuous strip of the lower Gondwana formations, seams II and III, can be expected below seam I in this area also, and deep bore holes around Tandsi village will reveal the nature, extent and quality of the seams.

The comparison of the petrographic profiles of seams I, II and III, at different places of workings for the same seam made by Pareek *et al.* (1964) has revealed that the megascopic varieties of coal persist laterally. As a matter of fact close petrographic similarity is obvious in the different sections of the same seam at different places of sample collection. There is, however, a well-marked variation in the petrographic constituents of coal. In Seam III, the proportion of fusinite increases with thickness of the seam at Rawanwara, combined with absence of sporinite. It is concluded that these features contrast with the uniform nature, composition and thickness of the overlying seams II and I. Apparently uniform conditions of deposition prevailed in the basin after the accumulation of the bottom layers.

TONSTEIN BAND

A thin band of shale tending to be carbonaceous shale and varying from 4 cm. to 10 cm. in thickness along the strike appears in the upper portion of seam I at Rakhikol colliery. Further east, in the Kalichhapar, Damua, Ghorawari and Datla collieries, the band is seen to persist and grades into siltstone in the Pench valley region. This lateral gradation of grey shale, carbonaceous shale into eventually siltstone over a distance of 40 km., is characteristic of this coalfield and the band forms a useful aid in seam correlation.

The examination of the samples of band has indicated that when fine-grained, it is very hard, tough and compact with whitish-grey to greyish colour and the broken surface shows typical speckled ap-

pearance. Microscopically, irregular streaks of carbonaceous matter, ubiquitous detrital quartz, plagioclase feldspar fragments of oligoclase to albite composition, and turbid aggregates and crystals of kaolinite and kaolinitic material are very commonly seen. The accessories include flakes of mica, bits of calcareous material and specks of sideritic matter. At places kaolinite occurs as irregular laths or is finely dispersed in the groundmass. This rock can be described as a sandy carbonaceous kaolinitic mudstone.

Such layers of thickness varying from 5 to 7 cm., being intercalations of black, dark brown, grey, etc., kaolin bands directly layered in coal seams have been named and described as "tonsteins" — "graupen-tonsteine", which are of stratigraphical value as persistent partings in the coal bed and permit to identify a certain seam (K. HÖEHNE — Personal Communication). Hoehne (1953) has also reported the occurrence of kaolin crystals in the Gondwana coal of India. Tonstein bands have been reported from different parts of the world (CHALARD, 1952; SCHEERE, 1958; WILLIAMSON, 1961; EDEN *et al.*, 1963).

CONCLUSIONS

In the Pench-Kanhan-Upper Tawa valley coalfield, the Talchir sandstones have a more or less uniform grain size, subrounded to rounded faces and exhibit well sorting. The Barakar sandstones show poor sorting and subangular to angular grains, feldspars being common and possibly derived from felspathic gneisses. The Motur sandstones also show inequigranular grain size and exhibit poor sorting characteristics. The red clays diminish westwards. These are in a way suggestive of a marked change in the environments from fluvio-glacial to fluvial and lacustrine conditions of deposition.

A total of nine metres of coal occurs in about 120 metres of the Barakar strata; seam I is the thickest and occurs 50 to 60 metres below the base of the Moturs. Seams II and III are of more or less similar thickness. The seam characteristics are that seam I has thinned out in the Pench valley — East Dongar Chickli and Rawanwara areas, and has bulged appearance towards east and west, along the strike. Seams II and III are thick in areas of seam I acquiring thinned proportions.

The coal seams of the Kanhan valley region have developed caking propensities and this character is attributable to the petrographic nature of the coals. Fusite (fusinite) is of quite high proportion in the Pench valley region, and accounts for the non caking character of the coals, while vitrite and clarite appearing in increased proportions with diminished amounts of the fusite have imparted caking tendencies to the coals of the Kanhan valley.

Igneous activity is represented by thick lava flows as the Deccan Trap. Dolerite dykes profusely intrude the area and represent the channels of lava extrusion. In the area south of Rakhikol, the Talchirs are intruded by a dolerite dyke showing spheroidal weathering, which is microscopically similar to coronites, observed by the author in the dykes intruding the metamorphics of the Jharia coalfield in parts of Dhanbad and Purulia districts.

The Pench valley region has a maximum covering of the Barakars by the lava flows. This is suggestive of the easterly source of the Deccan Trap. Their thick capping (thickness not known) over the Barakars has rendered working of these seams impossible economically. It is, however, of significance also to evaluate the rank transformations of the underlying seams

due to thermal effects of the igneous activity, when such sections are available to visiting scientists for study.

The coalfield has undergone considerable faulting during the post-Cretaceous period. That a dolerite dyke traverses a fault zone in the Ghorawari area is indicative of faulting being prevalent during pre-Deccan Trap intrusion period also. Step faulting is very common and most of the faults are strike faults with southwardly downthrow in most of the cases and marked by silicification in the sedimentaries. It is not unlikely that faulting in the area was connected with stresses in the Peninsular shield. The different areas preserved due to faulting have faults parallel to the southern boundary fault. Thus further faulting trended parallel to the main boundary fault and sliced the coal-bearing strips into segregated areas.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to Mr. C. Slater, Surveyor, Shaw Wallace & Co. Ltd., Parasia, for the helpful discussions, and to the authorities of Rakhikol, Ghorawari-Kalan, Ghorawari-Hirdaygarh, Datla, Eklehra, Chandameta and Rawanwara collieries for making available the mine and bore hole data for study.

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