ON THE MICROSCOPIC NATURE OF COALS FROM MAJRI AREA, WARDHA VALLEY COALFIELD, MAHARASHTRA

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ABSTRACT

The microscopic nature and composition of the coals from Majri (20° 8′: 79° 2′) area, Wardha Valley coalfield, Maharashtra, about which no data whatsoever exists, are presented in this paper. These are microfragmental coals, comprising inertinite, vitrinite and exinite (sporinite), in decreasing order of abundance, occurring as mainly durite, fusite, "intermediates", clarite and vitrite. The mineral and shaly matter is quite common and thoroughly intermixed with the organic layers, which alternate or are interbedded with shale and carbonaceous shale bands.

The Wardha valley coalfield is separated to its south-east from the adjacent Godavari valley coalfield by the Upper Gondwanas. The coal-bearing formations of these coalfields may thus continue below this cover. A large spread of the Gondwana sediments, whereby these coalfields form only a part of the Wardha-Godavari valley basin, is thus suggested. The petrological studies of the Majri, and Tandur (Godavari valley coalfield) coals have indicated close proximity, than with the coals of the other basins. There is, however, a lateral variation in the composition of coal, and that appears to be related to the source of sediments, conditions of deposition and the vegetal transformation.

INTRODUCTION

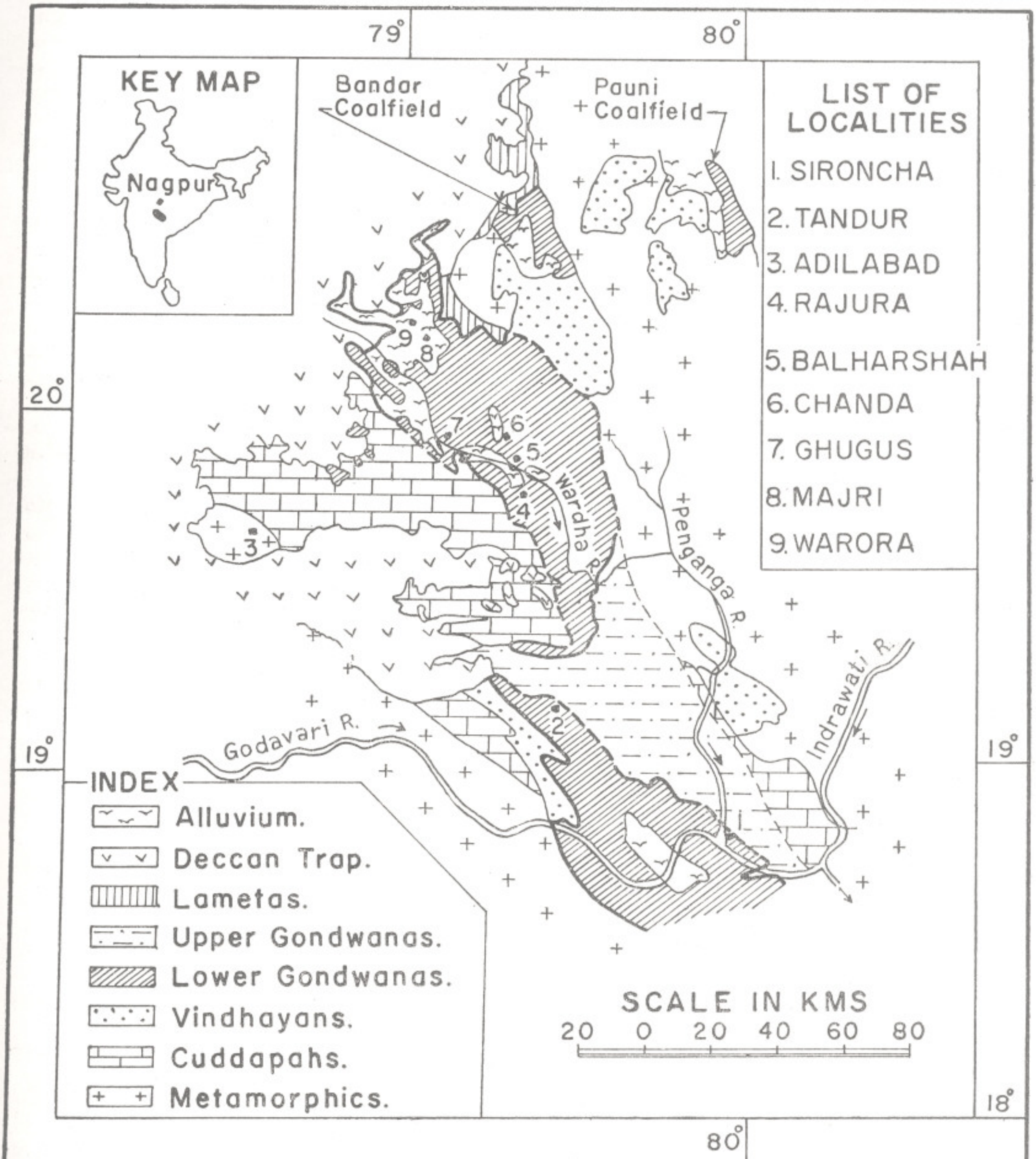
THE Majri (20°8′ : 79°2′) area forms the northern-most portion of the Wardha valley coalfield, named after the River Wardha traversing through the area, and falls in the district Chandrapur of Maharashtra. It is estimated that about 32 million tons of coal will be available in this part of the coalfield (Roy, 1962a, p. 28). The coal extracted from the mines existing at Majri is of the order of 60,000 tonnes per year, and is being used as a fuel for domestic needs, in steam generation for the locos, and in industries.

The Wardha valley coalfield falls to the north-west of the group of the Godavari valley coalfields. The Wardha and Godavari valley coalfields are separated by the stretch of Upper Gondwanas, extending over a strike length of 20 km., being also the trend of their disposition. That they once formed part of a large spread of Gondwana sediments in one original basin of deposition, the present Wardha-Godavari valley basin, is evidenced by the similarity of the geological features, lithological nature of the rock types, and a cover of the Upper Gondwanas existing between these coalfields. Pande (1970) reports the recent findings of coal-measures under the younger sediments, like the Kamthis and Lametas. Whether the microscopic nature of the coals from these coalfield areas is similar or different, is not yet known, since no data, whatsoever, exists on the Majri coals or of other areas in the Wardha valley, although data on coals of the Tandur area in the Godavari valley coalfield is available (Chatterjee *et al.*, 1966; Ghosh, 1962; Pareek *et al.*, 1965; Rao, 1962; Rao & Razvi, 1965). Studies of the Wardha valley coals in the Majri area were, therefore, taken up and the data is presented in this paper. The area was examined by one author (B.C.P.), who collected the samples of coal that form the basis of this study.

GEOLOGY OF THE AREA

The Gondwana sediments cover an area of over 4000 sq. km. in the Wardha valley basin. The main coal-bearing areas are the Warora-Majri, the Wun-Rajur, and Ghugus-Telwasa, in the western sector, and the Chanda-Balharshah, Sasti-Rajura, and Lathi-Antargaon in the eastern sector. The Majri area forms the northern part of the Wardha valley coalfield. Text-fig. 1 shows the geology of the coalfield, and the location of the Majri area.

The Wardha valley coalfield extends in a NW-SE direction, with the Archaeans, forming its eastern boundary, and the Puranas and the Vindhyans constituting its western boundary. The Talchirs appear in the central portion of the coalfield, with isolated, disconnected, tiny outcrops of the Barakars on its either sides. The bulk of the eastern and western sectors of the coalfield is covered by the Kamthis, which have an angular conformity, concealing



TEXT-FIG. 1 — GEOLOGICAL MAP OF THE NORTHERN PART OF WARDHA-GODAVARI VALLEY BASIN (AFTER HUGHES, & KING).

underneath the entire sequence of the Karharbari and Barakar formations (see Pande *in* Roy, 1962b, p. 44, 1963, p. 81-82). The Lameta beds occur as isolated outcrops on the north and north-west, while rest of the area is generally covered by the basaltic traps. The Gondwana sediments seem to have a broad gentle anticlinal structure with the western limb folded again near the faulted western contact (see Pande *in* Roy, 1964, p. 62).

The generalized sequence of the geological formations met with in the coalfield appears in Table 1. The thickness of the individual strata is difficult to be assessed, in view of the overlapping nature of the beds, but the total estimated thickness of the Lower Gondwana sequence may range up to 182 metres.

COAL SEAMS

The coal seams of the area do not outcrop anywhere, since the Barakars underlie a thick cover of the Kamthis and the Lametas. This has rendered the classification of coal seams difficult. Unless deep bore holes penetrate through the Kamthi cover, and the Barakar sequence, and comparision of the bore hole data made, the qualitative and quantitative assessment of the seams cannot be made with certainty. The sporadic published records available from the bore holes which have so far been drilled and the data available from the working colliery at Majri, indicates existence of one seam of over 15 metres thickness in the area.

Hughes (1877) recorded a coal seam of 15 metres thickness in between Majri and the R. Wardha. Fox (1934) reported two coal seams of 4·5 m., and 17·5 m. thickness in separate boreholes, west of the village near Kona-Naglon track. He also reported one coal seam of 4·5 m. thickness at 52 metres depth, and another of 3·3 m. at 66 metres depth in a carbonaceous horizon of 17 metres in the borehole near Pit I in the Warora colliery area. Exploratory drilling has been undertaken by the Geological Survey of India, and is in progress to determine the extent of the overlap of the

TABLE 1 — GEOLOGICAL SEQUENCE OF ROCK FORMATIONS

AGE	ROCK FORMATIONS
Recent	Gravel beds
Upper Cretaceous to Lower Eocene	Deccan Trap — Basaltic rocks
Upper Cretaceous	Lameta beds — Marls and calcareous sandstones
	— — — Unconformity — — —
Upper Gondwana	Kota and Maleri beds — Sandstones and fossiliferous siliceous limestones
	— — — Unconformity — — —
Lower Gondwana	Kamthi Series — Ferruginous sandstone, coarse to medium grained, and variegated shales and clays
	— — — Unconformity — — —
	Barakar Series — Felspathic sandstone, occasionally gritty, carbonaceous shale, shale, and coal seams
	Karharbari Stage — Even-grained glauconite-bearing sandstone, thick beds of clay, and thin coal seams
	Talchir Series — Hard compact equi-grained greenish sandstone, with undecomposed felspars, and olive green, occasionally typically needle-shaped shales
	— — — Unconformity — — —
Pre-Cambrian to Lower Palaeozoic	Vindhyans and Puranas — Sandstones, shales and limestones
	— — — Unconformity — — —
Archaeans	Metamorphics — Gneisses

Kamthis over the Barakars and disclose possible coal seams while determining the structure of the Gondwana basin (Roy, 1966; Jhingran, 1967). Existence of a thick carbonaceous horizon of thickness 16·63 m.-19·85 m. in the Majri area has also been reported, with the coal seam dipping 12° to 15° towards S. 55°-65° W. (Jhingran, 1967).

The Majri colliery is working the bottom section of this seam, which is of 9·5 m. thickness in No. 3 Air Shaft. Between the R. Wardha and the colliery, over a distance of 3 km., this seam thickens to 15·5 m. with well-developed partings of sandstone, shale, carbonaceous shale, etc., up to a thickness of about 7 metres. From the available data, it thus transpires that one coal seam of over 15 m. thickness with many partings extends over most of the area.

Chemically, the Majri coals have high moisture (9-12%), volatiles (31-35%), and highly variable ash up to 43 per cent. The coals are non coking, and are at present being utilized by the railways and industries. The coal is grade II, in quality.

MICROSCOPIC NATURE OF COALS

The Majri coals in hand specimens are quite hard, durain-predominating and indistinctly banded. Vitrain bands are uncommon, localized in nature, imparting a banded appearance to the coals. Fusain is quite common as lenses. Shale bands are frequent and persistent.

Microscopical studies of the coals were made in thin, polished-thin, and polished sections. The coals are microlaminated, micro-fragmental and composed of inertinite, vitrinite and exinite in the decreasing order of abundance. The maceral associations are durite, fusite, "intermediates", clarite, and vitrite, in decreasing order of abundance. Plate 1 shows the nature of the macerals and microlithotypes in the Majri coals.

MACERALS

Inertinite — It is the dominant maceral and comprises fusinite, fusinized resins, semifusinite, and micrinite. Fusinite shows mostly thin-walled cells, only some of which are intact, while others have undergone effects of compression by being in a fractured state. "Bogen-struktur" is quite common. A thin-walled woody layer in compacted state appears in Fig. 10. The fusinized tissues of thick-walled cells are no so common. Fragments of a fusinised thick-walled cellular tissue appear in the upper portion of the Fig. 11.

Fusinized resins are conspicuous micro-constituents and occur in a variety of shape and form. They exhibit moderate to high reflectivity in polished sections, under oil immersion (Figs. 4, 5, 6, 7, 9), and appear opaque even in the thinnest thin section (Fig. 12). Massive or with canals or voids (Figs. 4, 6, 7, 12), and highly vesicled varieties (Figs. 5, 9) are common and vary considerably in size. The occurrence of fusinized resins in different Gondwana coals is illustrated and described in another paper (Pareek, 1966).

Semifusinite, the transitional stage between vitrinite and fusinite, is not uncommon. Fragment of such a semifusinized tissue appears in the central portion of Fig. 3.

Micrinite is highly reflecting, massive or as angular bodies or grains (Fig. 8), of restricted occurrence in the vitrinite-rich layers (Figs. 1, 4, 7) or dominant in the inertinite-abounding coals (Figs. 2, 3, 8). Their actual shape and size is marred by their opacity in thin sections (Figs. 1, 2, 12).

Vitrinite — Thin to thick parallel sheets of vitrinite persist laterally (Fig. 1). Vitrinite fragments and fragmentary bits are, however, quite prevalent. The tissues showing clear cellular structure are rather a rarity, but traces of their being of the woody origin can be deciphered.

Exinite — Microspore and megaspore exines, sporogenus bodies, translucent resins, and cuticular matter constitute exinite, of which sporinite is the most common. Microspores are commonly associated with micrinite (Figs. 2, 3, 8, 12), and are sporadically distributed in between the vitrinite sheets (Figs. 1, 4, 7). The megaspore exines, microsporangia and sporogenous bodies occur in a variety of forms. Reddish-brown or reddish (in thin sections) or medium reflecting, with cavities and or highly reflecting granular matter (in polished sections), resin bodies are sporadically distributed throughout the seam.

Mineral and Shaly matter The mineral matter is prevalent as fine grains comprising felspars, quartz, siderite and clayey material, occurring associated with the inertinite macerals. Besides being present in the general matrix, quartz and chalcedony have also been observed occupying the cell lumen of fusinite. Shaly matter is prevalent in these coals. Coal free from the detrital matter is a rarity. Figure 2 shows the nature of the distribution of mineral grains, that have been removed away du ing thinning process of the section, while the Figs. 5 and 9 exhibit that of the shaly matter.

MICROLITHOTYPES

As will appear from the figures illustrated in Plate 1, durite is the very common to abundant microlithotype of these coals, and comprises micrinite, microspores, fragments of fusinite and of the semifusinite. Durite bands are persistent and quite thick, the maximum thickness recorded being 250 microns. They alternate with fusite lenses and lenticles. A band of fusite in association with shale appears in Fig. 10. Clarodurite and duroclarite form the "intermediates". Clarite (Fig. 1) and vitrite (Fig. 11) occur as thin lenticular bands of structureless nature.

PETROGRAPHIC COMPOSITION OF COALS

The maceral and microlithotype composition of the Majri coals appears in Table 2. For the sake of immediate comparision, the petrographic composition of the Tandur coals has also been incorporated in this Table.

TABLE 2 — PETROGRAPHIC COMPOSITION OF MAJRI AND TANDUR COALS

Petrographic Composition	Coal seams of Areas	
	Majri, Wardha Valley %	Tandur, Godavari Valley %
Maceral		
Vitrinite	25	34
Exinite	11	9
Inertinite	60	53
Mineral matter & Shaly	4	4
Microlithotype		
Vitrite + Clarite	18	11
"Intermediates"	25	35
Durite	40	30
Fusite	15	12
Shale	2	2

The Majri coals are dull and inertinite-rich. The occurrence of fusinized resins is a conspicuous feature of these coals. "Intermediates" and durite are common to very common, while vitrite, clarite, and fusite appear in subordinate proportions. In these characters, they have a marked similarity to the Tandur coals of the Godavari valley basin.

The Majri and Tandur coals are conspicuously different from coals of the other basins. The Damodar valley coals are of banded pattern essentially, and have vitrite and clarite prevalent throughout the majority of the seam sections. They are also different from the Son valley coals, which show greater affinity to the Mahanadi valley coals, rather than the Damodar valley coals. The Pench-Kanhan-Upper Tawa valley coals are conspicuous in that these coals have developed compositional characteristics, which have no affinity to those from any of the other basins. For detailed petrographic data on the coals of these different basins, contributions mention-worthy are by Casshyap (1965), Ganju (1955), Ganju and Pant (1963), Pareek (1958, 1963, 1964a, b, 1965a, b, 1966, 1969a, b, c, 1970), and Pareek *et al.* (1964, 1965).

The Majri coals, like the coals of Tandur area, are non coking, a characteristic which can be referred to their petrographic composition unfavourable for coking, in view of the relative abundance of the infusible constituents. The high content of the volatiles could also be attributed to the sporinite concentration. If any improvement is inferred in the proportion of fusible constituents, from the Tandur to the Majri areas, it is of regional importance. It is to be ascertained whether the nature, quality, and chemical composition of the coals of the Antargaon-Aksapur, Wamanpalli, Ballarpur, Sasti-Rajura, Chanda, Ghugus-Telwasa, Rajur or Wun, Warora and Bandar areas is same or different or shows limited or highly variable variations, laterally as well as vertically, across the seams in these areas, and the extent of differences in between each of them. These coalfields lie within a stretch of 200 km., from the Tandur area, and are separated by the Gondwana sediments. Since there is considerable splitting and coalescing of the coal seams, and a thick Upper Gondwana cover conceals the seams below, correlation of these seams is going to pose a problem. Systematic drilling at selected bore hole points, based on large scale geological mapping work, is the only answer to know the extent and nature of the Gondwana sediments in the coalfield, and present the correlation chart of the coal-bearing strata, and the associated rocks.

CONCLUSIONS

The Majri coals are characterized by common to dominant inertinite, prevalent as mainly durite, and prevalence of shale bands. Fusinized resins are conspicuous, and can be used as marker horizons. The fusibles are in deficiency, and this fact attributes in main to the non coking property of the coals. Sporinite content is quite high in certain sections and may prove useful, on beneficiation, for hydrogenation work. Micrinite-sporinite concentrations will find place as binder for coking coals of graded quality.

The Majri coals are similar to the Tandur coals, in these characters. Whether and to what extent the seams of the Tandur area are the continuation of those in the Wardha valley, can be proved only by correlation of the underground coal-bearing strata. This will also serve to indicate whether the seams have thickened south-east, and splitted up along the thick carbonaceous shale partings, so conspicuous in the Wardha valley. Petrographic studies have, however, exhibited limited similarity in the natur of coals from these areas.

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EXPLANATION OF PLATES

PLATE 1 — Photomicrographs of Coal.

(Figs. 1, 2, 3, 12 are from thin sections and × 105, while Figs. 4-11 are from polishe l sections under oil immersion and × 240).

1. Thin to thick parallel sheets of vitrinite, interbedded with microspores, and micrinite, occurring as duroclarite, grading into clarite (central part), and durite (top left portion).

2. Massive and granular micrinite, fragmentary fusinite, streaky microspores (sporinite), and whitish spaces originally occupied by detrital mineral grains, occurring as durite.

3. Sporinite-rich durite, unlike that in Fig. 2, having subordinate micrinite, a semifusinized woody tissue in the upper middle portion, and several detrital grains.

4. A highly reflecting fusinized resin of rounde l form, characterized by a finely carved outline in the left, and smooth one on the right sides. Four canals are prominent. The matrix is of vitrinite-rich duroclarite.

5. An intensely vesicled and quite highly reflecting fusinized resin deformed into an almost rectangular body with quite thick peripherial layer, occurring in shaly matter-rich durite.

6. An elongate and highly reflecting fusinized resin, characterized by several linear and curvilinear canals. Note a thin highly deformed discrete layer of slightly higher reflectivity surrounding the body, being conspicuous in the lower portion; this may represent the peeled-off layer of the resinous body caused during the intensive fusinization process. The matrix is of similarly reflecting micrinite and fusinite, the constituents of durite.

7. A highly deformed, much angular, cracked and splitted fusinized resin body of highly reflecting nature. Note the dissemination of micrinite grains within the fusinized resin body through the cracks, caused due to intensive carbonization. A halo can be conspicuously seen around the body, the matrix being duroclarite.

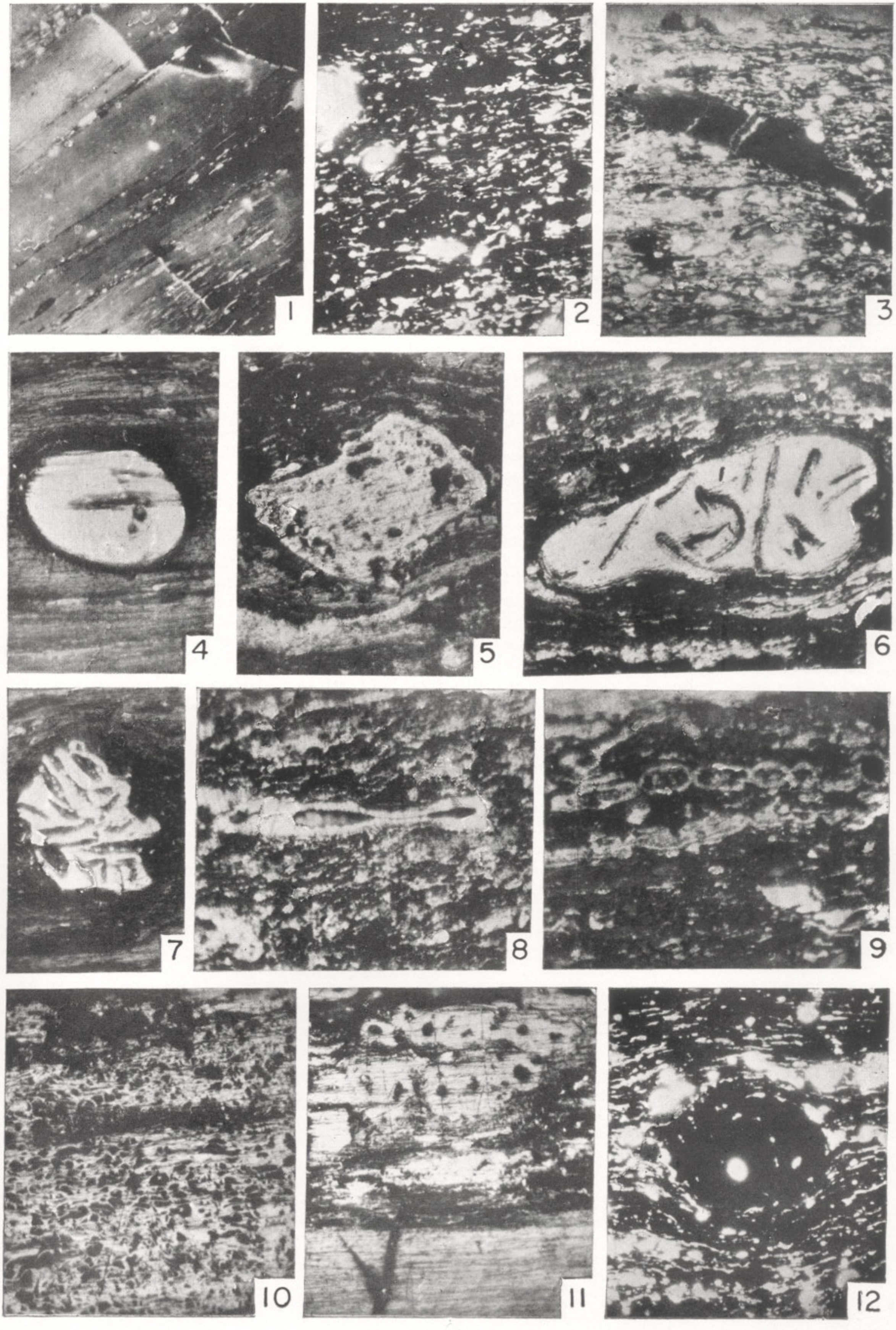
8. A dumb-bell shaped, highly reflecting, compressed fusinized resin (?), occurring in micrinite-rich durite matrix.

9. A chain of thin-walled vesicled fusinized resin bodies of much deformed shape, occurring in fusinite, micrinite, sporinite, and shale-abounding durite.

10. A layer of fusite, characterized by compressed, and fractured state of cell walls, that appear quite thin-walled, empty or shaly matter-infilled, in association towards the upper portion with shaly matter.

11. Thick-walled fusinized tissues, that have undergone fragmentation of the chains, occurring scattered in durite, associated with vitrite in the lower portion, being characterized by a crack and the cleat plane.

12. An opaque ball-shaped fusinized resin, occurring in micrinite, sporinite, fusinite, shaly matter and mineral grain associations as durite. The whitish shining object-like portions of the fusinized resin represent the canals, that become clearer only in polished sections.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