# PETROGRAPHIC CONSTITUTION OF JEYPORE COALS, UPPER ASSAM*

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## ABSTRACT

The purpose of the paper is to present, hitherto, not known characteristic petrographic aspects of the megascopic and microscopic constituents of Jeypore coals and to understand their nature and economic feasibility for utilization. These are presented by comments in general order of four commonly occurring ingredients or maceral groups, i.e., vitrinite, exinite, fusinite and mineral matter.

## INTRODUCTION

The petrographic composition of Jeypore coals having never received any attention, this may be taken as an exploration project, although, preliminary general knowledge concerning petrographic characters of Tertiary coals of Assam is available from microscopic studies made by some authors (GANJU, 1955 ; SEN & SEN, 1969 ; GHOSH, 1969 ; MUKHERJEE, 1976). It is, therefore, not expected that the data provided will remarkably be different from general information known about the Assam coals, nevertheless, it is desirable to obtain some specific information concerning petrographic composition of these coals since coal beds rarely maintain uniformity in petrographic compositions from place to place. The analytical data obtained here from petrographic studies of Jeypore coals may be looked upon mainly in the case of such knowledge for evaluation of the coals with other Assam coals for determining their feasibility for utilization.

The coal bearing rocks occur within a narrow belt in the foothills region bordering the Sibsagar and Lakhimpur districts extending for over 40 km with a width of nearly 800 metres. It lies between the latitudes 27°03′ to 27°20′, longitudes 95°10′ to 95°30′. Disang or Dilli river drains the area. The Jeypore (Jaipur) and the Dilli collieries are located on the right (east) and left (west) banks of the river. The area is approachable from Namrup railway station by the newly developed P.W.D. road between Nahorkatiya and Sonari.

MEDLICOTT (1865) carried out a geological reconnaissance of the Jeypore (Jaipur) and the Makum coalfields. A detail examination of the entire belt containing the coal bearing horizons was done by MALLETT (1875).

From economic point of view, the Nazira, Dilli-Jeypore and the Makum coalfields are very important, as they produce major part of coal output in Assam.

The Table—1 (after EVANS, 1932) below shows the stratigraphical succession of the Tertiary rocks exposed in the Disang or Dilli river section and the neighbouring areas.

Table 1

| | | | |
|---|---|---|---|
| Recent & Pleistocene | | Alluvium | |
| Mio-pliocene | DUPITILA GROUP | Namsang Formation | Sandstone with lignite pebbles, thin clays with mottled clays. |
| | ............Unconformity............ | | |

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| | | | |
|---|---|---|---|
| Miocene | TIPAM GROUP | Girujan Clay Formation | Mottled clays, sandy clays and sandstone alternations. |
| | | Tipam Sandstone Formation | Predominantly coarse ferrugenous sandstone with sandy shale, shale and mottled clay alternations. |
| | ...........Unconformity........... | | |
| | | Tikak Parbat Formation | Alternating sandstones, shales, sandy shale and clays with thick workable coal seams. |
| Oligocene | BARAIL GROUP | Baragolai Formation | Argillaceous alternations with sandstone occasionally thin coals and carbonaceous shales |
| | | Naogaon Formation | Massive sandstone |
| Eocene | DISANG GROUP | Disang Shales | Grey-dark grey splintery shales |

It is the Tikak Parbat Formation, the upper part of the Barail Group, which houses several workable coal seams.

## MATERIAL AND METHOD

Four coal samples from Jeypore colliery have been considered for the present study. The details of the samples are as follows :

Jeypore Colliery

1. Mine 7 Seam 4 .. .. .. Top
2. Mine 7 Seam 4 .. .. .. Bottom
3. Mine 10 Seam 6 .. .. .. Top
4. Mine 10 Seam 6 .. .. .. Bottom

Coal samples were crushed, sieved and particulatc pellets were prepared by embedding in Araldite (Navale & Srivastava, 1967). Finally the pellets were polished. Standard methods were followed for the preparation of polished pellets. Maceral and microlithotype analyses were done following the I.C.C.P. (1957, 1964) procedure on incident light amplival Carl Zeiss microscope with the help of a point counter.

## MEGASCOPIC CHARACTERS

Megascopically the Tertiary coals of Upper Assam, in general, and Jeypore and Makum coals in particular, are strikingly dissimilar in appearance when compared to the typical banded bituminous coals of Damuda Group (Lower Gondwana) of Peninsular India. These coals lack banded structure and appear to be entirely made up of vitrain. The vitrain exhibits a typical conglomeratic glossy mass embedded in bright coaly matter. High vitrain content has rendered easily crumbling nature to the coals. Sulphur content is high and occurs in two states, as proved by chemical analysis :—(*a*) inorganic sulphur, in minor amount, present as pyritic concretions, nodules, veins, crusts, and finely disseminated specks ; (*b*) organic sulphur, forming major part of the total sulphur, and is associated with coal constituents.

MICROSCOPIC CHARACTER

*Vitrinite*—The microscopic appearance of vitrinite varies considerably because some vitrinite exhibits cellular structure (Pl. 1, Fig. 2). The structure being more evident when the cells have been filled with wax, resin or gelified collinitic material as shown in the illustrations. In practice vitrinite showing cellular structure has been called *telinite*. Similarly vitrinite without cell structure has been designated as *collinite* (Pl. 1, Fig. 1). In Jeypore and Makum coals, studied by the authors, strikingly a very high incidence of telinite has been observed. The telinites are highly degraded by fungal growth rendering cellular structures very difficult to identify (Pl. 1, Figs. 3 & 4).

*Clarite* (Pl. 1, Fig. 5-7)—Clarite may be differentiated as spore clarite and cuticular clarite.

*Spore clarite* (Pl. 1, Figs. 5 & 6)—The spore content of the clarite of the Jeypore coals vary with a full range of possible variability. The spore content of clarite tends to be small, in general less than 3.00%. In cross-sections spore can be grouped broadly into thin-walled—*tenuispores* (Pl. 1, Fig. 8) and thick walled—*crassispores* (Pl. 1, Figs. 9 & 11). Sometimes it is possible to identify a spore more convincingly (Pl. 1, Fig. 10). Many clarite bands contain less than 1.00% of spores and it is quite unusual to find bands with as much as 3.00% of spore exines. The different amount of spore exines has an effect upon appearance of clarite. The variations in spore content may provide a means of estimating the approximate spore content of clarite bands as seen under usual magnification. Spore clarites impart toughness to coals.

*Cuticular clarite*—Cuticular clarite is not found in abundance. When present it serve to separate thin vitrinite bands. The amount of cuticular exinite is difficult to determine at low magnification. The individual cuticle is commonly very thin, generally thinner than individual spore exine but has much greater lateral extension. The thin cuticle (Pl. 1, Fig. 7) may lie between two vitrinite bands or between thin bands of clarite with spores and vitrinite. It does not appear that cuticles impart the same degree of toughness to clarain bands as imparted by spore exines.

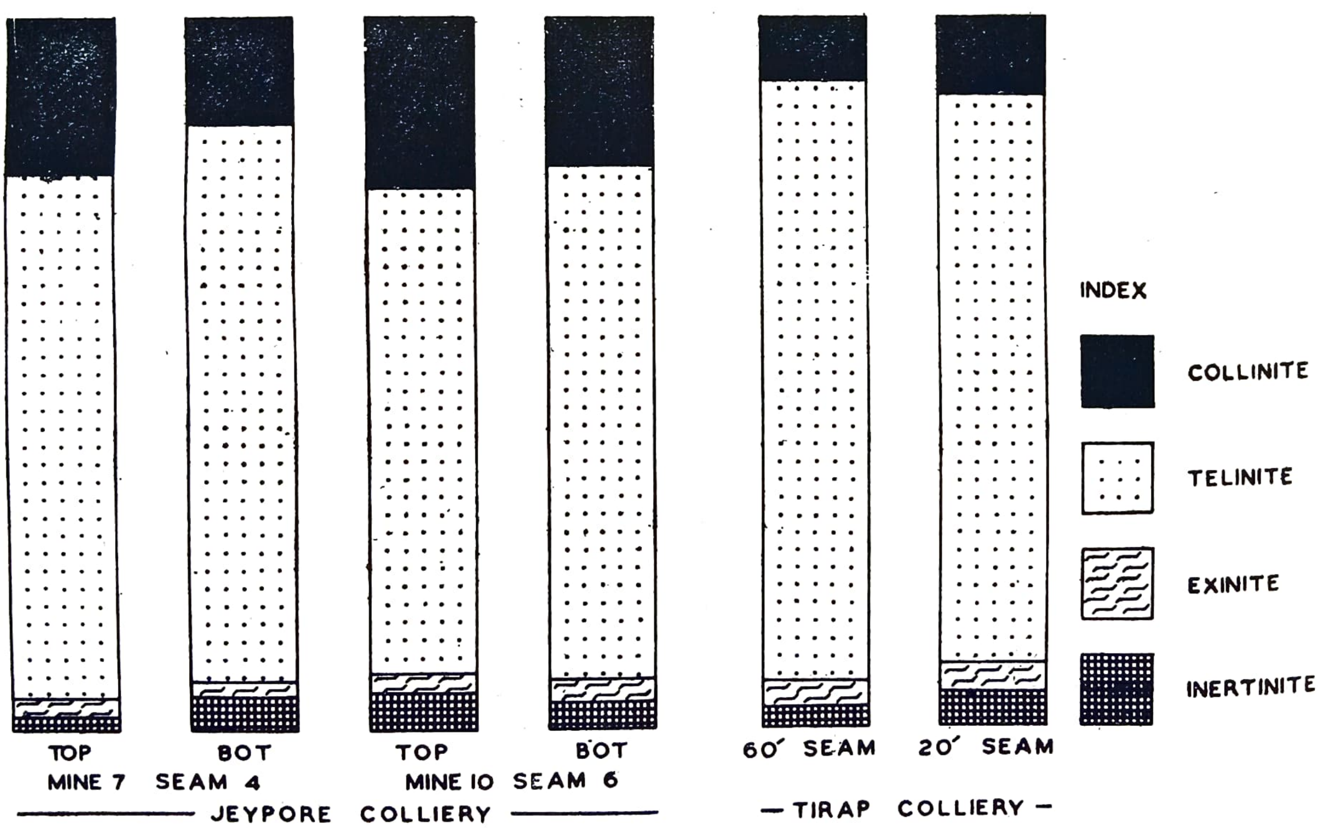
*Semifusinite and Sclerotinite* (Pl. 2, Figs. 12-21)—Semifusinite is transitional material intermediate between fusinite and vitrinite. The boundary between fusinite and semifusinite is probably less definite than between vitrinite and semifusinite but it is indefinite at both the limits. Generally semifusinites are formed from woody tissues as source material. The Jeypore coals are characterised by very low content of semifusinite (Pl. II, Fig. 12).

Fungal hyphae when closely meshed and compact, form parenchymatous tissue termed as Sclerotia. Sclerotia are composed of extremely hard substance-chitin, which has a good preserving capacity. The maceral includes structures of fungal hyphae, sclerotia and spores. Size and shape of the slcerotia and spore vary and they are flattened due to high pressure. The remains of resting fungi which constitute Sclerotinite are very commonly seen in the lignite. In Jeypore coals sclerotia are abundant and form almost half of the total inertinite content. Quite a few characteristic sclerotia have been recognised on the basis of morphological characters. They are comparable to few morphographic genera in the lignites of India (Navale, 1967). Some of them are *Sclerotites crassitesta* (Pl. 2, Figs. 13 & 16), *Sclerotites brandonianus* (Pl. 2, Figl 13), *Sclerotites* sp. (Pl. 2, Figs. 13, 18 & 21). Teleutospores with 2 to 3 cells are also present (Pl. 2, Figs. 17, 19 & 20). A new type of fungal Sclerotia, designated as *Sclerotites makumensis* (Pl. 2, Fig. 14), has been recorded. It consists of a thick walled main body (80 $\mu \times 66$ $\mu$), oval or subcircular (Pl. 2, Fig. 15) in shape, with a long (40 $\mu \times 10 \mu$) protruding beak like structure. A narrow lumen is traceable throughout the beak widening into the main body. Micrinite or opaque matter does not occur in the coals in sufficient quantity to materially affect the character of the coal. It is not always possible to differentiate micrinite and fusinite with certainty in small particles. Sometimes they appear as carbonized bright particles, round or elliptical in shape. Micrinite and pyrite may have somewhat, similar appearance in photographs that do not show the difference in colour although there is usually no difficulty in differentiating the two.

*Mineral Matter*—A very common and easily identified mineral in Jeypore coals is pyrite. It is by no means restricted in occurrence to vitrain. Sometimes, it fills the cellular cavities of inertinitic material (fusain etc.). Other mineral impurities in the coals consist of clay minerals. They are not common in contrast to Gondwana coals. Calcite and quartz also occur in the interstitial spaces of vitrain bands. But for pyrite which deprives the quality of coals, other minerals are rare and in fact the coals are free from them.

FREQUENCY DISTRIBUTION OF MICROCONSTITUENTS IN JEYPORE COALS

*Macerals*—The term maceral was introduced to designate the elementary microscopic constituents of coal. Vitrinite forms a predominant constituent in the assemblage of Jeypore coals. In mine 7, seam no. 4, the top portion of the 4.1 meters coal bed comprises 22.00% collinite, 73.50% telinite, 2.50% exinite and 2.00% inertinite. The inertinite comprises 1.00% each of sclerotinite and semifusinite macerals only while the bottom portion of the coal seam comprises 15.00% collinite, 78.00% telinite, 2.00% exinite and 5.00% inertinite in which sclerotinite forms 3.00% and semifusinite 2.00% (Histogram 1).




Histogram 1—Comparative distribution of maceral groups in Jeypore and Makum (Tirap) coalfields, upper Assam.

In mine 10, seam no. 6, the top portion of the 1.85 meters thick coal comprises 24.00% collinite, 68.00% telinite, 2.50% exinite and 5.50% inertinite in which sclerotinite forms 4.50% and semifusinite 1.00% while in the bottom portion the coal bed comprises 21.00% collinite, 72.00% telinite, 3.00% exinite and 4.00% inertinite in which sclerotinite forms 3.00% and semifusinite 1.00%. The Table-2 gives comparative assessment of the coal composition :

Table 2

| Macerals | Mine 7, Seam no. 4 (4.1 m thick) | | Mine 10, Seam no. 6 (1.85 m thick) | |
|---|---|---|---|---|
| | Top portion | Bottom portion | Top portion | Bottom portion |
| Collinite | 22.00% | 15.00% | 24.00% | 21.00% |
| Telinite | 73.50% | 78.00% | 68.00% | 72.00% |
| Exinite | 2.50% | 2.00% | 2.50% | 3.00% |
| Inertinite | 2.00% (Sclerotinite 1.00%) (Semifusinite 1.00%) | 5.00% (Sclerotinite 3.00% (Semifusinite 2.00%) | 5.50% (Sclerotinite 4.50%) (Semifusinite 1.00%) | 4.00% (Sclerotinite 3.00%) (Semifusinite 1.00%) |

By and large the top and the bottom portion of the seams resemble each other without showing any indication for change of environment of the deposition within the coal deposit or even between the two deposits to materially affect the nature, formation and constitution of coals. Collinization or gelification is more in the top portion of the bed. In seam 4, the top portion forms 22.00% of collinite while in the bottom portion it is 15.00%. Similarly, in seam 6, in the top portion collinite is 24.00% while in the bottom portion it is 21.00%. In general seam 6 has more of collinite substance suggesting further metamorphism of the coal swamp and may show a higher rank.

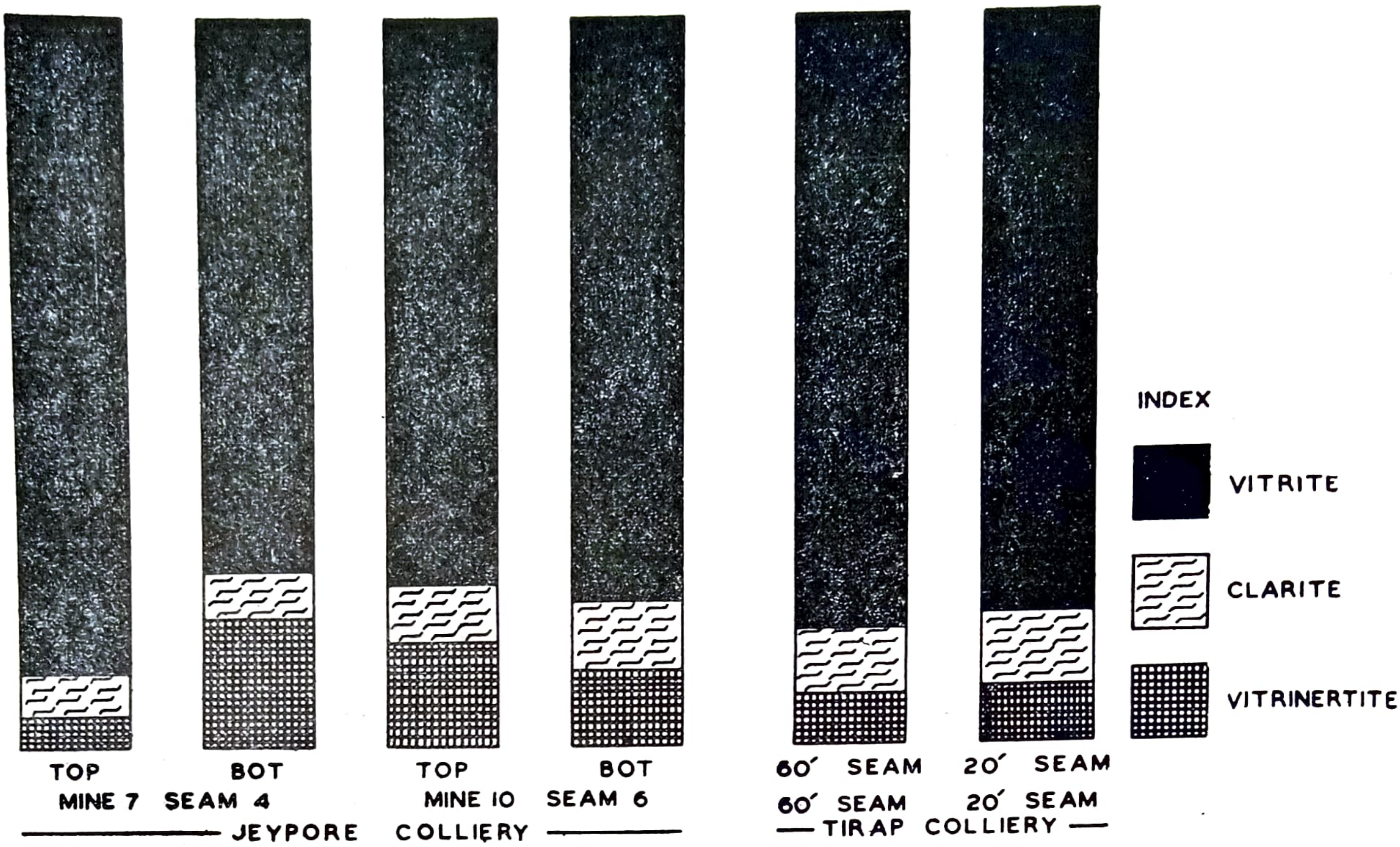
*Microlithotypes*—The term was introduced in 1954 to designate in the microscopy of humic coals the typical association of macerals. The microlithotype analysis of Tertiary coals of Assam has been undertaken for the first time. Among the recognizable vitrite, clarite and vitrinertite microlithotypes, vitrite forms a predominant microlithotype in the Jeypore coals. It is reasonable to expect the high incidence of vitrite microlithotype in the coals as they are predominated by vitrinite maceral groups.

In mine 7, seam 4, the top portion of the coal seam comprises 89.50% vitrite, 6.00% clarite and 4.50% vitrinertite while the bottom portion of the coal bed comprises 75.50% vitrite, 6.50% clarite and 18.00% vitrinertite (Histogram 2).

In mine 10, seam 6, the top portion of the seam comprises 77.50% vitrite, 8.00% clarite and 14.50% vitrinertite while the bottom portion of the coal comprises 80.00% vitrite, 9.50% clarite and 10.50% vitrinertite. The Table-3 gives a comparative analyses of the microlithotypes :

Table 3

| Microlithotypes | Mine 7, Seam no. 4 | | Mine 10, Seam no. 6 | |
|---|---|---|---|---|
| | Top portion | Bottom portion | Top portion | Bottom portion |
| Vitrite | 89.50% | 75.50% | 77.50% | 80.00% |
| Clarite | 6.00% | 6.50% | 8.00% | 9.50% |
| Vitrinertite | 4.50% | 18.00% | 14.50% | 10.50% |




Histogram 2—Comparative distribution of microlithotypes in Jeypore and Makum (Tirap) coalfields, Upper Assam.

The seam 4 of mine 7 comprises more of vitrinertite at the bottom portion which probably indicates relatively more exposure to aerobic decomposition during the process of compaction.

While in seam 6, of mine 10 vitrinertite is comparatively higher in top portion (14.50%) and less in bottom portion (10.50%) thereby suggesting reverse condition in the formation of coals.

## Comparison with other coals

Comparing with the well known Gondwana coals of Peninsular India (Sen *et al.*, 1967, Navale 1974-1975, Pareek 1967) the Jeypore coals may be very easily differentiated both mega-and microscopically by its high vitrinitic, least fusinitic and rarity of clastic mineral content. The well known durains and intermediate coal types, which form predominant coal components of Lower Gondwana coals, is never found in Jeypore coals but on the contrary, the vitrite characterizes the coals by having almost total vitrinite microconstituent. However, comparing with neighbouring Makum coals of Assam (Ghosh 1969, Sen & Sen 1969 and Mukherjee 1976), a close similarity may be seen in petrographic composition. Both the coals are characterized by high vitrinite coal type. When compared with the maceral analyses of Makum coals by Ghosh (1969), Sen and Sen (1969) and Mukherjee (1976) a slight variation in vitrinite and inertinite contents is observed. While exinite content of the coal remains almost identical in all the studies (Table-4).

The Jeypore coal is predominantly constituted by vitrinitic components which has special importance in utilization of coals as it becomes plastic when coal is heated. This property is important in the process of coke formation and also greatly influences the heating behaviour of the coals. As high incidence of vitrinite is associated with readily oxidizable property and low ash content, the coals are suggestive of economic utilization. However, relatively high amount of sulphur deprives the potential benefit of the coals

Table-4

| | TERTIARY COALS | | | | | GONDWANA COALS | |
|---|---|---|---|---|---|---|---|
| | Jeypore Coal | Makum Coals | | | | Lower Permian | Upper Permian |
| | | | Sen &Sen 1969 | Mukherjee 1976 | Ghosh 1969 | | |
| *Maceral groups* | | | | | | | |
| Vitrinite | 93.50% | 92.00% | 89.40% | 87.40% | 81.00% | 43.50% | 76.00% |
| Exinite | 2.50% | 3.50% | 1.50% | 4.30% | 3.60% | 10.40% | 8.00% |
| Inertinite | 4.00% | 4.50% | 9.10% | 6.00% | 11.90% | 46.10% | 16.00% |
| Mineral Matter | | | | 2.30% | 3.50% | | |
| *Microlithotypes* | | | | | | | |
| Vitrite+ Clarites | 87.90% | 92.50% | | | | 30.00% | 78.00% |
| Intermediates | | | | | | 50.00% | 12.00% |
| Fusite and Mineral matter | 11.90% | 7.50% | | | | 20.00% | 20.00% |

which of course is an adverse factor. Efforts are to be made for removal of pyritic impurities by chemical methods so that the coals with good coking constitutents may be utilized for industrial purposes.

## CONCLUSION

From over all assessment of the analytical data of the petrographic microconstituents, it may be presumed that the coals have overwhelmingly been derived from woody plants especially trees indicating a forest swamp type of vegetation and that macrofragmental material dominated in the coalification process is indicated by ultimate constituents of the coal. Poor inertinitic content suggests enough water level so as to facilitate vitriniza-tion of the coal forming plant material. These coals are characterized by the highest amount of vitrinite among all the Indian coals. By virtue of their vitrinitic content, coking ability is indicated but for the high percentage of sulphur.

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## EXPLANATION OF PLATES

(All photographs taken on polished surfaces with reflected light)

Plate 1

1. A collinite. 250×
2. A telinite showing well preserved cellular structure. 250×

3&4. Telinite showing fragments of collapsed cell walls alternating with compressed vitrinite bands. 250×

5& 6. Clarite (spore-clarite) showing sparsely arranged microspores. 250×

7. A clarite (cuticular clarite) showing cuticles arranged in a plane. 250×

8-11. Sectional view of microspores. 500×

Plate 2

12. A semifusinite. 250×

13. A *sclerotites brandonianus* at the right hand corner, *S. crassitesta* in the center and a *Sclerotites* sp. at the top. 250×

14 & 15. *Slcerotites makumensis* sp. nov. 500×

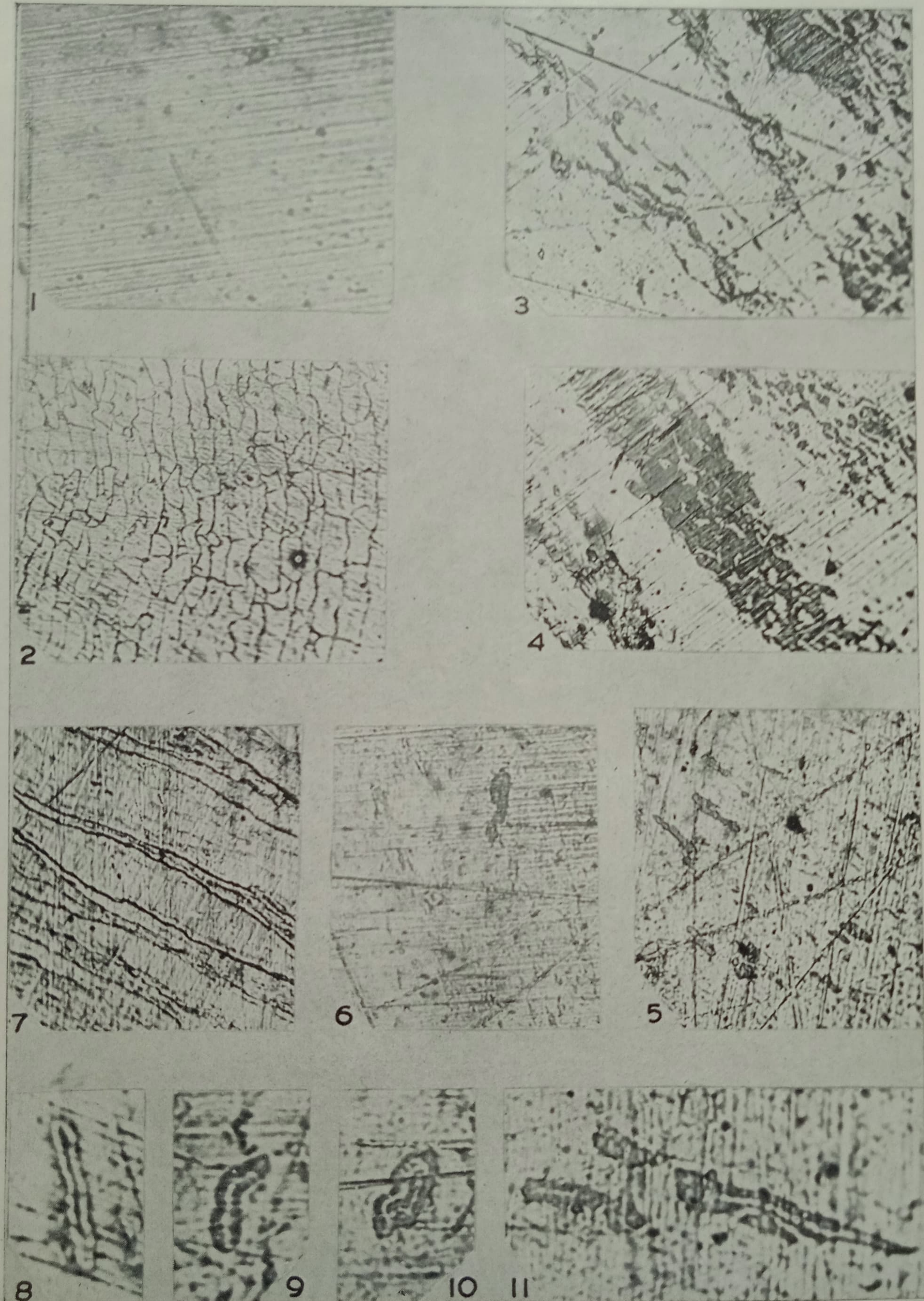
16. A *Sclerotites crassitesta* 500×

17. A three-celled teleutospore. 500×

18. Two *Sclerotites* sp. 250×

19. & 20. Two and three celled teleutospores. 500×

21. A five celled sclerotia. 500×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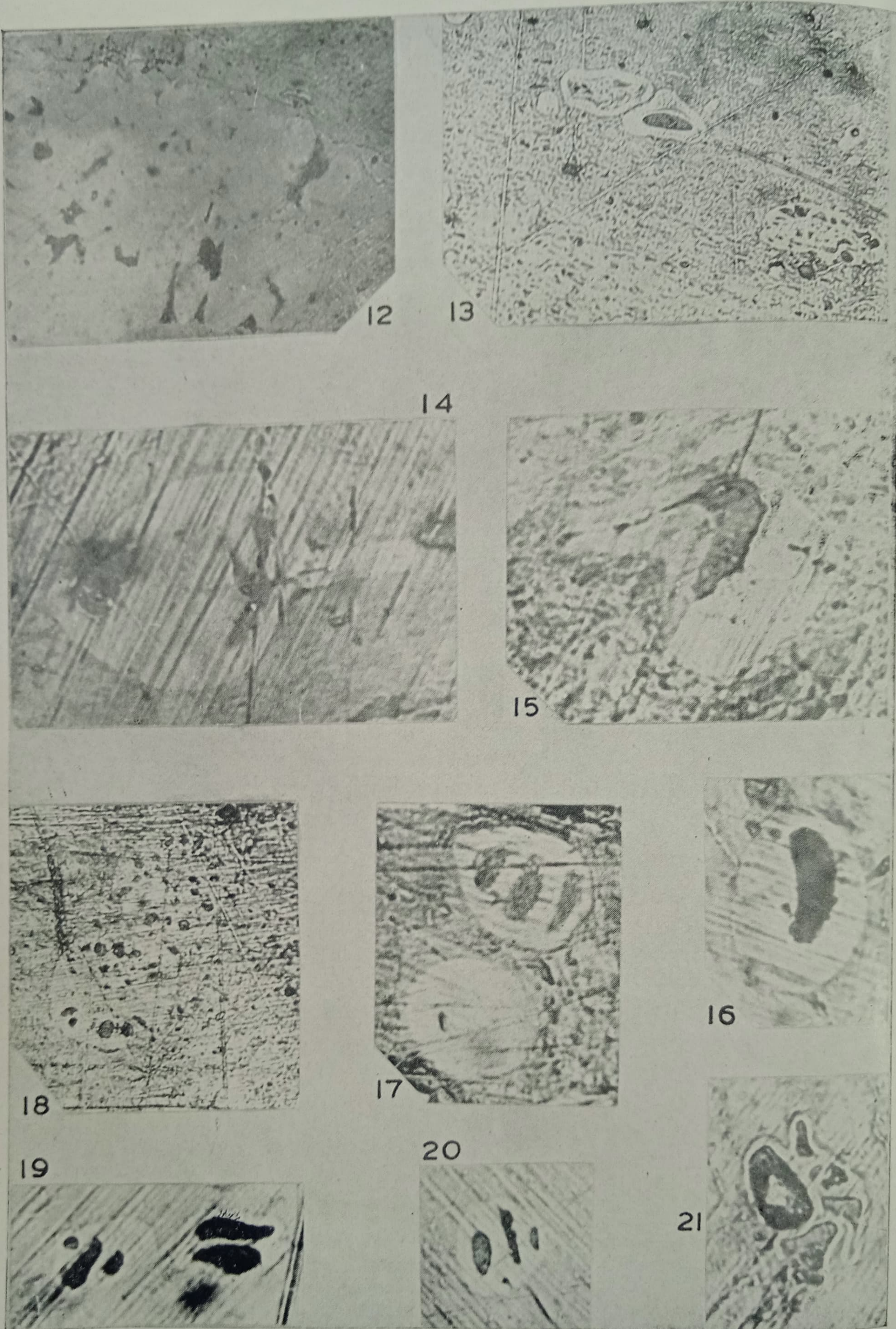


G. K. B. Navale & B. K. Misra—Plate 2