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Tel: 681-1392

MINE OFFICE
1339 THIRD AVENUE
PRINCE GEORGE, B.C.
PHONE: 564-5816

Northern Coal Mines Ltd.

June 6, 1972.

Deputy Minister of Mines &
Petroleum Resources,
Parliament Buildings,
Victoria, B. C.

Dear Sir,

Re: Our Bowron River coal property

We instructed by our President, Mr. Morris M. Menzies, we enclose for your information a copy of GSC Technical Report No. 93-H-13W-1 relating to our coal property.

Yours very truly,
NORTHERN COAL MINES, LTD.

Kenneth Li,
Secretary-Treasurer

KL
Encl:

J8/5 JTF

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GEOLOGICAL BRANCH
ASSESSMENT REPORT

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PETROGRAPHIC ANALYSIS –
SEE GLB FILE COAL PETROLOGY
(X-FILE – BOWRON RIVER)

BW - BOWRON RIVER 72(1)A

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CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

GEOLOGICAL SURVEY OF CANADA

TECHNICAL REPORT NO. 93-H-13W-1

PETROGRAPHY OF THE COAL FROM THE GARROWAY MINE IN THE BOWRON RIVER COAL AREA, BRITISH COLUMBIA

BY

J. ROGER DONALDSON

OTTAWA
1972

PETROGRAPHY OF THE COAL FROM THE GARROWAY MINE IN THE BOWRON RIVER COAL AREA, BRITISH COLUMBIA.

ABSTRACT

A petrographic study was carried out on coal from the Garroway Mine in the Bowron River Coal area in British Columbia.

The seam studied is of Tertiary age and the examination was part of a larger investigation on Canadian Coals of Tertiary Age.

Though the coal is reported as being a coking coal, stability predictions based on the chemical composition as determined by proximate analyses, reflectance (R_o) indices and maceral composition indicated otherwise. Results showed that the reactive-inert imbalance predominantly favoured the reactive components. These constituents contribute good swelling characteristics to a coke but lack of an optimum amount of the inert or dull coal components result in a coke that is weak.

The coal is reported to be high in percentage of the maceral resinite. Visible resin nodules were observed in the coal during sampling. The subsequent microscopic analysis did not substantiate this observation because this type was not observed during the analysis. Resin of the invisible type, due to vitrinization, could be treated only as a vitrinoid.

Though this coal would not produce a coke of good quality by itself it could be used possibly as a blend to mix with a coal which has good strength contributing properties and a lack of good swelling characteristics.

INTRODUCTION

The existence of coal on the Bowron River in British Columbia has been known for the last 100 years. Dawson noted in 1871 that coal was reported by Dewdney on the banks of the Bear River - later known as the Bowron River.

The seam sampled is from the Northern Coal Mines Ltd., Garroway Mine (see Fig. 1) which is located on the west bank of the Bowron, about 35 miles east of Prince George - a rapidly growing rail and industrial center. The mine is only five miles south of a newly paved highway that has recently been constructed from Prince George.

Due to the increased interest in B.C. coking coals, considerable development work has been done in the Bowron River area. Petrographic studies have been undertaken to determine the nature of the coal and its suitability for coking. The coal is reported to have a high resin content and the present company set out to mine the coal solely for the resin and have the coke as a low priced by-product. Favourable indications from swelling tests coupled with the mine's favourable location in respect to the Japanese market reversed this policy.

GENERAL GEOLOGY

The Bowron River valley is almost entirely covered with overburden and therefore the coal seam outcrops can only be observed along the banks of the river and along the creeks.

The rising ground on the valley-sides and a few points along the river itself are underlain by a group of largely green-coloured volcanic rocks and include fine tuffs, breccias and lavas. The only intrusives seen are several small dykes which intrude dark argillite near the north of Purden Creek (Holland 1948).

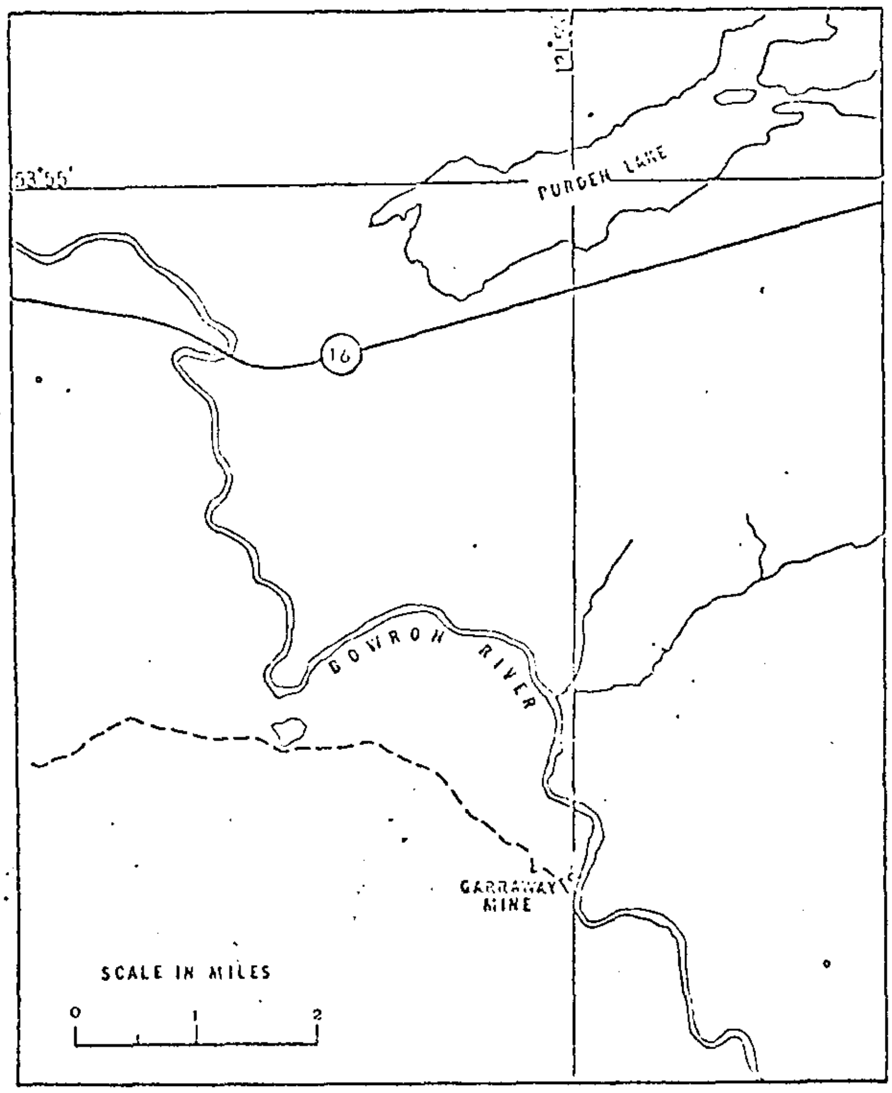

FIGURE 1. SAMPLE LOCATION MAP, BOWRON RIVER, B.C.

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The coal is found in a series of sandstones, shales and conglomerates that outcrop along the river. It is possible that the coal-bearing series may outcrop farther to the northwest and southeast but the formation has not been traced farther in those directions.

The coal formation comprises grey and buff sandstones inter-bedded with light to dark soft shales and sandy shales, some of which are carboniferous as well as several beds of conglomerate. The conglomerate contains cobbles of green volcanic rock / as much as 10 inches in diameter proving that the volcanics are the older. Several beds, / as much as 15 feet thick, of grey conglomerate outcrop along the river. The distribution of coal-bearing outcrops suggests that the formation underlies the Bowron River valley forming a belt 1½ to 2 miles wide and about 7 miles long.

Holland (1948) reported that a collection of fossilized plant remains was submitted to the late Dr. W.A. Bell for identification who reported, "the fossil plants from the Bowron River area are poor indeed.....but....I consider the age to be Tertiary". In 1968 Dr. Bell, in an unpublished report stated, "the evidence, unsatisfactory as it is, favours a time interval in the Upper Cretaceous, within the limits of Campanian-Maestrichtian and particularly a Campanian one".

From the foregoing it is obvious that dating the Bowron River measures is very difficult, the problem being compounded by the lack of good fossil material.

MacKay (1946) noted that the coals of the Bowron area are of Tertiary age, and at least 3 of the coal seams are of commercial interest. He also states that the coals have been classed by the Provincial Government as bituminous in rank.

In 1969, Dr. G.E. Rouse of the University of British Columbia, Dept. of Botany, reported, "I am reasonably sure that the Bowron suite is Tertiary in age; most likely between iddle Paleocene and mid Eocene,with a chance of

Though the age of the measures is in doubt due to the lack of good fossil evidence, it is generally considered that the coals found in the Bowron River area are of Tertiary Age.

Sample Preparation and Megascopic Examination

A column sample was taken from the upper seam of the productive part of the coal measures from the Garroway Mine, stated to be 10 ft. thick.

The sample represents 7 feet of coal exposed at face of prospect slope. The column was taken to the laboratory cut into smaller, more manageable blocks and mounted in Paraplex - a plastis mounting medium.

After mounting, these blocks were labelled as to their relative position in the column and oriented with respect to top and bottom.

The blocks were then polished on a Buehler polishing lap using a standard acceptable procedure. They were then examined megascopically using a hand lens and a very low power stereoscopic microscope (X5).

In general appearance, the coal examined is a normal banded coal composed almost entirely of the bright components vitrain and clarain. Subordinate amounts of shaly coal, coaly shale and shale also occur. The coal has a high lustre and is hard and dense.

The megascopic profile of the seam is reproduced in figure 2, which shows that the seam is split by four distinct partings. The pure coal, contained between these partings was divided into nine petrographic intervals based on the relative proportions of the entities present.

The resulting breakdown showed that intervals I and V are composed mainly of the shale-rich entities while the remaining 7 are of clean coal which differs only in the vitrain to clarain ratio. Vitrain exceeds clarain in interval II, IV and IX while the reverse is true in intervals III, VI, VII and VIII. Throughout these bright intervals the shaly impurities occur in minor percentages.

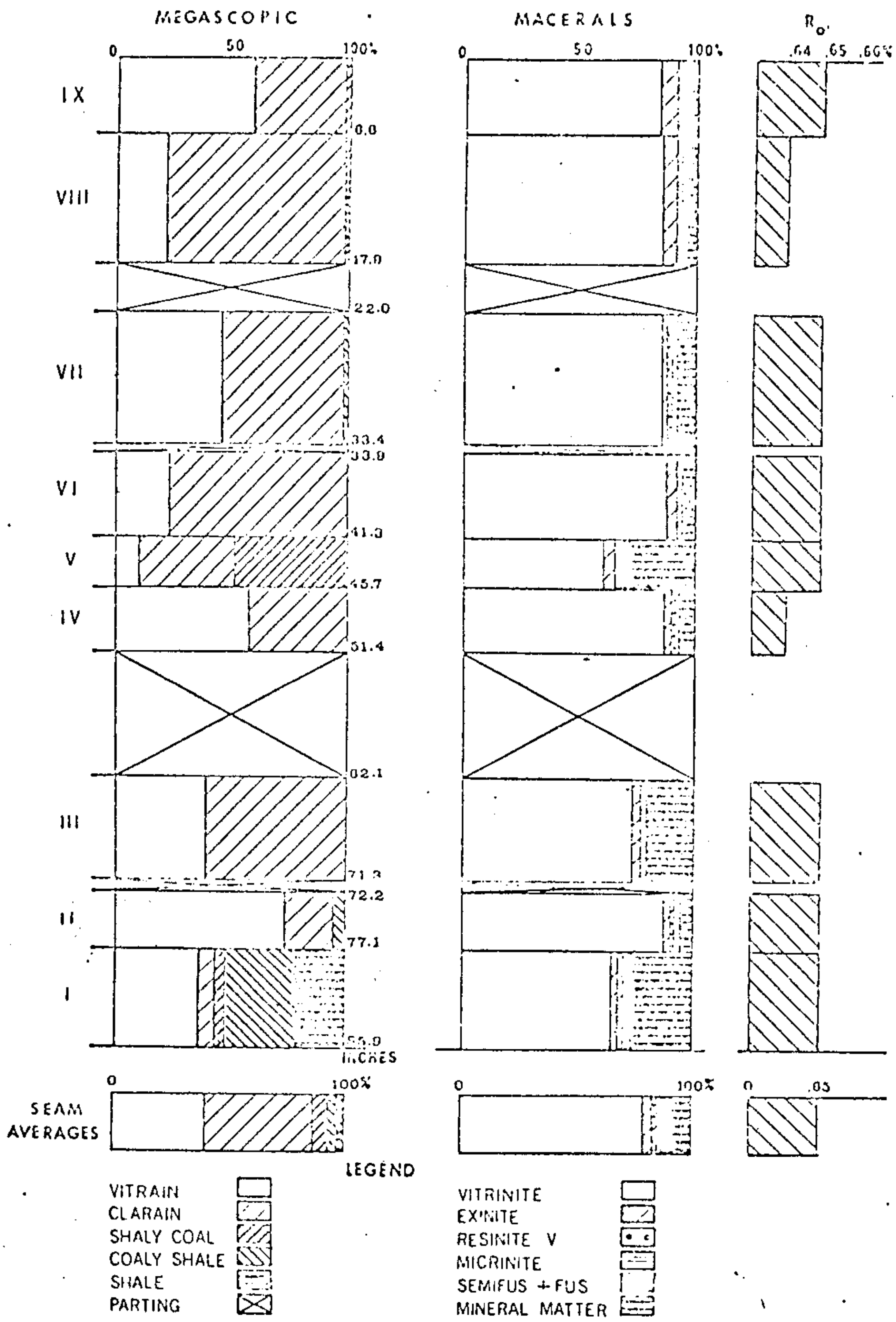

FIGURE 2. PETROGRAPHIC COMPOSITION AND R_o. INDICES OF THE UPPER SEAM, BOWRON RIVER, B.C.

Microscopic Examination

Coal from the megascopically determined intervals was then prepared for microscopic examination.

The coal representing each interval was crushed to -20 mesh and riffled to yield a representative sample. A grain mount was prepared from each interval and polished on a Buehler Automet polishing lap. The polished grain mounts were then used for reflectance measurements and maceral determination. Reflectance measurements are normally made on vitrinite, the most abundant constituent in most coals. Measurement of this parameter is a petrographic way of expressing rank. An increase in rank is accompanied by an increase in reflectance and this can be measured quite precisely. Such measurements on a given coal are usually reported in two ways:

1. An average of a number of readings may be calculated and the rank of the coal expressed by a single reflectance index.
2. The reflectance data also may be used to subdivide the vitrinite into so-called "V" types. These are designated by number as V6, V7, etc. These numbers signify a reflectance range. Thus V6 means vitrinite with a reflectance range between 0.60 and 0.69% in oil, while V7 has a range between 0.70 and 0.79%.

Reflective indices were determined with a Leitz microscope fitted with a photometer. This is a similar arrangement to that which is generally accepted and used by other petrology laboratories. The instrumentation and its standardizations are described in the "Third Draft, Equipment and Procedures for Determining Microscopically the Maximum and Mean Minimum Reflectance of the Organic Components in Polished Specimens of Coal, ASTM Designation D5 Subcommittee XVIII Petrographic analysis of Coal" by J.L. Bayer. It is described also by Schapiro and Gray (1960).

The results of the reflectance study are shown on figure 2 in the right hand column headed R_o. These show that the mean maximum reflectance of the vitrinite component is almost constant from the top to the bottom of the seam.

That there is little variation in the consistency of the vitrinite is shown by the fact that the reflective index of the various intervals only fluctuates from 0.64 to 0.65 which is within the range of the statistical error encountered in the work. The average reflectance for the entire seam is calculated to be 0.65.

A further indication as to the lack of variety in the vitrinite is shown by the fact that there were only 4 vitrinite types in evidence in the entire nine intervals which ranged from V4 to V7. The vitrinite type V6 accounted for 66 per cent of these reflectance readings.

The rank of the coal was determined chemically using the method outlined in the A.S.T.M. standards on coal and coke (1962). The coal was found to be of high volatile B bituminous rank. Rank as determined by reflectance was in accord with the A.S.T.M. method.

The grain mounts used in the above R_o study were repolished and re-examined to determine the maceral content of the coal. Macerals are the basic constituents of coal and are analagous to the minerals of inorganic rocks. The ones identified in the present study are vitrinite, exinite, resinite, micrinite, semifusinite and fusinite. Mineral matter also was determined. Definitions of the macerals as well as the method followed in determining their quantity conform to those suggested in the International Handbook of Coal Petrology (1963). The results of this examination are shown graphically in the center column of figure 2 and numerically in table I. During the analysis the macerals semifusinite and fusinite were considered separately but these later combined to produce the column in figure 2 because they appear to represent stages in a genetically related group. The fact that the combined total of these two macerals does not exceed 5 per cent in any interval facilitated plotting.

As previously stated the seam in the Garroway Mine is very bright, hard and has a high lustre. The maceral analyses of the various petrographic intervals substantiates this initial impression.

Table I

Interval	Height Inches	Vitrinite %	Exinite %	Resinite %	Micrinite %	Semifusinite %	Fusinite %	Mineral Matter %	Total %
IX	6.6	84	7	—	1	4	1	3	100
VIII	11.3	85	6	—	1	1	—	7	100
VII	11.4	85	2	1	1	—	—	11	100
VI	7.4	88	4	—	2	—	—	6	100
V	4.4	61	4	—	1	3	1	30	100
IV	5.7	90	3	2	—	—	—	5	100
III	9.2	73	3	—	1	—	—	23	100
II	4.9	90	2	1	1	—	—	6	100
I	8.8	65	1	—	1	2	1	30	100
Seam Average	69.7	80.2	3.6	0.4	1.0	1.1	0.3	13.4	100

Maceral Content of the IX Petrographic Intervals of the Upper Seam, Bowron River Area

The seam is composed almost entirely of the bright coal component vitrinite. This maceral is the major entity of all nine intervals reaching a high of 90 per cent in interval IV, the brightest unit and dropping to a low of 61 per cent in interval V, which is the dullest interval. The monotony of the column is broken by the three intervals I, III, and V which have higher amounts of mineral impurities. The mineral pyrite and various shale minerals account for the mineral matter. The other maceral components are present only in minor percentages.

The seam under study has been noted for its relatively high resin content. Black reports on two types of resin, namely soluble or "Canadian" resin and insoluble resin. The former is reported to compare favourably with "Congo" resin which has a well-established place in world markets. This resin was named "Canadian" by the Batelle Institute (Black 1967). This "Canadian" or soluble resin was reported to amount to 4 per cent in this coal. In contrast to the above "soluble resin" which is invisible, megascopically the insoluble resin is visible and is said to be present in the coal in an amount equal to the "soluble resin" (approximately 4%).

During the visit to the mine to collect the sample studied, the visible resin was observed in the coal. The resin appeared as small (±1 inch), elongated, amber-yellow nodules randomly distributed throughout the seam.

The invisible, soluble resin was assumed to be so only in a megascopic examination, but would be visible during the microscopic phase. The resulting low percentages actually observed during the microscopic examinations therefore were disappointing.

A fragment of the visible resin, hand-picked from the seam, was examined in oil under reflected light and showed a distinct brownish red-orange colour and therefore appeared as a readily identifiable component. During the subsequent analysis, none of this type was observed in the coal. The small percentages of resinite evident ranged from light to dark grey in colour.

The discrepency between the high resin values mentioned in the report by Black and the paucity of resin found by the present analysis could be attributed to "vitrinization". Stach (1968) reports that the elliptical resin bodies can lose their resinous characters by polymerisation and may be transformed into grey vitrinite. Such resinous material in a petrological examination would have to be assessed as vitrinite or, more strictly, as semi-vitrinite. Thus it would appear that through this process of polymerisation the resinite loses its original optical properties and assumed the same colour as vitrinite. It is conceivable that in this process the resin loses some of its "exinitic" properties and takes on more vitrinitic characteristics.

COKE STABILITY

The present mine operators found that the coal near the top of the slope produced a coke button with a swelling index of 1 and that it increased as the mining proceeded down the dip of the seam.

Coke stability can be predicted with an accuracy of 94 per cent (Berry, et al.,1967) if the maceral content and the reflectance data of the seam are known. The method followed in the present study was that described by Schapiro, Gray and Eusner (1961) and the calculated stabilities for the petrographic intervals and a composite of the entire seam were compiled. The method considers the macerals as belonging to two groups, namely those which are reactive (vitrinite, exinite, resinite, 1/3 semifusinite) and those which are inert (fusinite, micrinite, 2/3's semifusinite, mineral matter). The method further assumes that for maximum coke strength there is an optimum ratio of reactives to inerts and that this ratio varies with rank.

The results of the stability determinations for the Bowron coal are shown in Table II.

Table II

Interval	I	II	III	IV	V	VI	VII	VIII	IX	Seam Average
Stability	6	0	0	0	23	0	0	0	0	9

Predicted Coke Stabilities of the Petrographic Intervals and Seam Average of Upper Seam, Bowron River Area.

These results show that all intervals with the exception of intervals I and V have a calculated predicted stability of 0. The remaining intervals, I and V have stabilities of 6 and 23 respectively. The predicted stability for the entire seam was 9 as compared with a stability of 50-60 for known coking coals.

The resulting low stability factor can be almost solely attributed to the lack of the so-called inert macerals such as the semifusinite, fusinite and micrinite.

As can be seen from figure 2, the seam is composed of almost 80 per cent of the reactive components vitrinite and exinite. These are the macerals that contribute the swelling properties to the coke. As previously stated, resinite behaves in a manner similar to exinite and this adds considerably to the swelling characteristics. Coal that contains 5 per cent resinite is considered a high resinous coal and therefore the 8 per cent reported by Black puts the seam under study in this category. This overabundance of swelling reactives would yield a favourable coke button but not necessarily a strong coke.

On the other hand, a coal that would be considered a good coking coal would have a predicted coke stability of from 50 to 60. The reason that this coal has such poor predicted stability is due to the paucity of the inert macerals which impart strength to the coke. The calculation of stabilities is based on the ratio of reactive entities which in general produce the swelling characteristics to the inert components which give the coke its strength. It is, therefore, unlikely that this coal would produce a good coke. The coal could, however, be used as a blend to mix with a low volatile coal that has a high inert maceral content. Further study would be required to determine the suitability of this coal for blending.

SUMMARY AND CONCLUSIONS

The upper seam of the productive part of the coal measures in the Bowron River area is composed of a clean-looking coal with a very high lustre. The coal is dense and hard and contains small amber-yellow resin nodules dispersed through it.

The coal is a high volatile bituminous coal by A.S.T.M. standards and this was borne out by the mean maximum reflectance index of 0.65.

The coal has yielded a coke button with a free swelling index of 1 near the top of the slope and 3 at the face. The operators predict a button of 5 as they procedd down dip. This is not over-optimistic as the coal is composed mainly of those macerals that contribute volatiles and hence swelling of the coke. The lower indices of 1 and 3 obtained on the samples mentioned above may be due to oxidation of coal collected relatively near the outcrop.

This abundance of reactives is detrimental to the process of coke making with this coal since the inert macerals which give strength to coke are present in very small proportions. It is the lack of this inert component that gives a predicted coke stability of only 9 for the seam even though one of the established petrographic intervals gave a figure of 23. This was the highest figure obtained and, when weighed against the 50-60 stability index produced by good coking coals, indicates a coke of inferior quality. The coal possibly could be used as a blend with a coal which is low in reactive macerals.

There was little petrographic indication of the high (8%) resin content attributed to this coal. This lack could be attributed to the amount of bitrinization undergone by the resin or by the superiority of a chemical analysis to determine the resin content of this coal.

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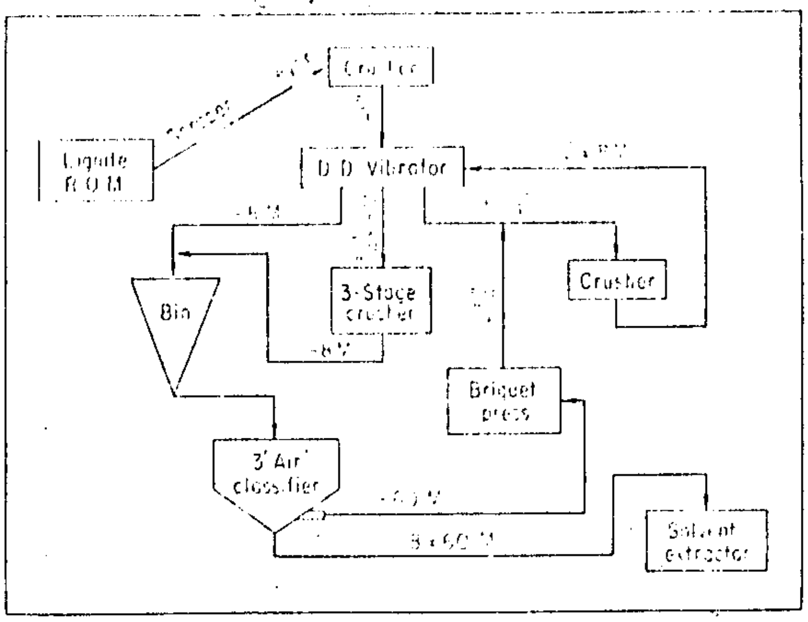
PROVIDING closely controlled size range of lignite fines is function of air classifier.



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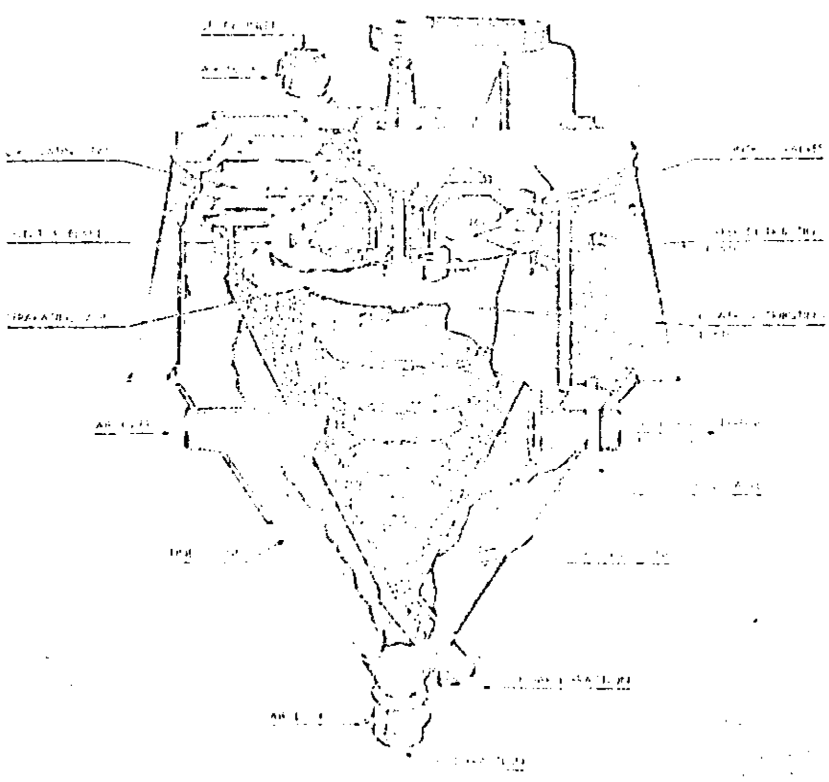
Montan wax is the basic material for the production of a number of waxes, and is a substitute for carnauba and beeswax in making paper sizings and in polishes, paints, candles, soaps, pastes and so on. It is used also in production of plastics and resins, inks, waterproofing materials and as a binder in carbon-paper coatings having non-smudge characteristics.

The air classifier is a 3-ft Sturtevant separator. Its purpose in the ALPCO circuit is to isolate an 8x

(Continued on p 86)



SIMPLE adjustment of external controls results in precise classification of fines at selected limits.