1967/87
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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1967/87

COAL AT GOVE PENINSULA N.T.

by

R.G. Dodson

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RECORD 1967/87

Contents

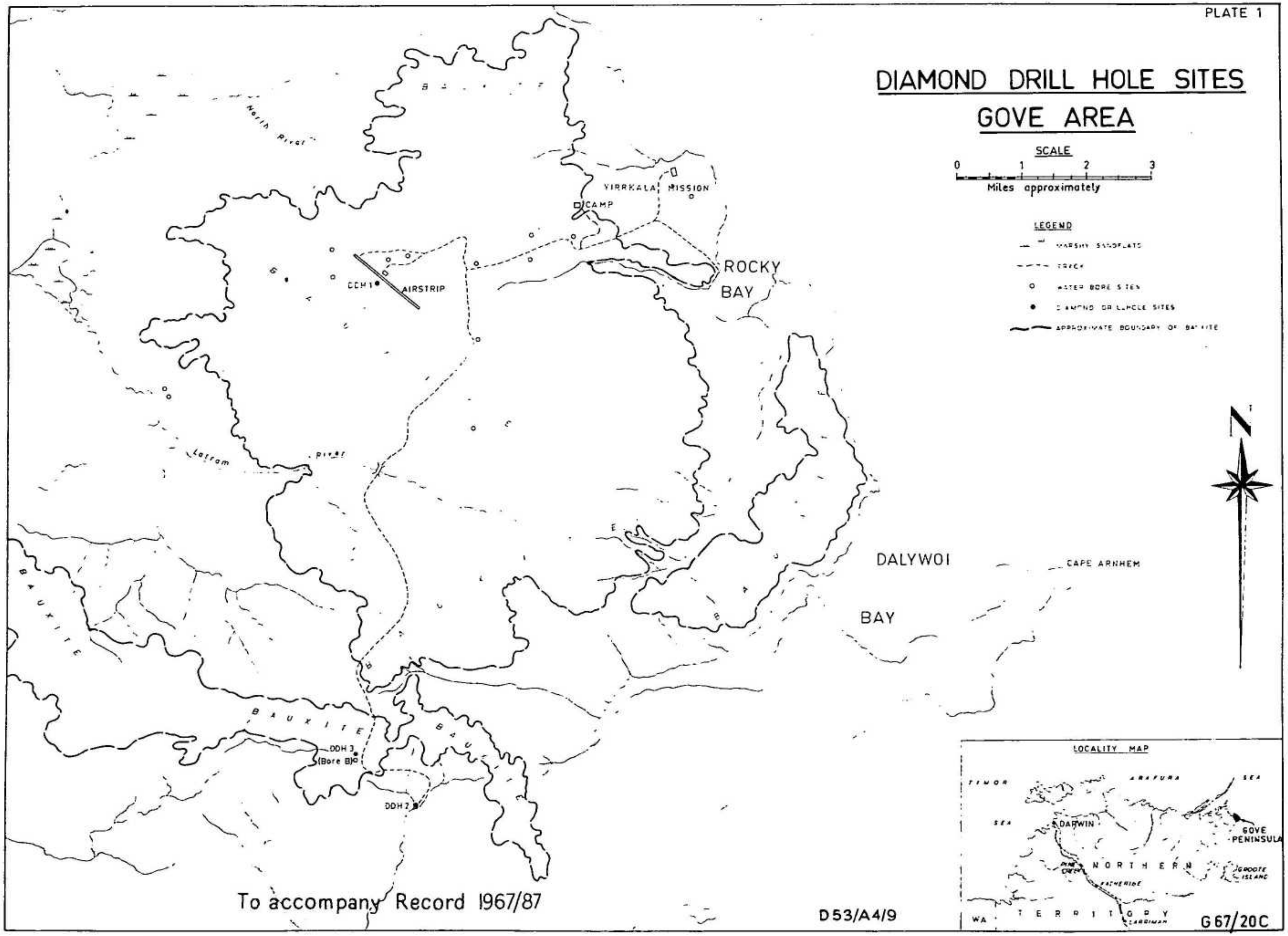


PLATE 1
DIAMOND DRILL HOLE SITES
GOVE AREA
SCALE
0 1 2 3
Miles approximately
LEGEND
YIRRKALA MISSION
CAMP
ROCKY
BAY
DDH 1
AIRSTRIP
North River
Latram River
DALYWOI
BAY
CAPE ARNHEM
BAUXITE
DDH 3
(Bore B)
DDH 2
LOCALITY MAP
TIMOR
SEA
ARAFURA
SEA
DARWIN
GOVE PENINSULA
NORTHERN
TERRITORY
GROOTE ISLAND
WA
To accompany Record 1967/87
D53/A4/9
G67/20C

SUMMARY

During a survey of the groundwater resources of Gove Peninsula conducted by personnel of the Water Resources Branch N.T., intersections of coal were made in several bore holes. In view of the economic importance of a potential source of fuel at Gove, a programme of diamond drilling was planned to investigate the extent and importance of the coal deposits.

The coal seams intersected are thin, lens-shaped, low grade and occur at depths greater than 200 feet below the surface; drilling was discontinued after the third drillhole was completed.

INTRODUCTION

Narrow seams of coal were intersected in several exploratory bore holes put down during a survey of underground water reserves in the Gove area by Water Resources Branch N.T. After the discovery of this coal, an investigation was made of the sedimentary succession at Gove to establish the significance and economic potential of the coal. The investigation consisted of a programme of diamond drilling by Mines Branch. Three holes were sited initially by the writer.

Specimens of siltstone and coal were submitted to Bureau of Mineral Resources for palynological study (see appendix 3) and samples of coal to the C.S.I.R.O. Division of Coal Research for testing (see appendix 2).

LOCATION AND ACCESS

Gove peninsula forms the north-eastern corner of the Arnhem Land Aboriginal Reserve. The area is well wooded, but locally it has been cleared at the sites of former and present settlements. The Yirrkala mission is situated on the north-eastern part of the peninsula.

MacRobertson Miller Airlines Ltd. operate a regular service between Darwin and Gove airstrip. Access to Gove by sea at present is by way of a coastal barge service. Rare visits are made by coastal craft owned by Mission organisations.

PREVIOUS GEOLOGICAL WORK

The earliest record of geological work in the Gove area is a brief description by H.Y.L. Brown (1907) of a geological reconnaissance of the coastal area from Van Dieman Gulf to the McArthur River. H.B. Owen (1952) made a brief survey of the bauxite deposits at Gove. He considered that granite forms a foundation underlying the sediments of the area, concluding that the Gove and Wessel Island sedimentary successions were similar. D.E. Gardner (1955) surveyed the bauxite deposits at Gove describing the bauxite as a layered formation consisting of a pisolitic cap overlying tubular bauxite which in turn rests on "non-plastic red clay".

In 1962 the Gove area was mapped (Arnhem Bay-Gove Sheet 1:250,000) by a Bureau of Mineral Resources field party. The geology of the Gove peninsula was interpreted by D. Dunnet (1965) as a bauxite cap overlying a succession of "lateritic soil and ferruginous cemented detritus", laid on a foundation of garnetiferous granite.

W. Morton (1966) investigated the groundwater resources of the Gove Peninsula. The survey included drilling of boreholes sited on an existing grid of 2000 feet spacings, originally surveyed by The New Guinea Resources Prospecting Co. Ltd., nine bores were drilled. In a description of the succession underlying the bauxite, Morton pointed out that strata intersected in bores could not always be related to the sequence in adjacent bores, inferring lensing of the sediments.

Exploratory work in connection with the Gove bauxite has continued to the present.

DETAILS OF GEOLOGY

During the present survey no systematic mapping was undertaken. Knowledge of the geology of the area is based on examination of outcrops and examination of diamond drill cores and borehole cuttings.

The geology of Gove Peninsula consists essentially of a foundation of granite overlain by sediments of Cretaceous age which in turn are capped by bauxite.

Granite

Granite core from the bottom of DDH.1 and DDH.2 is similar to granite outcrops in the vicinity of Yirrkala Mission and on the shoreline of Melville Bay. It is a coarsely crystalline biotite-garnet type with abundant xenoliths of schistose rock. The granite was described as the Bradshaw granite by D. Dunnet (1965).

Mesozoic Sediments

The sediments were apparently laid down on an undulating surface of granite. In the three diamond drill holes, the granite-sedimentary contact was intersected at the following depths:- DDH.1, 419 feet below mean sea level, DDH.2, 352 feet below mean sea level and DDH.3, 14 feet below mean sea level. Elsewhere in the Gove Peninsula area granite forms prominent outcrops.

The succession is subject to lateral variation, there being little similarity between the sequence intersected in each of the three drill holes. The sediments comprise a series of poorly consolidated, coarse-textured kaolinitic arkosic sand, with intercalations of fine textured claystone, locally with carbonaceous partings. The Mesozoic sediments are capped by approximately 30 feet of bauxite in the plateau area.

The arkosic sands are composed of angular to sub-angular quartz grains with kaolinised feldspar. Heavy minerals identified in concentrates from the sands are ilmenite, hematite, biotite, garnet, zircon, rutile, pyrite, and rare monazite. Apart from a slightly coarser texture and less weathered condition in the lower most sediments, little variation can be detected in the arkosic sands.

The claystones are typically pale fawn, cream or light grey in colour. In DDH.2, a brick red claystone horizon occurs at a depth of 260-264 feet. The claystone is fine-textured and includes quartz grains, fine mica flakes and small quantities of heavy minerals similar to those identified in the arkosic horizons; sphalerite is present in certain sections. The highest concentration of sphalerite is in a thin layer of claystone in DDH.2 at a depth of 402'6" below the surface. It occurs as finely disseminated specks in narrow seams, locally concentrated into larger clusters at the edge of carbonaceous seams. Some of the claystone grades into siltstone.

The Coal occurs both as narrow seams relatively free of impurities, and as dispersed shreds in claystone. The seams range from narrow partings less than half an inch thick to a maximum thickness of 3 inches, intersected in DDH.2 at a depth of 208 feet. In DDH.1, the total thickness of coal intersected amounted to 4½ inches, in DDH.2 to approximately 5 inches. The coal is charcoal-like in appearance, and it has retained well defined cell structure. P.R. Evans (see Appendix 3) identified spores from the coal as Albian stage (Lower Cretaceous) micro-flora. Composition of the coal approximates brown coal: (See Appendix 2). In all coal seams, sphalerite was recognised. Pyrite is less common but is present in all the coal seams.

The Bauxite

The Mesozoic sediments are capped by approximately 30 feet of bauxite composed of an upper layer of pisolitic material underlain by tubular bauxite.

CONCLUSIONS

Diamond drilling at Gove Peninsula proved the existence of narrow partings of brown coal in argillaceous horizons of the Mesozoic sedimentary succession. The coal was formed by conversion under low pressure of scattered wood remains. As only limited vegetable matter was available little coal was formed. In view of the low grade of the coal, the thinness and lensing characteristics of the seams, and the depth below surface level at which they occur, the coal seams cannot be considered to be economically important.

Kaolinitic clay suitable for a local ceramic industry may be obtainable from the arkosic sands underlying the bauxite. The sand is usually poorly consolidated and as such, could be quarried easily. Extraction of the clay might be possible by washing. The remoteness of the area makes it unlikely that transportation of kaolin to the nearest market would be economic. The material may however prove suitable for use by aborigines at a mission or Welfare Department establishment.

REFERENCES

BROWN, H.Y.L., 1907 - Geological Reconnaissance from Van Dieman Gulf to the McArthur River, Etc., Report by Government Geologist, Northern Territory of South Australia.

DUNNET, D., 1965 - Arnhem Bay/Gove, N.T. Bur. Min. Resour. Aust. 1:250,000 Geological Series Map and Explanatory Notes.

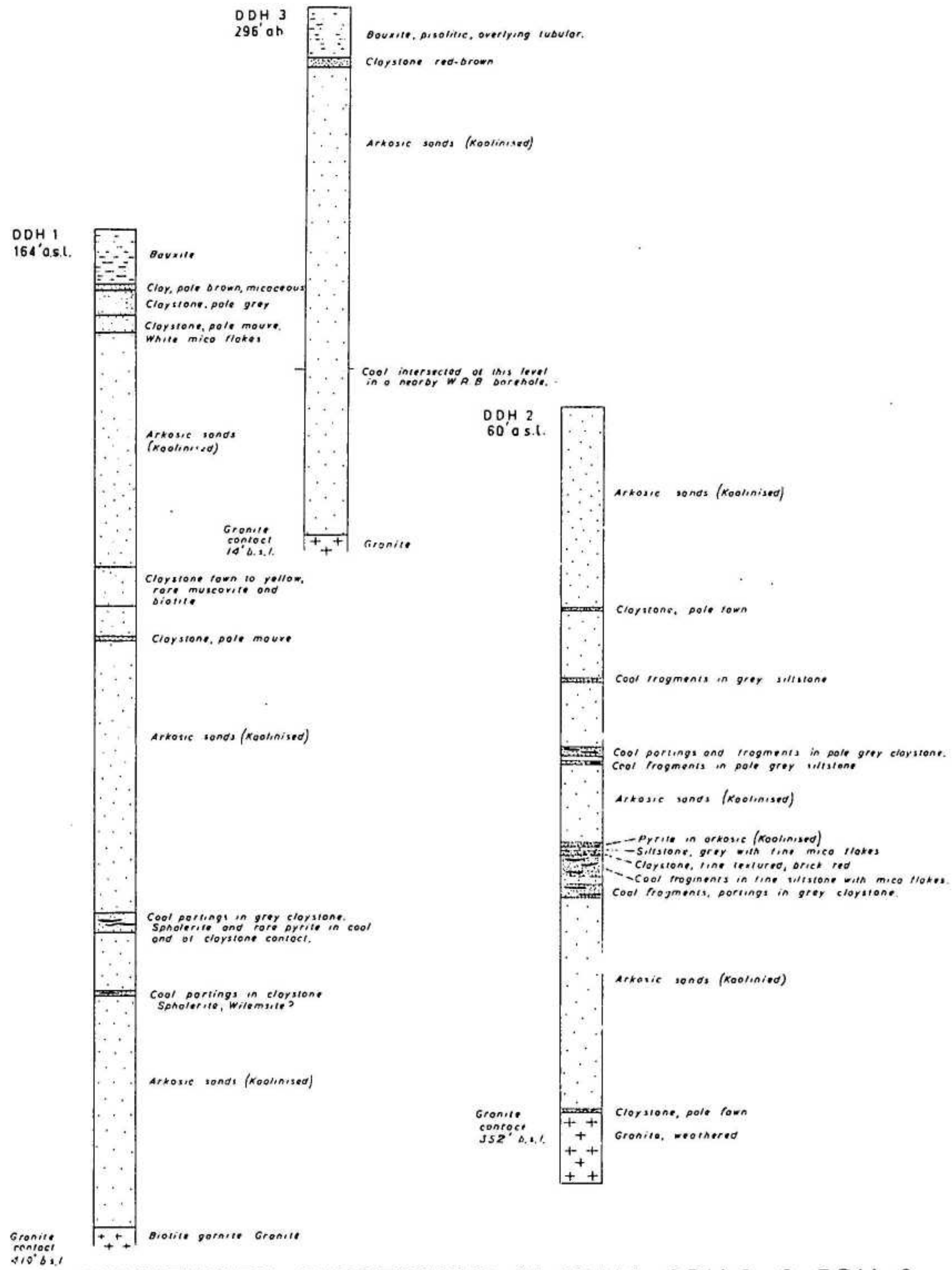
GARDNER, D.E., 1955 - Bauxite Survey, Gove Peninsula, Arnhem Land N.T. Progress Report on Geological Investigation. Bur. Min. Resour. Aust. Rec. 1955/64.

MORTON, W., 1966 - Groundwater Resources Gove Peninsula N.T. Water Resources Branch Report 1965/4 Unpublished.

OWEN, H.B., 1952 - Bauxite at Gove. Arnhem Land, Northern Territory. Bur. Min. Resour. Aust. Rec. 1952/70. Unpublished.

Appendix 1 - Logs of Drill Holes

PLATE 2



SEDIMENTARY SUCCESSIONS IN DDH 1, DDH 2 & DDH 3 GOVE AREA

To accompany Record 1967/87

COMPILED BY RESIDENT GEOLOGICAL SECTION: DRAWN BY MINES BRANCH DRAUGHTING OFFICE, DARWIN, N.T. MARCH, 1967.   D53/A4/10   G67/21 D

APPENDIX 2.

DIVISION OF MINERAL CHEMISTRY - COAL RESEARCH LABORATORY

BOREHOLE SAMPLES OF BROWN COAL FROM GOVE, N.T.

by

(C.S.I.R.O. INVESTIGATION 211R.)

D.J. Swaine and G.H.Taylor

INTRODUCTION

Three samples from boreholes put down at Gove, N.T. were submitted by Mr. R.G. Dodson, Northern Territory Administration, by arrangement with the Bureau of Mineral Resources, Canberra. They are part of two diamond drill cores (D.D.H.C. No.1 and D.D.H.C. No.2). Amongst the techniques used to examine the samples were microscopical examinations in transmitted and reflected light, X-ray Diffraction, X-ray emission spectroscopy, optical emission spectroscopy (including the use of the laser microprobe) and general chemical analysis.

This report incorporates data from our Miscellaneous Reports 283, 285 and 286.

Details of Samples.

Sample I: This was material from a narrow band from between 208'2" and 208'5" in drill core D.D.H.C No.2. Cracks in the surface of the specimen as received suggested that some loss of moisture had occurred, possibly due to exposure before insertion into the plastic containers.* As the amount of material was limited, only single determinations were carried out in some cases.

Sample II: About 5 g of granular material was supplied from between 404'9" and 405' of drill core D.D.H.C. No.1

Sample III: About 5 g of granular material was supplied from a depth of 447' in drill core D.D.H.C. No.1.

Microscopical Examination

Sample I: The sample is of brown coal and throughout contains well developed woody structure. Indeed the greater part of the sample represents a single former piece of wood, which, although contorted, exhibits essential continuity of structure. This botanical structure is not greatly compacted and contains angular cavities from a few to some tens of microns across.

In many of these cavities, there occur numerous nodular crystals of sphalerite (ZnS), mostly ranging from 2 to 12 microns, rarely up to 30 microns across. Most such grains are equidimensional with some well-developed crystal faces. The identity of the sphalerite was confirmed by X-ray as well as by microscopic techniques. It is noteworthy that the zinc represents 5% of the sample examined. Comparison of the ash yield of the coal with the proportion of sphalerite confirmed that this mineral comprises the majority of the inorganic matter in the sample. Small, comparatively rare grains of pyrite were also observed.

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* It is strongly recommended that all coal samples should be inserted into plastic sleeves and sealed immediately on being withdrawn from the core barrel.

TABLE 1 - Analyses of Sample from Gove Borehole.

(Results are given as percentages unless otherwise stated.)

Moisture as received		17.8	
Basis	a.d.	dry	d.a.f.
Moisture	15.4	-	-
Ash	7.5	8.8	-
Volatile matter	34.0	40.1	44.0
Fixed carbon	43.1	51.1	56.0
Calorific value (Btu/lb)	8,960	10,590	11,620
Sulphur - Total	2.6	3.1	-
Sphaleritic	2.1	2.5	-
Pyritic	0.1	0.1	-
Sulphate	0.0	0.0	-
Organic (difference)	0.4	0.5	-
Carbon (uncorr. for CO_2)	53.2	62.9	69.0
Hydrogen	3.4	4.0	4.4
Nitrogen	0.2	0.3	0.3
Sulphur (organic)	0.4	0.5	0.5
Oxygen (difference)	19.9	23.5	25.8

Sample II: Part of the "coaly" material in this sample has relatively uncompacted cellular woody structure, but the majority appears to have been an organic mud. It comprises structured and structureless fragments, mostly of rounded or sub-rounded outline from 50 microns across down to the finest sizes visible. This granular texture could have resulted from the initial degradation of the plant material, but may well be due to redeposition of the plant material.

Fine (less than 10 microns) isolated crystals of pyrite occur in both the botanically structured and the granular textured materials. Grains of quartz up to 1.0 mm across and containing oriented rutile needles occur in the sample both free and as inclusions in the coal. Feldspar grains up to 100 microns across occur less commonly in a similar manner. Occasional platy masses of limonite up to 0.5 mm across were observed and also rare grains of (possibly) sphalerite.

Sample III: This coal differs appreciably from that described above in being well compacted with very little open cellular structure. The coal is derived from woody material but this botanical structure is much less readily apparent than in the uncollapsed structures of the coal at 405'. It is nevertheless a brown coal as is indicated by a reflectance of 0.35% - a value comparable to that of Morwell and Leigh Creek coals.

The mineral content of the coal is limited to rare, fine (less than 5 microns) crystals of pyrite. A few clay-rich rock fragments are included with the sample - these contain quartz and pyrite grains up to 50 microns across.

Chemical and other Analyses

The results of chemical analyses on Sample I are given in Table 1 and of semi-quantitative optical emission spectrographic analyses of Samples I -III in Tables 2 and 3. In view of the exceptionally high zinc content of the ash from Sample I, the accuracy may not be high for some elements; the preparation of special standards was not undertaken. On the basis of the spectrographic analyses, approximate ash analyses, showing the major constituents, are given in Table 3.

Discussion

Sample I

The chemical analyses (for example, moisture, carbon) are in keeping with the microscopical observation that the sample is of brown coal. The low silicon and aluminium, together with the higher iron, calcium and sodium, would suggest that the coal is of low rank.

The unusually high zinc content was confirmed by direct determinations using X-ray emission spectroscopy, which showed 5.07% and 5.19% Zn in dry coal. While small amounts of sphalerite ($<<1\%$) occur fairly commonly in bituminous coals, no single coal sample having such a high concentration of any sulphide other than pyrite or marcasite has previously been examined in these laboratories. The mode of occurrence precludes the possibility of the sphalerite being detrital.

The concentrations of vanadium, germanium, and probably cadmium, are high. However, the association of germanium and cadmium with zinc in sphalerite is not unexpected, whereas the high level of vanadium is unusual.

Samples II and III

As noted in the results of the microscopical examination, Sample III differs from Sample II. However, Sample III is a brown coal, the reflectance value being similar to that of Morwell and Leigh Creek coals.

There are several differences in the contents of inorganic constituents in these two samples, namely:-

(i) Sample III is unusually high in chromium for a coal sample, although Sample II has a similar content to Sample I. The explanation of this high chromium content is not evident, and contamination is unlikely.

(ii) Sample III is much higher in germanium than Sample II, but not as high as Sample I.

(iii) The high level of vanadium in Sample III is similar to that found in Sample I; Sample II has a much lower content, which is, however, more than usually found in Australian coals.

(iv) Sample III is unusually high in zirconium for an Australian coal.

(v) Sample III gave an ash much lower in zinc and sodium than Sample I, but correspondingly higher in silicon and aluminium. Sample II gave an ash slightly higher in silicon and aluminium, but lower in other inorganic constituents than Sample III.

(vi) The most noteworthy difference between these two samples and Sample I is the markedly lower zinc content. Indeed Samples II and III have zinc contents which are within the range found for most Australian coals. The high vanadium and germanium contents in Sample III are similar to those found in Sample I, but cadmium was not detected in Samples II and III. These observations would seem to indicate that the vanadium and germanium are organically bound.

September, 1967

TABLE 2. TRACE-ELEMENT ANALYSES

(Results are in parts per million)

Element	Sample I		Sample II		Sample III	
	In Ash	Calc. to Air-dried Coal	In Ash	Calc. to Air-dried Coal	In Ash	Calc. to Air-dried Coal
B	~30	~2	40	15	40	4
Ba	~1000	~70	<800	<300	<800	<70
Be	40	3	15	5	20	2
Cd	(Note 1)	-	<300	<100	<300	<30
Co	~100	7	30	10	40	4
Cr	~1000	~70	300	100	~4000	~400
Cu	150	10	100	30	150	15
Ga	~1000	~70	100	30	600	50
Ge	~10000	~700	25	9	~3000	~300
La	<100	<7	100	30	<100	<10
Mn	800	60	60	20	400	40
Mo	~300	~20	<3	<1	15	1.5
Ni	200	15	100	30	200	20
Pb	200	15	100	30	150	15
Sc	200	15	30	10	400	40
Sn	~40	3	<20	<7	150	15
Sr	~1000	~70	1000	300	1500	150
Ti	~3000	200	~6000	~2000	10000	900
V	~25000 (Note 2)	~2000	400	150	~30000	~2500
Y	200	15	300	100	400	40
Zn	(Note 3)	-	~200	~70	600	50
Zr	~1000	~70	400	150	~30000	~2500
Ash Yield (air-dried coal):	7.5%		34.1%		8.9%	

The following elements were not detected:- Ag, As, Au, Bi, Hf, In, Ir, Li, Nb, P, Pd, Pt, Os, Re, Rh, Ru, Sb, Ta, Th, Tl, W, Yb.

Note 1. In the presence of such a high concentration of vanadium, interference with cadmium made the detection and determination almost impossible. Cadmium is present, probably at not more than 0.1% Cd.

Note 2. At this level, most unusual for a coal ash, the vanadium spectrum is line-rich, and gives interference on several of our usual lines; hence, other lines had to be sought.

Note 3. In this ash, the zinc content was estimated as approximately 60% Zn; this is equivalent to 5% Zn in air-dried coal. The presence of such a high concentration of zinc means that the normal coal ash standards are of limited application, even after buffering.

TABLE 3. COMPOSITION OF ASH - MAJOR ELEMENTS

Constituent	expressed as	Sample I %	Sample II %	Sample III %
Silica	SiO_2	~2	65	60
Alumina	Al_2O_3	~3	20	10
Iron oxide	Fe_2O_3	8	1	5
Titanium oxide	TiO_2	0.5	1	1.5
Manganese oxide	Mn_3O_4	0.1	0.1	0.5
Calcium oxide	CaO	4	0.6	3
Magnesium oxide	MgO	1.5	0.5	1
Sodium oxide	Na_2O	5	0.05	0.3
Potassium oxide	K_2O	not determined		
Sulphate	SO_3	not determined		
Germanium dioxide	GeO_2	1.5	0.003	0.4
Vanadium pentoxide	V_2O_5	4	0.07	5
Chromium trioxide	Cr_2O_3	~ 0.1	0.04	0.6
Zirconium dioxide	ZrO_2	~ 0.1	0.05	4
Zinc oxide	ZnO	75	0.02	0.07

NOTE: These are approximate results based on spectrographic determinations (same plate as trace-element analyses).

APPENDIX 3

PALYNOLOGICAL EXAMINATION OF A LOWER CRETACEOUS (ALBIAN) SILTSTONE FROM GOVE PENINSULA, NORTHERN TERRITORY

- by -

P.R. EVANS

An horizon of grey siltstone between arkosic sandstones from D.D.H. 2, 210', below the bauxite deposits on Gove Peninsula, Arnhem Land, Northern Territory, has yielded a late Albian microflora. The siltstone is probably of lacustrine origin, deposited in a temperate, pluvial climate. The age and freshwater origin distinguish it from marine Neocomian strata occurring to the southwest of the peninsula. Marine equivalents occur at Mornington Island to the southeast and on Groote Island. The microflora includes indeterminate fungal? conidiophores, Leiotriletes sp. 599, Cyclosporites sp. 600, Cicatricosisporites hughesi Dett. (sp. 490), (sp. 490), Gleicheniidites cf. G. circinidites (Cookson) (sp. 602) Cingutriletes sp. 601, Kraeuselisporites sp. 607, Contignisporites cf. C. multistriatus Dett. (sp. 419), Sculptatomonoleti sp. 604, Polypodiisporites sp. 608, Vitreisporties pallidus (Reiss) (sp. 344), Microcachyridites antarcticus Cookson (sp. 404). Cycadopites nitidus (Balme) (sp. 402), Schizosporis (?) sp. 605.

EXPLANATION OF PLATE

Figure 1 - Leiotriletes sp. 599
MFP 3990. 1.015.076

2 - Cingutriletes sp. 601
MFP 3990. 2.173.192

3 - Leiotriletes sp. 599
MFP 3990 1.266.175

4 - Cyclosporites sp. 600
MFP 3990. 2.171.131

5 - Gleicheniidites cf. G. circinidites (Cookson) (sp. 602)
MFP 3990. 2.077.193

6, 7 - Kraeuselisporites sp. 607
MFP 3990. 1.058. 052

8 - Contignisporites cf. c.multistriatus Dettmann (sp. 419)
MFP 3990. 1.005.146

9 - Microcachyridites antarcticus Cookson (sp. 404)
MFP 3990. 2.082.193

10 - Cicatricosisporites hughesi Dettmann (sp. 490)

Figure 11 - Disaccites sp. 603
MFP 3990. 2.124.169

12 - Disaccites sp. 603
MFP 3990. 2.124.169

13 - Cycadopites nidadus (Balme) (sp. 402)
MFP 3990. 1.012,146

14 - Sculptatomonoleti sp. 604
MFP 3990. 2.152.171

15 - Polypodiisporites sp. 608
MFP 3990. 1.005.126

16 - Fungal ? conidiophore sp. 606
MFP 3990. 2.132.010

17 - Vitreisporites pallidus (Reissinger) (sp. 344)
MFP 3990. 2.132.012

18 - Schizosporis(?) sp. 605
MFP 3990. 1.099.190

19 - Schizosporis (?) sp. 605
MFP 3990. 2.057.137

20 - Schizosporis (?) sp. 605
MFP 3990. 1.082.207

Magnifications: figs. 1 - 17 - 600X
figs. 18 - 20 - 1125X

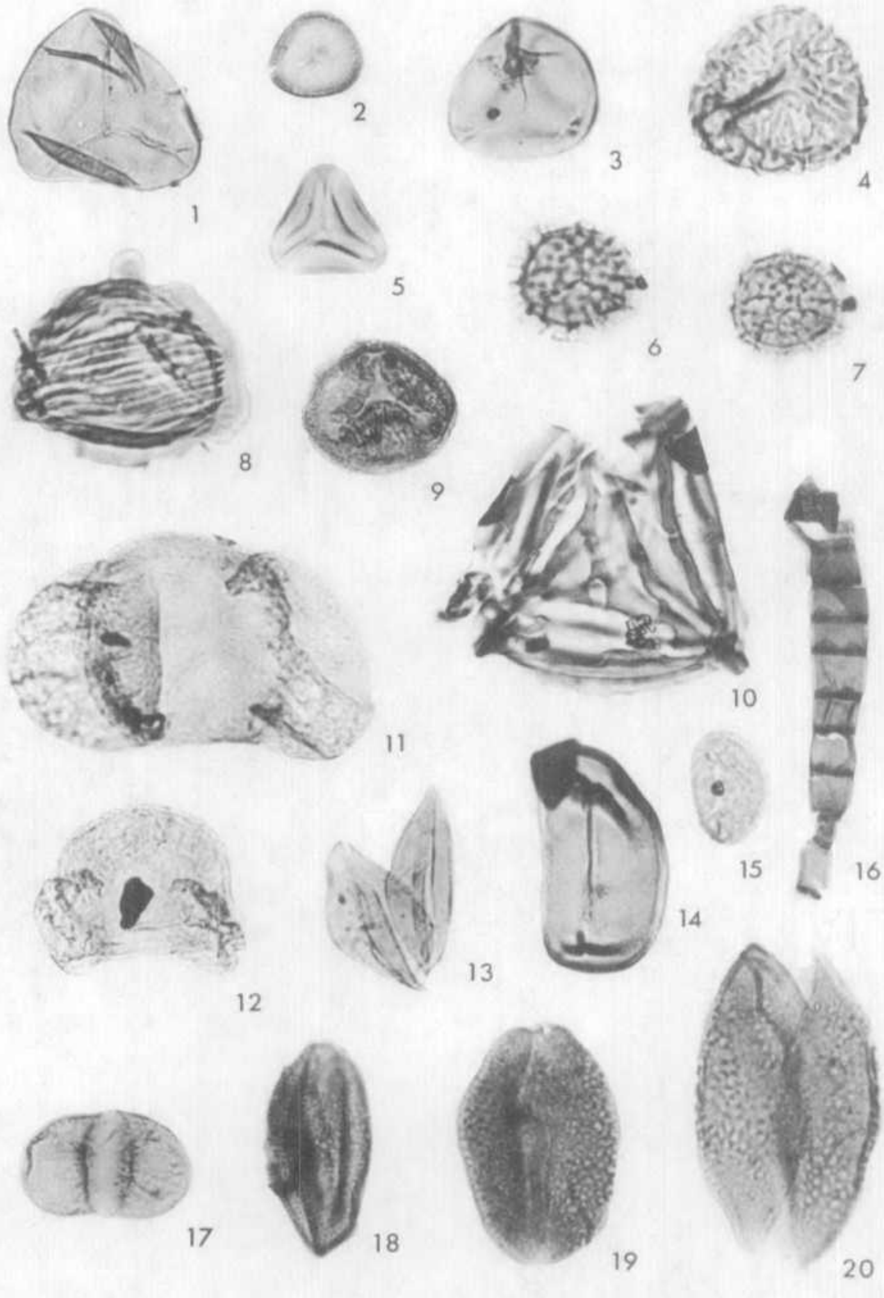

PLATE 1