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COALITION MINING LIMITED

SUKUNKA COAL PROJECT

GEOLOGY

VOLUME 1 SUPPLEMENT

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PREFACE

This geological report on the Sukunka Coal Project, British Columbia, Canada, has been prepared for Coalition Mining Limited by Clifford McElroy & Associates Pty. Limited.

The report, in 5 volumes, contains the results of the geological programme carried out during the 1972 field season.

The text, with supporting tables and figures, is included in Volume 1, together with Appendices A, B and C. Appendices D, E and F are in Volume 2 and Volume 3 contains Appendices G and H. The bore data for the holes drilled in 1972 is in Volume 4. Maps and geological cross-sections are in Volume 5.

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S U K U N K A   C O A L   P R O J E C T

GEOLOGICAL REPORT

1972 SUPPLEMENT

PREPARED FOR : COALITION MINING LIMITED

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SYDNEY

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SECTION 2

SUMMARY

As a result of additional drilling in 1972, the Measured Reserves of washed coal have been increased from 40.61 million long tons to 44.99 million long tons. Additional analyses have been carried out, both of coal from bore cores of Chamberlain and Skeeter Seams and of underground samples of the Chamberlain Seam. These have confirmed that the washed product of both seams will have an ash content of between 4.0% and 5.3%, a C.S. No. between 7 and 7½ and on a D.A.F. basis, volatile matter of between 20% and 26%.

Development underground mining, at Mine No. 1 in Plate 2a, of the Chamberlain Seam encountered one minor dislocation of the floor and six roof falls up until December 19, 1972. The fallen roof to that date represented 9.5% of the linear drivage. The falls were associated with structural deformation of the roof strata.

The external boundaries and the internal structural configuration of Plates 2c and 3 have been established more precisely and the distribution, thickness and quality of the Chamberlain and Skeeter Seams in Plate 3 are more accurately defined.

Significant additions have been made to detailed stratigraphic and structural concepts which have greatly facilitated the evaluation of the geological factors as they affect both the overall and detailed plan of mine development.

An appraisal of the coal seams in the Gates Member of the Commotion Formation has shown that these do not have sufficient economic potential in the Sukunka area to warrant further investigation.

Further geological investigations are recommended for 1973 to obtain additional structural data underground in Mine No. 1 and to more accurately define the structure and seam outcrop in Plates 1 and 2c to assist in detailed mine planning. Rock mechanics and gassiness studies by appropriate specialists should accompany the geological work.

It is also recommended that an appraisal be made of other areas of the Foothills Belt in the Peace River District, in which there may be economic coal deposits.

SECTION 3

INTRODUCTION

3.1 REVIEW

This report, the 1972 Supplement, presents the results of the geological field programme carried out on the Sukunka Coal Project between June and December 1972. The aim of the 1972 programme was to extend and refine the results of the very extensive geological investigations of 1971. The results of that earlier programme are incorporated in a 12 volume report prepared by Clifford McElroy & Associates Pty. Limited and submitted to Coalition Mining Limited on March 10, 1972.

This report therefore incorporates data and conclusions which supplements the data presented in the 1972 Report. Constant reference is made to the earlier report to avoid unnecessary repetition of data.

3.2 OBJECTIVES OF THE 1972 GEOLOGICAL PROGRAMME

Section 7 of the 1972 Report outlined the next phase of field investigations which were considered necessary to elucidate certain aspects of the geology or to refine information on coal quality and reserve categories. The objectives of the programme are summarized below -

(a) To more accurately delineate the boundaries, internal structure, resources of coal and location of the outcrop of the coal seams in Plate 2c.

(b) To obtain additional data on the Chamberlain and Skeeter Seams in Plate 3 to enable the resources of coal to be classified as Measured Resources and to further define the internal structure and boundary faults.

(c) To provide additional information on the structure at the level of the Chamberlain Seam in Plate 1, particularly with respect to the possible existence of east/west trending faults.

(d) To undertake a preliminary assessment of the potential of the coal seams in the Gates Member.

(e) To undertake detailed mapping of the underground workings as driving of the headings of No. 1 Mine proceeded in Plate 2a, and to carry out such investigations and sampling during the development mining as might be necessary to assist in a comprehensive assessment of the geological predictions in the 1972 Report.

(f) To carry out, in conjunction with the drilling programme, gas testing procedures and temperature measurements to assist in predictions of mining conditions.

3.3 THE GEOLOGICAL PROGRAMME

Over most of the period from July to December 1972, the planning and field supervision of the geological programme was undertaken by Mr. G.R. Wallis; Mr. J.H. Bryan was responsible for these activities in September and October. Mr. G.R. Jordan, one of the key personnel in the 1971 programme, was on site for the entire 1972 programme. Mr. F.H.S. Tebbutt participated in the field programme in September and October. Mr. C. Farrell was a field assistant in August and early September. Mr. N. Nanbu of Nissho-Iwai Co. Ltd., assisted the geological staff at the site for periods in September and December. Dr. C.T. McElroy provided continuing guidance and advice throughout the entire programme and visited the Sukunka site early in January 1973.

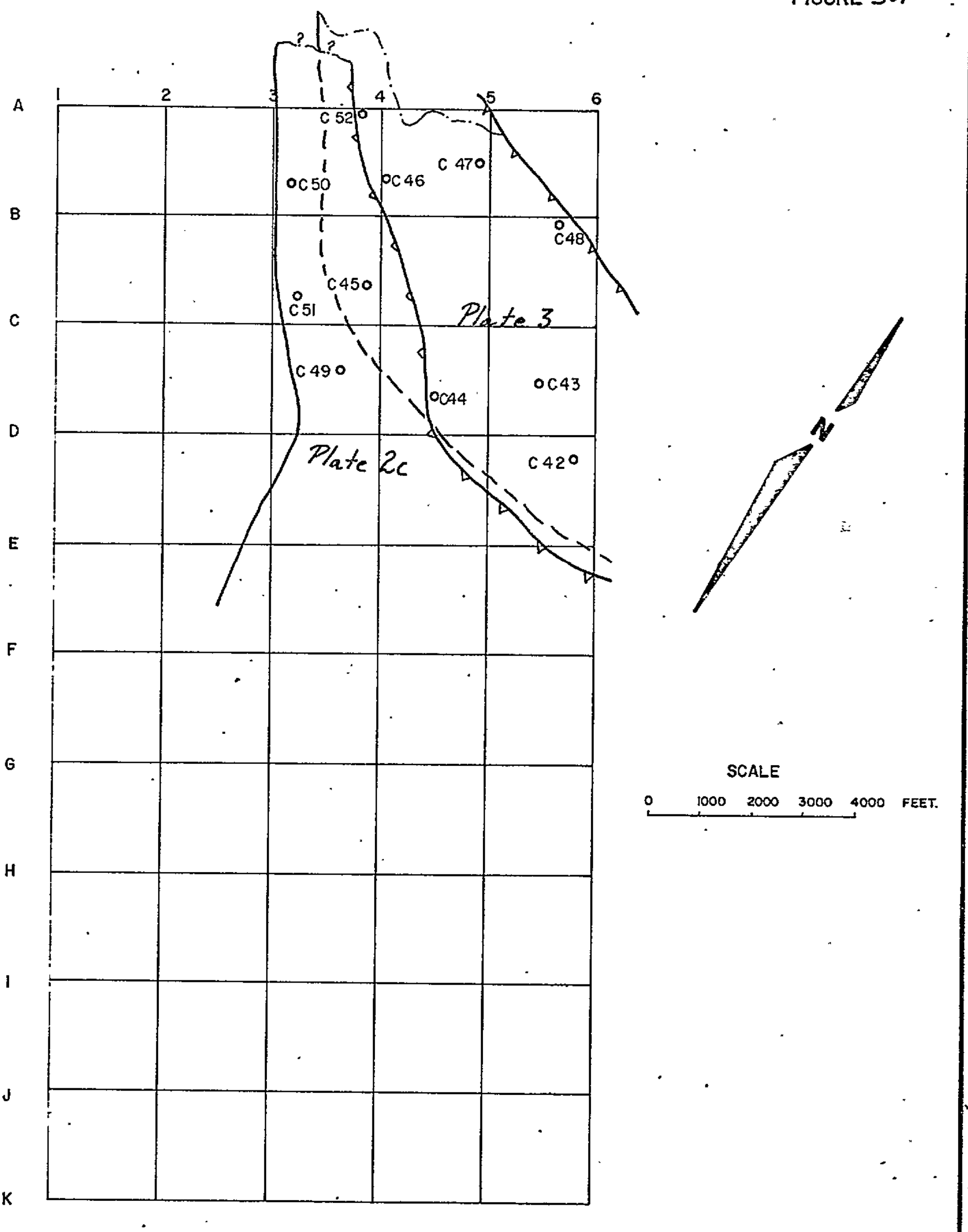
After initial on-site planning of the geological programme in July 1972, the drilling programme commenced in August and eleven diamond drill holes, totalling 9,029 feet, were completed in November by Canadian Longyear Drilling Limited. Radiation (gamma ray/neutron) logs were run on all drill holes and temperature logs were run on six of the eleven drill holes. Eight gas samples from the Chamberlain Seam and one from the Skeeter Seam were collected from fresh core samples. Pajari down-hole surveys were taken at the base of the three deeper drill holes, D.D.H.'s C-42, C-43 and C-44.

Five of the drill holes were located to intersect the Chamberlain Seam in Plate 2c and six were located in Plate 3. Table 3.1 and Figure 3.1 give the location of the holes drilled in the 1972 programme.

The coal core samples were shipped to Australia and analysed by Cargo Superintendents Co. (A/sia) Pty. Ltd., using the same laboratory techniques that were employed to analyse the coal cores from the 1971 programme. Two bulk samples were analysed in Vancouver by Commercial Testing and Engineering Co. Limited and a channel sample taken underground adjacent to the intersection of D.D.H. CM-1 was halved. The half-samples were then analysed by each laboratory to enable comparison of the results.

A trench was cut across the Chamberlain and Skeeter Seams above Skeeter Creek in the north, adjacent to the Skeeter Fault and in Plate 3. The thickness of overburden, up to 30 feet of glacial drift, prevented more extensive outcrop stripping in this area. No outcrop stripping of the coal seams was carried out in Plate 1.

FIGURE 3-1



DRILL HOLE LOCATIONS 1972
GEOLOGICAL PROGRAMME

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

January 1973.

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

TABLE 3.1

GRID REFERENCES TO SUKUNKA BORE HOLES

1971 PROGRAMME DRILL HOLES

S - Series				C - Series				CS & CM Series		R - Series	
Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.	Hole	Grid Ref.
S- 1	A1	S-28	G1	C- 1	H3	C-26	I5	CS- 1	A1	R- 1	H2
- 2	G0	-29	G5	- 2	C1	-27	K3	- 2	A1	- 2	H2
- 4	H2	-30	F5	- 3	F1	-28	J4	- 3	A2	- 3	I2
- 5	D3	-31	E4	- 4	B2	-29	K5	- 4	B2	- 4	H2
- 6	C5	-32	K6	- 4a	B2	-30	A1	- 5	B2	- 5	I2
- 7	D0	-34	E1	- 5	F2	-31	A0	- 6	B2	- 6	I2
- 8	A1	-35	F5	- 6	B2	-32	C2	- 7	B2	- 7	I2
- 9	A1	-36	H5	- 7	C1	-33	G1	CM- 1	A2	- 8	I2
-10	I1	-37	E2	- 8	D3	-34	C4	- 2	A2	- 9	I3
-11	I3	-38	F1	- 9	E1	-35	F1	- 3	A2	-10	I2
-12	J2	-39	J5	-10	C1	-36	E3	- 4	D1	-11	H1
-13	I2	-40	E4	-11	B1	-37	G2	- 5	E1	-12	I3
-14	B0	-41	D3	-12	F1	-38	C4	- 6	B3	-13	I4
-15	H1	-42	J3	-13	F4	-39	C4	- 7	B3	-14	I4
-16	K1	-43	D0	-14	H4	-40	J2	- 8	C2	-15	A1
-17	C1	-43a	D0	-15	G6	-41	H0	- 9	D2		
-18	D2	-43b	D0	-16	J1						
-19	C2	-44	H4	-17	E6	1972 PROGRAMME DRILL HOLES					
-20	E2	-45	D1	-18	K2						
-21	E3	-46	I1	-19	K6			C-Series			
-22	B2	-47	A2	-20	J6			C-45	C3	C-49	D3
-23	E2	-48	E0	-21	J4	C-42	E5	-46	B4	-50	B3
-24	C2	-49	A1	-22	I3	-43	D5	-47	B4	-51	C3
-25	F3	-50	B2	-23	K4	-44	D4	-48	C5	-52	B3
-26	F2			-24	K1						
-27	G3			-25	K2						

The reference point for each grid square is the south-eastern corner.

Geological mapping was undertaken in the vicinity of the trench in Plate 3 and this assisted in delineating the location of the Skeeter Fault and added to the knowledge of the structure in the north-western part of Plate 3.

An assessment of the potential of the coal seams in the Gates Member was accomplished by detailed logging of that part of the succession in selected drill holes, subsequent correlation of the sequence and the sampling of selected coal seams.

A detailed examination of the roof strata of the Chamberlain and Skeeter Seams in drill holes along the No. 1 Mine headings provided useful additional data for prediction of roof conditions.

The examination of the bench at the No. 1 Mine afforded an opportunity to study the small scale structural features in both the coal and the interseam sediments. Mapping of the underground workings into the Chamberlain Seam, at a scale of 1" = 10 feet, was carried out as driving proceeded. The sides of the headings were generally too wet to allow all minor joints in the coal to be measured, but detailed observations on the roof and floor and on the thickness of coal and the sheared zone above the coal was undertaken throughout the workings as at 19th December, 1972.

3.4 REPORT PREPARATION AND DATA PRESENTATION

For convenience and to enable ready cross reference, this Supplement retains the same section headings and format that were used in the 1972 Report, although, of necessity, some sections are excluded.

Each section of this report incorporates a brief summary or introduction in which reference is made to the 1972 Report.

This report presents and discusses any revised interpretations that arise from new data.

The maps which accompany this report include some which are modified from the previous report. These are denoted by the addition of "A" to the previous map number. Additional maps, Maps 26 to 36, incorporate new data or interpretations, or illustrate more clearly geological correlations outlined in the 1972 Report.

Seven geological cross sections A', A, B', B, C', C and D are included in this report with modifications that resulted from the data obtained in the 1972 programme. Section D', compiled from data obtained in the 1972 drilling programme, is a completely new cross section.

SECTION 4

GEOLOGY

This section of the report deals with the new facets of stratigraphic and structural geology arising from the 1972 field season. In the interests of conciseness, only new information is included in this report except where a framework is required for the discussion of a particular aspect.

Reference should be made to the corresponding section of the 1972 Report for the considerable amount of data relevant to the stratigraphy and structure of the property.

The principal contribution to stratigraphic knowledge has been the confirmation of the validity of the rock units as previously defined. The many new features of the structural geology have been brought together in considerable detail in the several sub-sections of Section 4.3.

4.1 STRATIGRAPHIC NOMENCLATURE

The stratigraphic nomenclature adopted in the 1972 Report had been established by Stott (1960, 1961, 1963 and 1968), Hughes (1964 and 1967) and others, though some informal nomenclature was introduced for practical stratigraphic purposes.

The terms 'Upper Gething sequence' and 'Lower Gething sequence' are retained in this report on the basis of their continued usefulness in stratigraphic studies in the Sukunka area. A more widespread recognition of distinct stratigraphic units in the Gething Formation would be necessary before setting up a formal sub-division into members.

The Moosebar Formation is a well established stratigraphic unit lying between the Gething Formation and the Gates Member of the Commotion Formation. The black mudstones of the Moosebar Formation are overlain in the Sukunka area by a sequence of interbedded fine-grained sandstones and siltstones which are some 400 feet thick.

The term 'Sukunka Member' was informally introduced by Hughes (unpub.) to apply to that sequence and the term has been used in the text, bore logs and maps both in this Supplementary Report and in the 1972 Report.

It has become apparent, however, that the name 'Sukunka Member' has been used differently at different times to describe various intervals of the Lower Cretaceous strata in the Foothills Belt. Although still used in the present report, it would seem best to delete the term 'Sukunka Member' from future reports on the Sukunka Coal Project.

The Sukunka Member represents a transitional phase of deposition between the marine mudstones of the Moosebar Formation and the conglomerate/sandstone/coal sequence of the Gates Member. If it could be shown that these transition sediments were widespread then it would be appropriate to assign to them formation status. An alternate solution that would rationalise the nomenclature would be to assign the interbedded sandstones and siltstones to the Moosebar Formation and to make use of the informal terms 'Upper Moosebar sequence' and 'Lower Moosebar sequence'. These informal terms may be adopted in future reports on the Sukunka Coal Project. Further studies may provide evidence for assigning them "member" status within the Moosebar Formation.

The Gates Member is well established as the lower unit of the Commotion Formation. The importance of this unit as a coal bearing sequence in the vicinity of the Wolverine River and to the south has yielded more detailed information on the stratigraphy. In that area, but also in the Sukunka area, meaningful stratigraphic subdivision of the Gates Member has been possible. It is now considered that the lower unit of the Commotion Formation, formerly the Gates Member, can be assigned formational status and that the distinct rock units which together make up that sequence, be assigned member status.

Thus, the "Gates Formation" would overlie the Moosebar Formation and underlie the Commotion Formation, the latter being subdivided into the Hullcross Member and the Boulder Creek Member. The Gates Formation is already recognised as such by Stott (1968) in the Upper Peace River area.

4.2 STRATIGRAPHY

The programme of 11 diamond drill holes provided detailed information on the Chamberlain and Skeeter Seams and confirmed the overall stratigraphic succession that was detailed in the 1972 Report.

Additional information on the Gates Member obtained formed the basis for a study of the stratigraphy of that unit and enabled a preliminary assessment of the potential of the coal seams to be undertaken. The results of this work are included as Appendix F in this report, while a summary is included in Section 4.2.2.

4.2.1 GETHING FORMATION

The following summary of the stratigraphy of the Gething Formation will provide a useful background for the ensuing discussion of particular aspects of the stratigraphy that have arisen.

For convenience, that part of the Gething Formation above the base of the Chamberlain Seam has been informally referred to as the Upper Gething sequence. Twelve rock units are recognised within this interval of between 150 feet and 200 feet of strata. Three less well defined rock units are recognised within the 600 feet thick Lower Gething sequence.

The Chamberlain Seam, the basal unit (Unit 1) of the Upper Gething sequence, is continuous throughout the Sukunka area and is generally in excess of 8 feet thick. This seam of medium volatile hard coking coal is remarkably free of stone bands, though an upper split separated by a sandstone band is present in the southern part of the area. Between 15 feet and 40 feet of argillaceous sediments (Units 2; 3 and 4) lie between the Chamberlain Seam and the Skeeter Seam (Unit 5). While the latter seam is up to 8 feet thick, it includes at least one and usually two rock bands and thins to the south.

Quartz-lithic sandstones separated by siltstone/claystone interbeds or laminites (Units 6 to 10) occupy an interval of about 120 feet between the Skeeter Seam and the Bird Seam. The Bird Seam (Unit 11) is between 2 feet and 5 feet thick in the Sukunka area and thickens to the south where thicknesses of between 5 feet and 7 feet have been recorded. This seam is a useful marker horizon near the top of the Gething Formation; it has a high sulphur content due mainly to the presence of pyrite. A greenish-grey glauconitic sandstone (Unit 12) overlies the Bird Seam and is the uppermost unit of the Upper Gething sequence.

(i) CORRELATION OF UNITS IN THE UPPER GETHING SEQUENCE

For the greater part of the exploration grid, each stratigraphic unit in the Upper Gething sequence can be readily correlated from drill hole to drill hole. There are, however, significant facies changes within the 50 feet or so of strata that immediately overlie the Chamberlain Seam. Because of the facies changes, it is possible to deduce several alternate correlations for that interval of strata. For the area where the Skeeter Seam constitutes a working section of coal, there are no alternate correlations; the Chamberlain Seam is also a continuous unit throughout the project area.

This correlation problem is of academic stratigraphic importance only as neither the reserves nor the mining plan are in any way affected.

Maps 27, 28 and 29 are a series of correlation diagrams showing Upper Gething stratigraphy in drill holes from the 1971 and earlier exploration programmes. Each of these maps includes a sketch locality map showing the location of the drill holes included in the section. Map 27 shows the correlation of units between the Bird and Chamberlain Seams in an east/west section across the exploration grid. Correlation of the Skeeter Seam across the area is substantiated by the Chamberlain Seam roof sequence, coloured blue on the diagram and an interbedded laminite sequence, coloured green. An alternative interpretation has been suggested where the Skeeter Seam and the upper split of the Chamberlain Seam are correlated. From Map 27 it can be seen that it is difficult to correlate the Skeeter Seam with the Upper Split of the Chamberlain Seam without introducing significant facies changes of the interseam sediments between D.D.H. C-14 and D.D.H. S-36. The alternative interpretation also involves a questionable correlation of the argillaceous units above the Chamberlain Seam in D.D.H.'s C-1, C-14, S-36 and S-44.

Map 28 shows the extent of the facies changes from the northern part to the southern part of the exploration grid. Map 29 clearly shows the development of the Upper Split of the Chamberlain Seam and D.D.H. C-27 includes both the Upper and Lower Split of the Chamberlain Seam and the Skeeter Seam.

Drilling in the southern part of Plate 3 in 1972 revealed the presence of the Upper Split of the Chamberlain Seam in an area shown on Map 9A. The Skeeter Seam thins in this direction and only the Chamberlain Seam or the Lower Split of that seam constitutes a working section of coal. Drill hole to drill hole correlations in Plate 3 indicate that the Upper Split of the Chamberlain Seam could possibly be equivalent to the coal of the Lower Split of the Skeeter Seam.

4.2.2 MOOSEBAR FORMATION

There is no additional stratigraphic information on the Moosebar Formation as a result of the 1972 programme. Reference should be made to the 1972 Report for a summary of the stratigraphy of this rock unit.

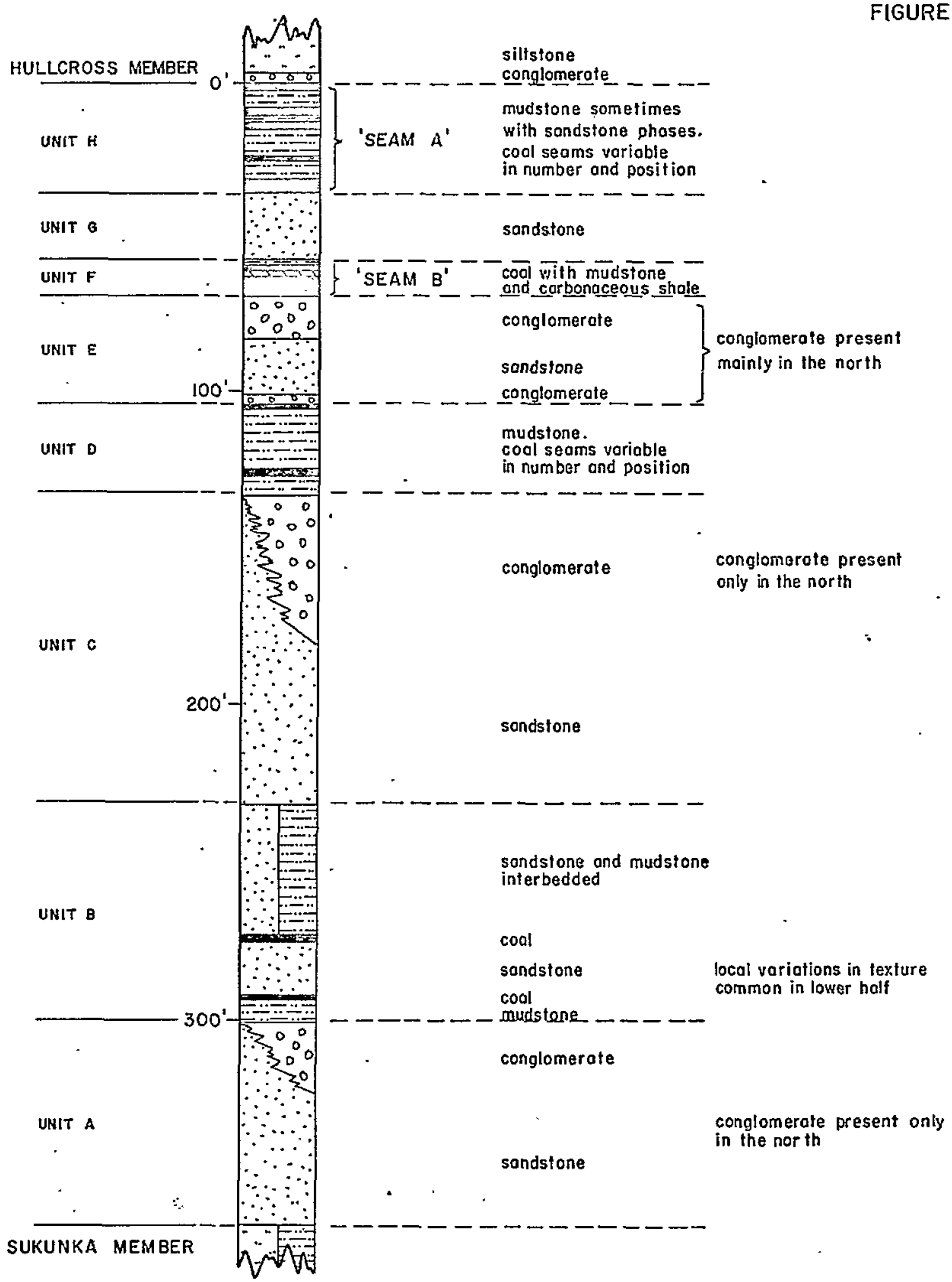
4.2.3 SUKUNKA MEMBER - COMMOTION FORMATION

Possible changes in stratigraphic nomenclature involving this unit are discussed in Section 4.1. The 1972 drilling programme confirmed the stratigraphic data on this unit that is included in the 1972 Report.

4.2.4 GATES MEMBER - COMMOTION FORMATION

A seam of good quality coal was encountered towards the top of the Gates Member in D.D.H. C-42. A brief study of the stratigraphy of the Gates Member was undertaken to enable correlation of this seam with other seams encountered in previous drill holes. The results of that study, together with an appraisal of the coal seams are included in Appendix F. The

FIGURE 4·1



SCALE
1" = 50 Feet

COMPOSITE GRAPHIC SECTION OF GATES MEMBER COMMOTION FORMATION

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February, 1973

Prepared by: CLIFFORD McELROY & ASSOCIATES Pty. Limited subdivision of the Gates Member into eight units, Units A to H, is shown on Figure 4.1. 'Seam B' may include a working section of coal in an area of about one square mile lying along and to the north-east of grid line 6 between grid lines D and H. Several shallow drill holes outside the exploration grid would be required to more fully test 'Seam B' in that area. The economic potential is considered to be too low, however, to warrant further expenditure on proving up this seam.

4.2.5 HULLCROSS MEMBER - COMMOTION FORMATION

No additional information on this unit was acquired.

4.2.6 BOULDER CREEK MEMBER

No additional information on this unit was acquired.

REFERENCES

HUGHES, J.E., 1964: Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills; B.C. Dept. of Mines and Petroleum Resources, Bulletin No. 51.

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STOTT, D.F., 1960: Cretaceous Rocks between Smoky and Pine Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can. (Dept. Min. and Tech.Surv.), Paper 60-16.

____, 1961: Type Sections of some Formations of the Lower Cretaceous Fort St. John Group near Pine River, British Columbia; Geol. Surv. of Can. (Dept. Min. and Tech. Surv.), Paper 61-11.

____, 1963: Stratigraphy of the Lower Cretaceous Fort St. John Group and Gething and Cadomin Formations, Foothills of Northern Alberta and British Columbia; Geol. Surv. Can. (Dept. Min. and Tech. Surv.), Paper 62-39.

____, 1968: Lower Cretaceous Bullhead and Fort St. John Groups, between Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can. (Dept. Ener., Min. & Res.), Bull. 152.

4.3 STRUCTURAL GEOLOGY

4.3.1 INTRODUCTION

The 1971 exploration programme enabled the definition of the structural elements of the deposit to be accurately defined, as was detailed in Section 4.3.7 of the 1972 Report.

In summary, the area was divided into 3 principal structural elements, Plates 1, 2 and 3, of gently dipping unmetamorphosed strata, which are separated and partly internally dislocated, by a series of low angle thrust faults. The faults are such as to act as discrete barriers to workable blocks of coal.

Approximately the northern half of Plate 2 is divided into 3 sub-plates, Plates 2a, 2b and 2c, by two intra-plate faults, the Rim and Pond Faults. Four other intra-plate faults exist to the south and east of this area.

The surface phase of the 1972 exploration programme was directed, in general terms, towards further refining the structural attitude of faults in Plate 2c and confirming the generally favourable structural configuration of Plate 3. The conclusions drawn are set out below in Sections 4.3.2 (Plate 2c) and 4.3.3 (Plate 3). No new information accrued from this phase in relation to Plates 1, 2a, 2b or that part of Plate 2 south of grid line F except for the mapping of the bench of Mine No. 1 (Section 4.3.4). For a discussion of the structure of these regions of the project area, reference should be made to the 1972 Report. The conclusion drawn and the mining conditions detailed in that report in respect of these regions have only slightly been modified by the recently completed programme.

In conjunction with the surface operations, an underground mapping programme was implemented to fully document the various structural features observed. This information is discussed and analysed in Sections 4.3.5 and 4.3.6 and summarised in Section 4.3.7.

Map 30 at a scale of 1 inch equals 400 feet, shows the surface geology of Plates 2a, 2b and 2c; Maps 6A and 7A illustrate the structural geology of Plates 1 and 3 and Plate 2, respectively.

4.3.2 PLATE 2c STRUCTURE

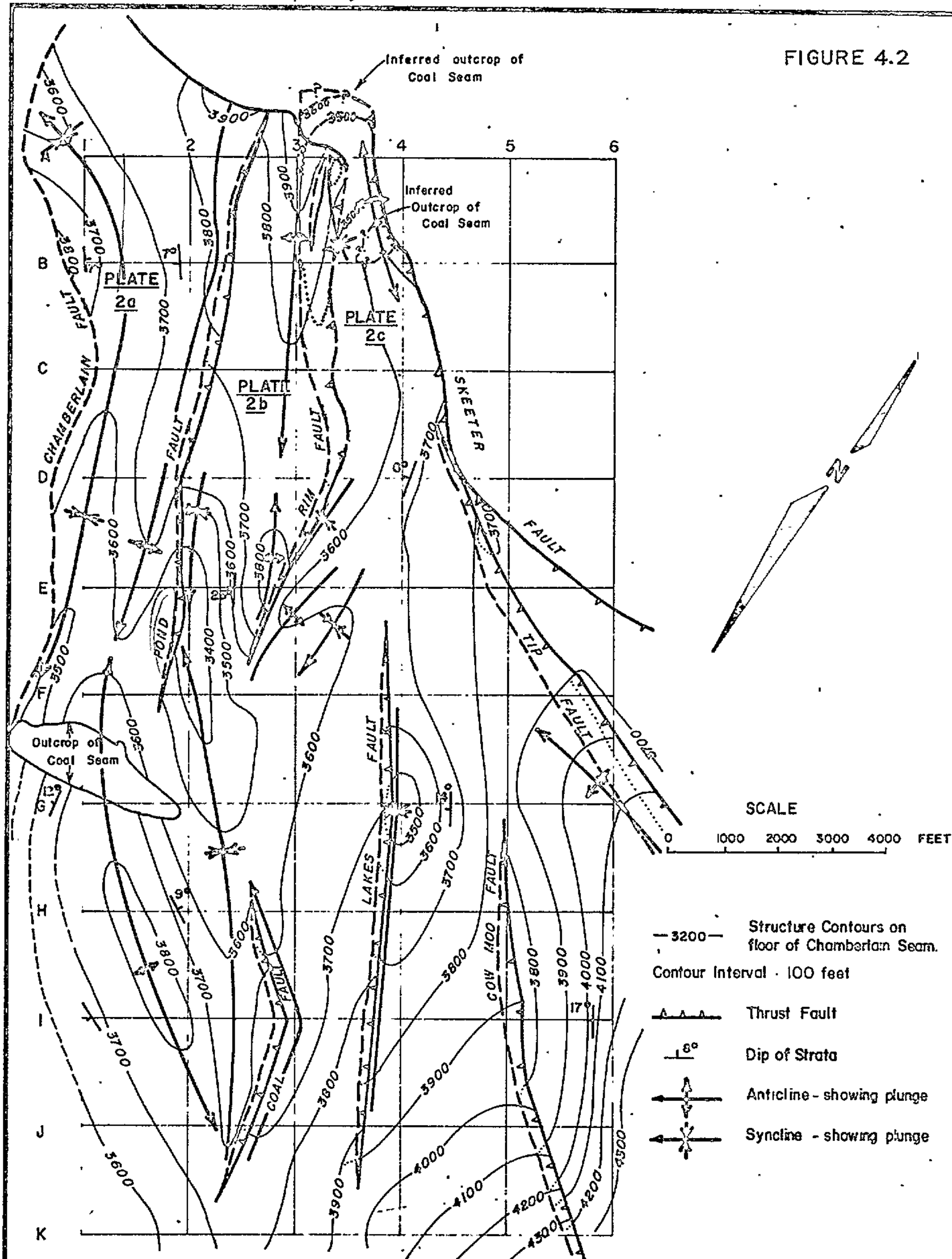
Plate 2c is bounded to the east by the Skeeter Fault and to the west by the Rim Fault. These features are shown on Map 7A and in Figure 4.2.

The geological programme conducted in respect of Plate 2c was aimed specifically at verifying the presence or absence of a 'splinter' fault to the Rim Fault and an extension of the Tip Fault, within Plate 2c, as was interpreted from the 1971 programme. Additionally, the programme was aimed at more accurately establishing the trend of the Rim Fault.

Six drill holes were used to achieve the objective of this phase of the programme, D.D.H.'s C-44, C-45, C-49, C-50, C-51 and C-52.

Two of these drill holes, D.D.H. C-50 and D.D.H. C-51 were designed to intersect the Rim Fault and to establish the trend of this fault more precisely. The drilling results re-inforced the previous interpretation with only minor adjustments being made to the structure contours of the Chamberlain Seam floor, see Map 7A. The location of the Rim Fault is now considered to be accurately located from the outcrop in the north to grid line C; previous work had fully confirmed the location of this fault south of grid line C.

FIGURE 4.2



SKETCH MAP

REGIONAL STRUCTURAL FEATURES PLATE 2

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 7A FOR DETAILED STRUCTURE CONTOURS

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January 1973

To further refine the structure of this narrow part of Plate 2c, D.D.H. C-49 was located between D.D.H. C-45 and D.D.H. S-41 to further determine the presence of the postulated splinter fault off the Rim Fault. The results of D.D.H. C-49 indicate that this small fault is not present at the level of the Chamberlain Seam. Modifications to the earlier structural interpretations can be seen on Cross Sections C', C, D' and D, and on Map 7A in this report.

Two drill holes were designed to test areas of possible structural disturbance within Plate 2c. D.D.H. C-45 was located to intersect the Chamberlain Seam at a point where extensions of either or both of the Tip Fault and the splinter fault of the Rim Fault might be encountered. The Chamberlain Seam was not affected by faulting in this drill hole and there is no evidence to suggest that either fault extends into this part of Plate 2c.

The location of the Skeeter Fault, in the north, between Plate 2c and Plate 3, was more precisely located by D.D.H. C-52. Map 7A shows the slightly modified location of the Skeeter Fault at the level of the Chamberlain Seam. Refer to Map 7, accompanying the 1972 Report for the previous interpretation. The drill hole throw on the Skeeter Fault in D.D.H. C-52 is 220 feet.

Additional information on the structure of Plate 2c was obtained in D.D.H. C-44, which was primarily designed to provide data on the Chamberlain Seam in Plate 3. Information from this drill hole resulted in a modification to the eastern boundary of Plate 2c between grid lines D and E and the extension of the Tip Fault, to the north about 900 feet, as shown on Map 7A.

A minor thrust fault within Plate 2c is considered to be present between grid lines A and B at the level of the Chamberlain Seam. The postulated location of this fault is shown on Map 7A.

A drill hole throw of 40 feet in D.D.H. C-50 and of 20 feet in D.D.H. C-6 is attributed to this minor north-west trending thrust fault. No evidence is available to suggest that this minor fault extends south of grid line B.

While the Chamberlain Seam has not yet been exposed along the northern outcrop, the 1972 drilling programme and the trenching in Plate 3 immediately to the east of the Skeeter Fault, has enabled the location of the outcrop of this seam to be inferred with a high degree of confidence. (See Map 30).

The gross configuration of the structure of the Chamberlain Seam is shown on Map 7A. The seam falls to a basin structure just south of grid line A at a grade of approximately 8^{o}. Grades to the south of this point are considerably flatter, less than 3^{o} on the regional scale, with a cross dip of 6^{o} to the west.

As a result of the 1972 drilling programme, the structure of the Chamberlain Seam in Plate 2c has been more precisely defined. From the geological information now available, this area of the Chamberlain Seam is considered to be suitable for mining.

However, due consideration must be given to the location of the inferred seam outcrop adjacent to the Skeeter Fault, in planning mine headings. The outcrop is classified as inferred and consequently requires definition by shallow drilling and trenching if entries are to be commenced in this area, as has been proposed.

The mining conditions of this plate are discussed in Section 6 of this report.

4.3.3 PLATE 3 STRUCTURE

Plate 3 is bounded by the Skeeter Fault to the south-west and the Bullmoose Fault Complex to the east. The 1971 drill hole data defined the boundaries of this plate, but provided limited data on the intra-plate structure.

Both diamond drilling and outcrop stripping techniques were used to provide the necessary geological data required to define, as far as practicable, the configuration of this plate.

The relevant drill holes are D.D.H.'s C-42, C-43, C-44, C-46, C-47, C-48 and C-52.

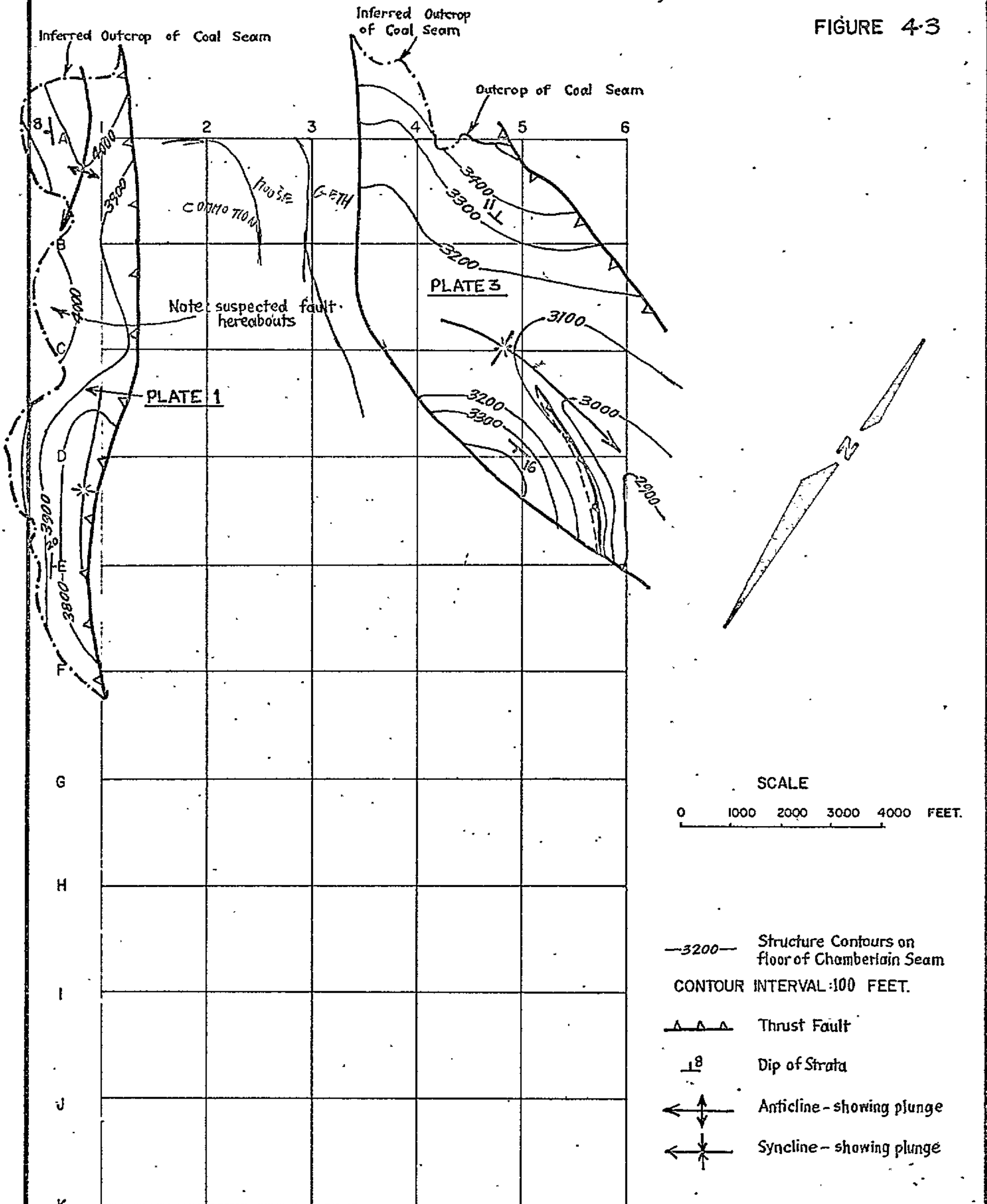
The results of these drill holes have substantiated the earlier predictions concerning the structure and only slight alterations have been made to the structural configuration of the Chamberlain Seam within Plate 3. Comparison of Map 6 (1972 Report) with Map 6A in this report illustrates the modifications that have been made as a result of the 1972 drilling programme. (Figure 4.3 refers)

The gross structure of this plate is an easterly plunging syncline with the axis approximately in the centre of the plate, with the majority of the plate having dips suitable for continuous miner operation.

The plunge of the syncline is essentially flat from the north of the plate to grid point C-5 after which it steepens to about 4^{o}. The northern limb has a maximum dip of $11\frac{1}{2}^{o}$. The southern limb which contains a fault trending parallel to the axis of the syncline, has a maximum dip of approximately 16^{o}. This area of steep dip is 1200 feet wide at its maximum and occurs at the southern extremity of the plate.

The location of the western margin of Plate 3, at the Chamberlain Seam level, has been more accurately defined by drilling, and geological mapping has enabled the attitude of the seam in the north-western part of Plate 3 to be more accurately determined.

FIGURE 4·3



SKETCH MAP

REGIONAL STRUCTURAL FEATURES
PLATES 1 and 3

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 6A FOR DETAILED STRUCTURE CONTOURS

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January 1973.

The western boundary of Plate 3 has been modified as follows. The northern half of the boundary has been relocated to the west and trends in a north-westerly direction. This has resulted from data obtained from the trenching carried out in 1972 and from the drilling of D.D.H. C-52. This drill hole showed that both the throw and heave of the Skeeter Fault is somewhat greater than was previously interpreted.

The 1972 drilling programme has indicated that a minor thrust fault occurs within Plate 3. This fault extends from 500 feet north of grid line D' trending in a southerly direction to meet the boundary of the plate near grid line E, as is shown on Map 6A.

This fault is recognized within the Upper Gething sequence in D.D.H.'s C-17, C-42 and C-43 where drill hole throws of 73', 65' and 78' respectively were recorded. The fault closely parallels the structural trend and is shown on Cross Sections D' and D.

In addition, D.D.H. C-46 shows considerable tectonic disturbance within the Upper Gething sequence. Several small faults and shear zones were encountered and at the level of the Skeeter Seam there is a vertical displacement of 22 feet on one of these minor faults. Dips of up to 46° were measured but at the level of the Chamberlain Seam, the dip is approximately 12°. The displacement of the Skeeter Seam may be caused by a splinter fault off the Skeeter Fault. However, no trend for this small fault can be established from the available data.

Considering the proximity of D.D.H. C-46 to the Skeeter Fault, the deformation of the core in this drill hole is interpreted to represent the outer part of the fault zone.

The outcrop stripping carried out in this plate was limited to a trench cutting across the coal seams, as the overburden is 29 feet thick at this locality. Continuous exposure of the seam for geological reasons alone was deemed economically impractical.

The exposure is at an elevation of 3,500' a.s.l. and located near the hinge of a broad anticline which plunges towards the south-east. At the exposure, the dip at the roof of the Skeeter Seam is 15° towards 188° and at the sandstone floor of the Chamberlain Seam is 15° towards 155°. The first attitude is probably more representative of the dip in the area since the Chamberlain Seam floor is usually irregular and reliable general dips are difficult to obtain.

A sandstone unit exposed below the Chamberlain Seam is regarded as a structural marker bed and the structural continuity of the coal seams may be reasonably inferred from the attitude of this unit.

4.3.4 NO. 1 MINE SURFACE EXPOSURE - PLATE 2a

The benching for No. 1 Mine and the consequent exposure of both the Skeeter and Chamberlain Seams afforded an opportunity to study some of the small scale structures which affect the coal seams and the interseam sediments. Figure 4.4 shows the outcrop of the two seams and the location of structures which are detailed in Figures 4.5 and 4.6.

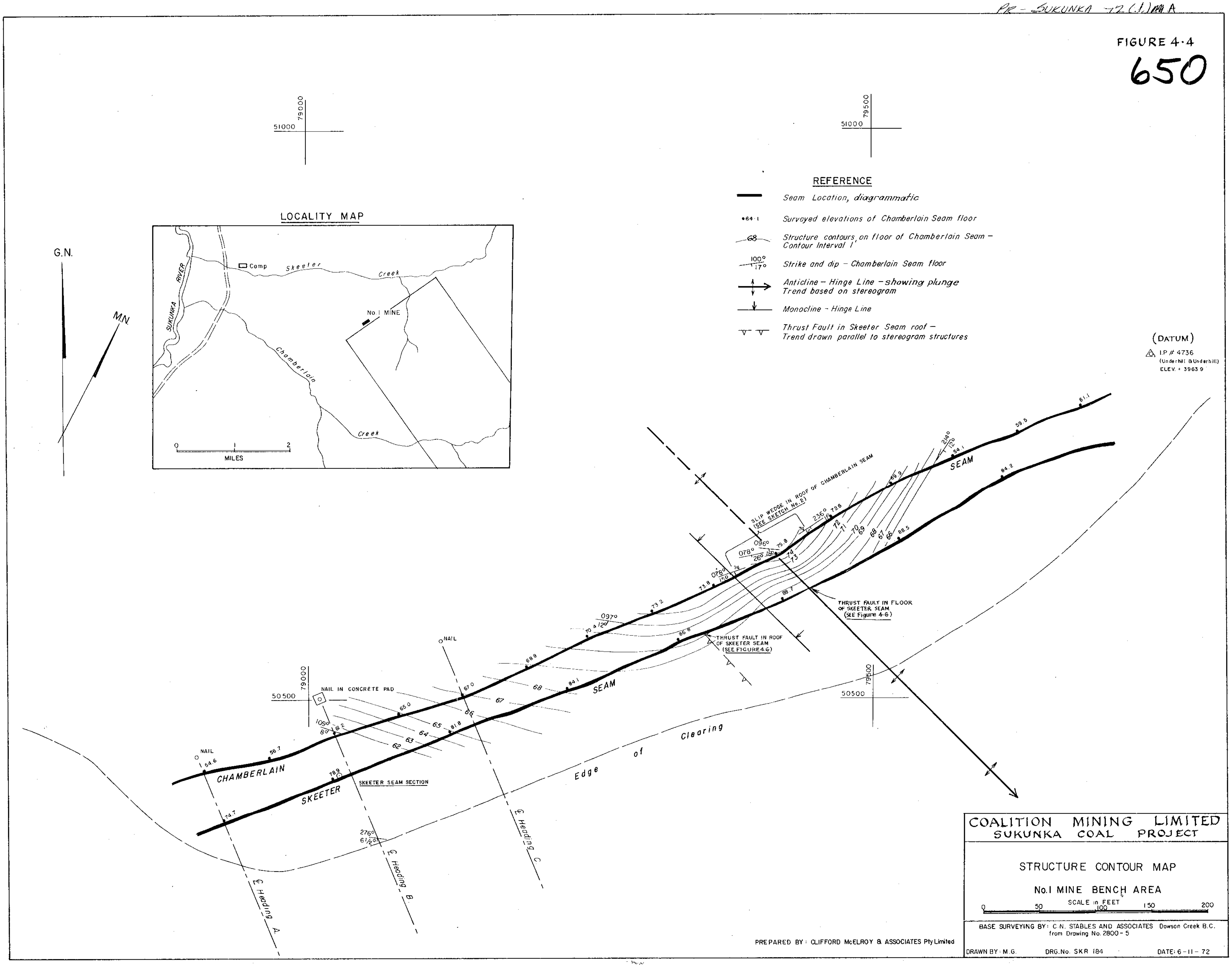
(i) STRUCTURAL SETTING

Sukunka No. 1 Mine is located at the outcrop of the Chamberlain Seam at the northern end of Plate 2a. The portals are located to the west of the crest of the southerly trending, south plunging anticline which lies immediately west of the Pond Fault. The anticline locally plunges at 11° on a bearing of 130° at the outcrop. The regional trend of the anticline is 147°. As the

PR - SUKUNKA 72 (1) A

FIGURE 4·4

650



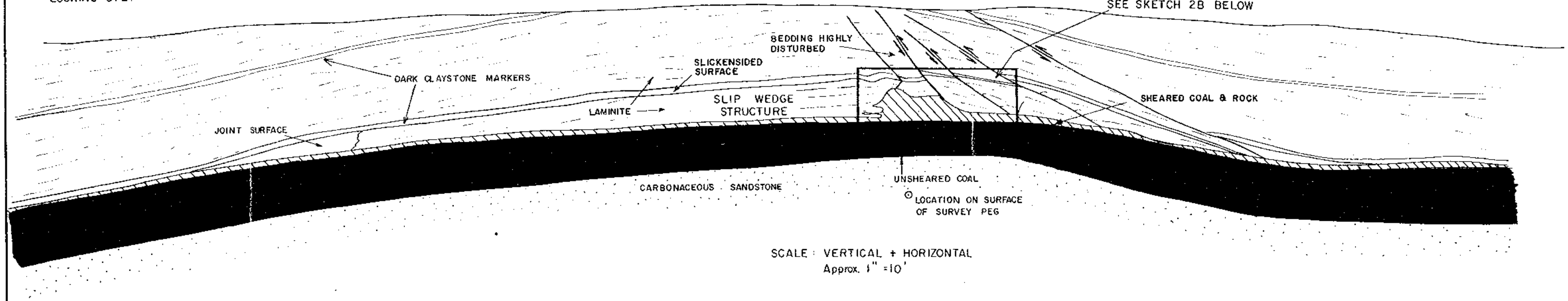
PR-SUKUNKA (1) A

SKETCH SECTION – CHAMBERLAIN SEAM EXPOSURE
MINE No. I
SHOWING 'SLIP WEDGE'

FIGURE 4·5

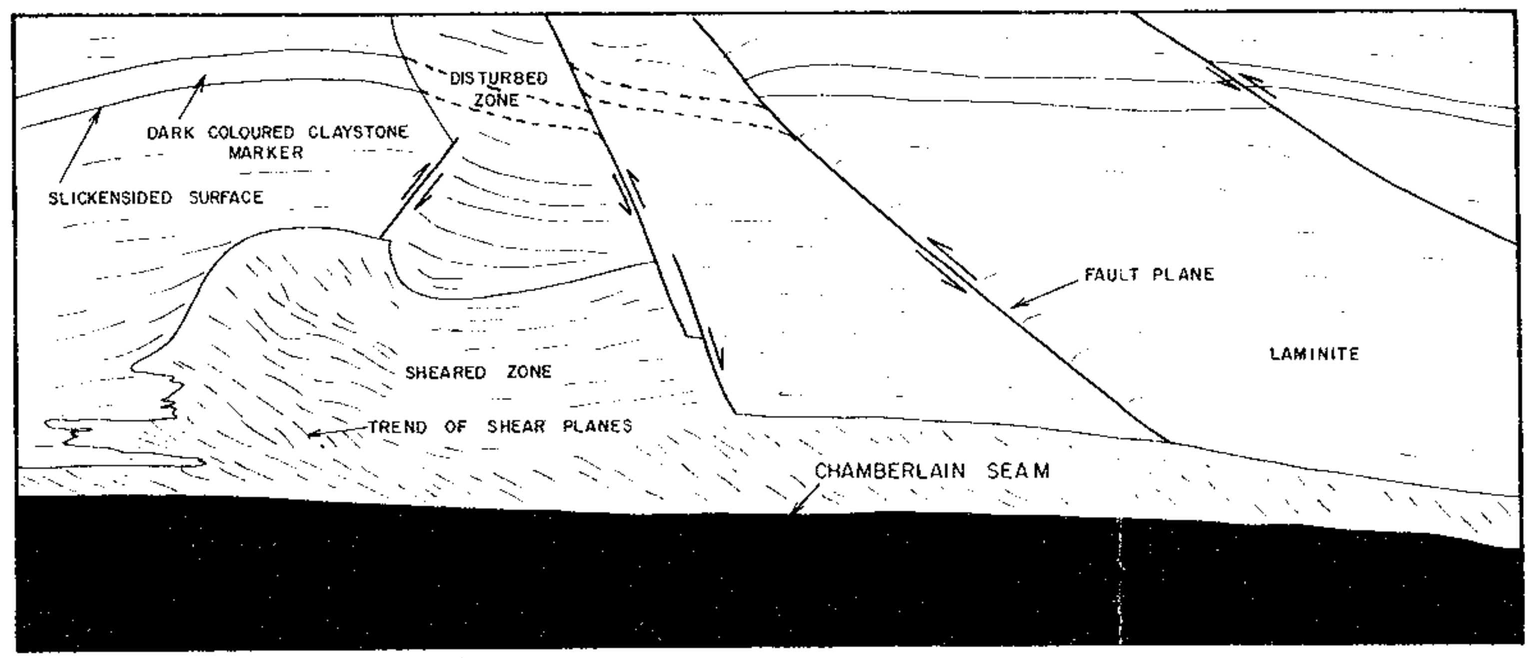
650

SKETCH No. 2A
LOOKING S.E.



SCALE: VERTICAL + HORIZONTAL
Approx. 1" = 10'

SKETCH No. 2B
SHOWING DETAIL OF SKETCH 2A
& TRENDS OF SHEAR PLANES IN SHEARED ZONE



SCALE: VERTICAL + HORIZONTAL
Approx. 1" = 2'

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FOR LOCATION: SEE PLAN 1

DRAWN BY: M.G. DATE: 6-11-72 REF No. SKR 175 axial plane of the fold dips almost vertically, the fold is essentially symmetrical; dips on either limb vary locally, but average 7° regionally.

In the immediate vicinity of the small monocline, shown on Figure 4.4, the Chamberlain Seam is significantly thinner (5.3 feet) than elsewhere along the exposure, where the thickness varies from between 5.5 feet and 6.6 feet.

A number of structures which affect the coal seams are described below, followed by a discussion on the generation of these structures.

(ii) DESCRIPTION OF STRUCTURES

(a) Shear Zone in Roof - Chamberlain Seam

The upper part of the Chamberlain Seam is sheared in this area, with up to 0.8 feet of sheared coal and laminite lying immediately below unsheared roof strata. The sheared and iron-stained laminite occurs as a distinct unit above the sheared coal. The thickness of sheared coal is usually greater than the thickness of sheared laminite, although minor amounts of sheared laminite or mudstone occur within the sheared coal.

The nature, thickness and extent of this sheared unit in A, B and C Headings of Mine No. 1 are included with the data collected during the underground mapping, Section 4.3.5 below.

The shearing in the coal at the top of the Chamberlain Seam was recorded previously and is attributed to movement along the bedding in the initial stages of deformation. The bedding planes in the laminite above the shear zone are extensively slickensided and highly polished, reflecting the relative movement of the roof strata over the coal seam.

A local thickening of the sheared coal near the hinge of the anticline is detailed in Sketches 2A and 2B, Figure 4.5.

(b) 'Slip Wedge' of Roof Strata - Chamberlain Seam

The term 'slip wedge' is introduced here to specifically apply to a wedge-shaped section of roof strata which has suffered lateral movement with respect to the underlying coal seam, and which has been over-ridden by stratigraphically equivalent roof strata along fault planes coincident with bedding.

A 'slip wedge' of this type exists above the Chamberlain Seam in the axial region of the anticline at No. 1 Mine Site. Sketch 2A, Figure 4.5, shows the extent of the slip wedge and the nature of the structures developed within it and in the overlying strata. A thickened section of sheared coal is developed in association with this structure. Sketch 2B, Figure 4.5, is a detailed sketch of this part of the structure.

These structures, together with those outlined in the 1972 Report, have been encountered in the underground workings and are further described in Section 4.3.5 and 4.3.6 below.

(c) Thrust Fault in Roof - Skeeter Seam

Figure 4.6 shows the location of a minor thrust fault which displaces the roof of the Skeeter Seam. Figure 4.6(i) shows that the fault has a throw of 2 feet and a heave of 5 feet. The fault extends from the roof strata into the seam, but does not affect the floor. A tectonic thickening of the Skeeter Seam has occurred on the upper plate of the fault.

(d) Thrust Fault in Floor - Skeeter Seam

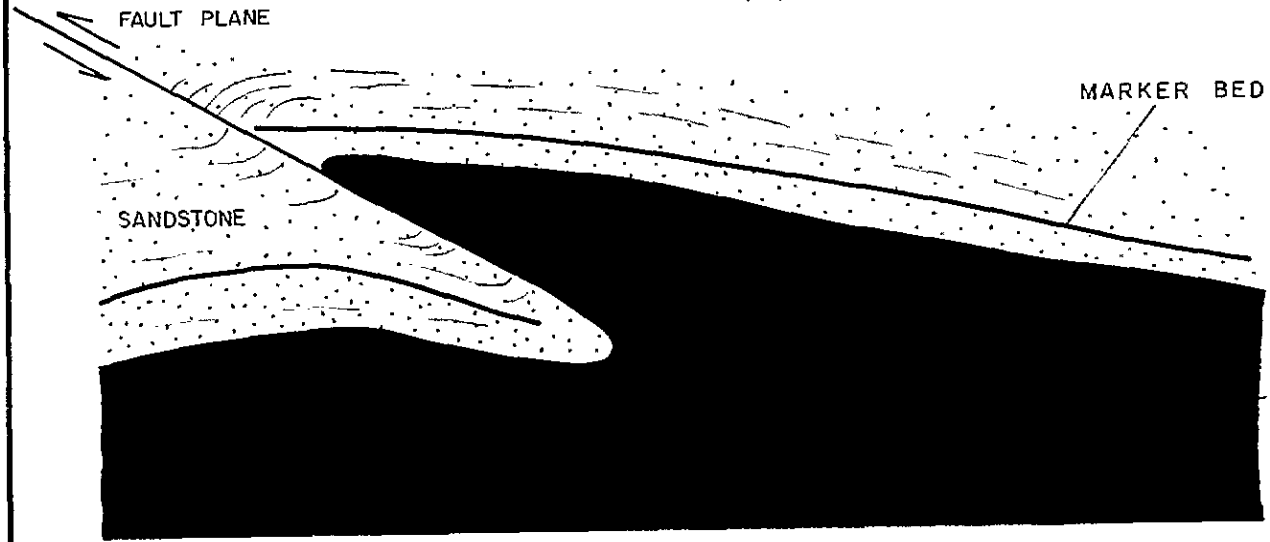
A minor thrust fault displaces the floor of the Skeeter Seam at the hinge of the anticline, above the 'slip wedge' structure in

FIGURE 4·6

SKETCH SECTION – SKEETER SEAM EXPOSURE
MINE No. 1

(i) SHOWING ROOF STRUCTURES – 'THRUST FAULTS'
ABOVE SKEETER SEAM

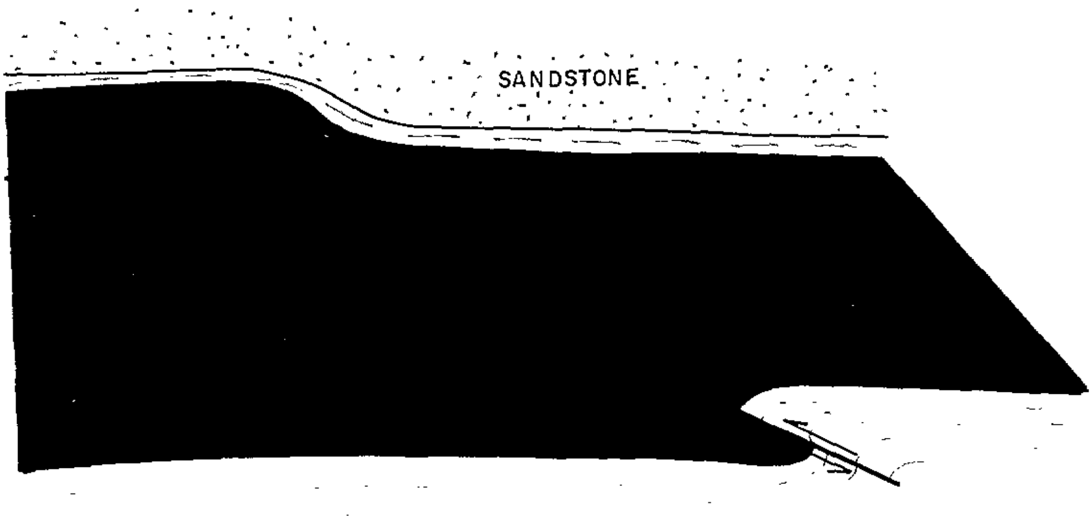
(FOR LOCATION – SEE PLAN 1.)



SEAM THICKNESS DIAGRAMATIC ONLY

SCALE 1" = 2'

(ii) THRUST FAULT – FLOOR OF SKEETER SEAM



SEAM THICKNESS DIAGRAMATIC

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for
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DRAWN BY M.G.

DATE: 6–11–72

PR – SUKUNKA 72 (1) B.

the Chamberlain Seam roof. The fault, which is considered to be related to similar faults within the 'slip wedge' is parallel to the fold axis and dips at 22^{o} to the south-west and displaces the floor of the Skeeter Seam 0.5 feet. (See Figure 4.6(ii)).

(iii) GENERATION OF STRUCTURES

The following sequence of events is considered to be responsible for the generation of the structures described in Section 4.3.4 (ii) above.

(a) A relative movement of roof strata immediately above the Chamberlain Seam, essentially along the bedding plane, resulted in the formation of sheared coal and roof strata in a zone between 0.5 feet and 1.0 feet thick, at the top of the seam.

(b) The development of the 'slip wedge' due to the lateral movement of a mass of roof strata over a wedge of equivalent roof strata.

(c) The initial stages of folding were accompanied by the development of small scale, low angle, south-west dipping thrust faults in the hinge area of the broad anticlinal structure. These faults have had a minor affect on the roof of both the Chamberlain and Skeeter Seams and on the floor of the Skeeter Seam.

The thick, competent sandstone unit which underlies the Chamberlain Seam is considered to have acted as a resistent buffer during the mild structural deformation of the overlying strata. It appears that the relative absence of structural deformation at the level of the Skeeter and Chamberlain Seams, both on a local and regional scale, can be attributed to the existence of this massive sandstone unit lying below the Chamberlain Seam.

4.3.5 SMALL SCALE TECTONIC STRUCTURES - UNDERGROUND

In this section the physical characteristics of several small scale tectonic structures are described. Discussion of such regularly occurring features as joints, cleats and slickensided surfaces underground are included in Section 4.3.6.

The structures described are -

(i) a zone of shearing at the top of the seam below the laminite roof;

(ii) roof structures which have been termed 'slip wedges' in Section 4.3.2 (ii)(b);

(iii) a small scale thrust fault located in the seam floor.

(i) ZONE OF SHEARING

The zone of shearing at the top of the seam occurs immediately below the laminite roof rock and varies in thickness between 0.22 and 0.67 feet. Figure 4.8, Diagram A shows the relationship of the sheared zone to the coal seam and roof rock. This sheared zone has been observed throughout the workings of the mine. It consists of sheared fragments of coal and rock. In much of this zone there are sheared fragments of the "bone" layer which is defined as "stone, coaly".

It is postulated that the sheared layer is the fault zone of a bedding plane fault between the Chamberlain Seam roof rocks and the underlying unsheared coal seam. The amount of displacement along this fault cannot be determined since there is no stratigraphic displacement. A direction of movement can be determined from the direction of a primary set of slickensides etched on the seam roof, the dominant bearing of which is 214°. The significance is discussed in the analysis of structure in Section 4.3.6.

(ii) ROOF STRUCTURES - 'SLIP WEDGE'

The feature considered in this section is observed within the Chamberlain Seam roof and is related to the slip wedge structure located on the surface near Mine Site No. 1. (See Section 4.3.4 above for definition).

The slip wedge structure results from the dislocation of a wedge of the Chamberlain Seam roof during the phase of bedding plane faulting. This faulting phase also produced the zone of shearing at the top of the seam, as discussed in (i) above.

The wedge of rock has been over-ridden by the bulk of the Chamberlain Seam roof strata along bedding planes and low angle thrust faults. At a surface exposure, the over-riding movement of the roof above the wedge has been observed to take place along a single polished and slickensided surface.

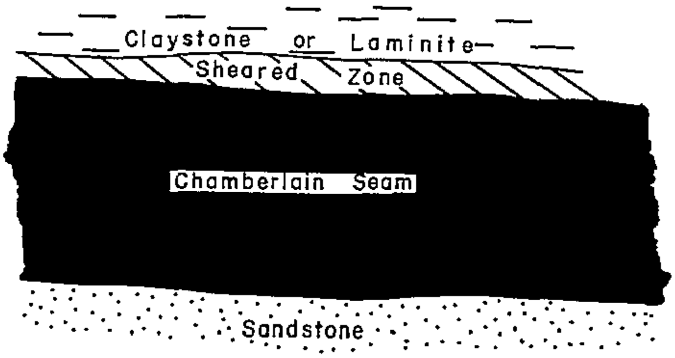
Related structures seen underground have a fault zone developed between the wedge and roof contact surfaces.

This zone varies in thickness up to 4 feet and consists of a series of slices of laminite dipping at approximately 40° to the bedding and striking perpendicular to the trend of the prominent slickenside direction etched in the roof. The term "sigmoidal laminite" has been adopted to define this feature.

Bending and attenuation of the ends of each slice tends to suggest the relative direction of movement of rocks on either side of this structure as is shown in Figure No. 4.7, Diagram B.

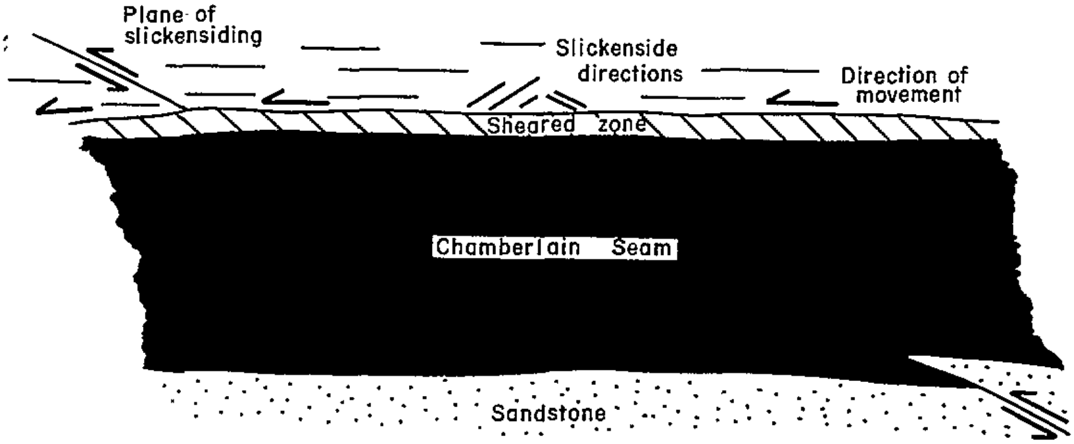
FIGURE 4-7

DIAGRAM A



Scale: 1" = 2'

DIAGRAM B



Sketch only

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DATE January ,1973

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Structures of this type are seen at the junction of B heading and No. 1 cut-through where part of the roof has fallen, exposing a section of roof strata.

Within an area of fallen roof between the portal and No. 1 cut-through along C heading this type of structure is also exposed.

From the exposures in the subsurface these structures appear to be generated at or near a point where the movement along the bedding within the roof changed direction and cut across some of the roof strata. At this point, material carried along the fault plane may be trapped. The slices of laminite are scraped off during faulting and stacked against this material. The size of each plate increases with distance from the initial point until a maximum is reached and the structure terminates against highly disturbed laminite. At this point, the structure in the roof joins the bedding plane fault at the top of the seam.

These structures produce an increase in the volume of material in the sediments between the Skeeter and Chamberlain Seams and a limit for this increase in volume appears to exist at a thickness of between 3 and 4 feet.

At the lateral extremities of this structure, the increase in volume is accommodated in one case by folding of the underlying material at the top of the seam. In this case, the fold axis trends 160°.

In the second case, the volume is accommodated by movement along closely spaced sub-vertical fractures as opposed to folding. These fractures trend 108°. These relationships are shown in text Figure No. 4.8, Diagrams A to E.

FIGURE 4·8

RELATIONSHIPS AT FRONT OF SLIP WEDGE

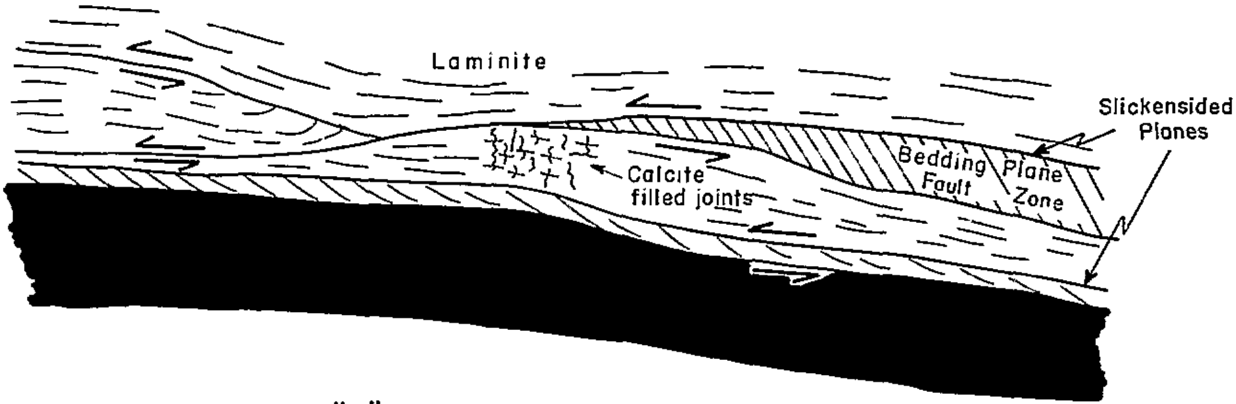

DIAGRAM "A" SCALE: 1" = 2'

DETAIL OF WEDGE ZONE

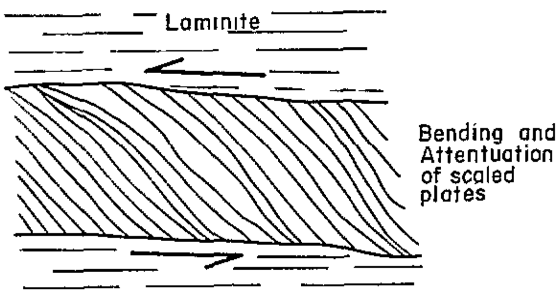

DIAGRAM "B" SCALE: 1" = 1'

TERMINATION OF SLIP WEDGE

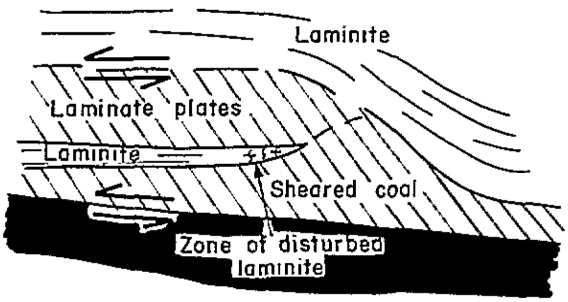

DIAGRAM "C" SCALE: 1" = 2'

MARGIN OF WEDGE

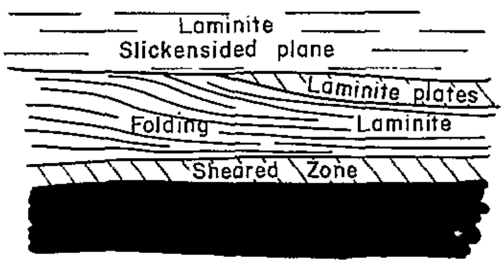

DIAGRAM "D" SCALE: 1" = 2'

MARGIN OF WEDGE

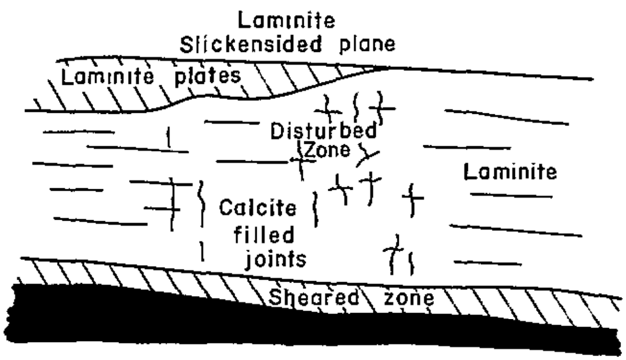

DIAGRAM "E" SCALE: 1" = 2'

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It is not possible at this stage to determine directions of elongation of these structures as would be seen in plan. However, the exposure in B heading shows that the margins can be irregular in shape.

(iii) THRUST FAULT IN SEAM FLOOR

At a point 18 feet outbye of No. 5 cut-through in B heading, a small scale thrust fault located in the floor of the Chamberlain Seam was intersected. The displacement along the fault has a throw of 0.8 feet but the heave could not be determined. The strike of this structure is 245°, which is significantly different from the regional structural trend of approximately 310°.

The location of the fault appears to be related to a change of dip of the seam. Also, the attitude of this fault does not appear related to the stress system which resulted in the primary slickensided surfaces etched along the seam roof.

At the Chamberlain Seam roof, neither is there displacement of the seam nor can the fault be traced for any significant distance into the seam.

However, within the roof, two zones of slickensided surfaces exist both of which trend into the roof, described as (a) and (b) below, which are considered to be related to the fault.

(a) The first of these, 15 feet outbye of the above thrust fault, has slickensided surfaces which are discontinuous and variable in their trend. This feature is considered to result from differential compaction and was originally formed directly above the thrust fault in the floor. This suggests that 15 feet of movement along the bedding plane fault took place after the generation of the thrust fault in the floor. This amount of displacement would appear to represent the final phase of movement and is very small by comparison with the total amount of displacement thought to have taken place at the top of the seam.

(b) The second slickensided surface is located 7.0 feet outbye of the first slickensided structure, i.e. (a) above. Reconstruction of the situation by sections, at the time of thrusting, suggests that this structure is the continuation to the seam roof of the thrust fault within the floor. However, while there is no displacement of the seam at this point, the slickensides indicate that there has been at least a small amount of movement within the roof. It is therefore suggested that the stress related to thrusting within the floor generated a plane of weakness within the roof along which some movement of the roof took place. The transport of material was initiated from the bedding plane fault still taking place at this time, at the top of the seam.

These relationships are illustrated in text Figure 4.7, Diagram B.

It is concluded that the development of this fault post-dates the generation of most of the bedding plane fault movement of the roof of this seam and, in fact, took place towards the close of the folding period, hence the relationship to the change of dip.

4.3.6 ANALYSIS OF SUBSURFACE STRUCTURES

The underground mapping programme, as described in this sub-section, documents the following structural parameters: joints, slickensides, bedding planes and small scale thrust faults. An analysis of these features is included.

Section 4.3.5, above, documents more specific aspects of some of these features.

The data was recorded on data sheets and plotted at a scale of 1 inch equals 10 feet. Map 31 reproduces this data at a reduced scale of 1 inch equals 20 feet. The data was analysed by use of a stereographic projection and is reproduced as Figure 4.10.

An independent opinion was sought from Dr. M.J. Rickard, a specialist in Structural Geology, of the Australian National University, Canberra, on the structural analysis of the data presented here. Detailed discussions extending over 2 days with geologists of this company ensued. Dr. Rickard's report is reproduced as Appendix B-1, and reference is made to particular aspects of that report in the text.

It must be stressed that the area of observation, i.e. Mine No. 1, is very limited in relation to even Plate 2a, hence any conclusions drawn must be qualified by this constraint.

Conclusions to this study are included in sub-section (iv).

(i) OBJECTIVES

The underground structural mapping programme was developed to investigate the following aspects -

(a) To show whether the orientation of the structures encountered underground tended to confirm the gross structural picture as shown in plan on the structure contour map as well as in the sections.

(b) To identify any indicators which would assist in predicting changes in geological conditions as mining was taking place, i.e. predicting changes in roof conditions within a very short distance of the continuous miner (say one or two miner lengths).

(c) To identify patterns that the mapped structure may show and to try to relate these patterns to a model showing the most probable simple stress system existing at the time of deformation.

(d) To determine statistically the areas and volumes of poor and fallen roof strata and thus allow predictions to be made of delays caused by these problems.

Additionally, two other points have been kept in mind for future consideration -

(e) The structures mapped at present may show spatially varying trends in adjacent areas. Therefore, predictions of changes, if any, may be possible when other areas are mapped.

(f) If it can be established that the orientation of stresses changed during the period of deformation, it should be possible to show the probable style of the structures formed during each of these phases.

(ii) DISCUSSION OF ASSUMPTIONS

In this interpretation the conclusion is drawn as foreshadowed in foregoing sections, that the shear zone at the top of the Chamberlain Seam is a fault zone, in this case a bedding plane fault. (See Sections 4.3.4 and 4.3.5). The nature of the material in this zone and the slickensided overlying surface indicates that this is the case, and the conclusion is confirmed by the lack of structures penetrating the shear zone from the strata, either above or below.

It is assumed that the direction of the bedding plane faulting is defined by the directions of movement on the slickensided surfaces. No other movement direction is observed (or observable) within the shear zone of coal and rock itself.

This point was taken into consideration because two directions of movement along the roof can be seen with one set of slickensides clearly etched upon the other, at some locations. Since this is the case, one must consider the possibility of other movement directions concealed within the shear zone itself. It is felt that once the fault zone had begun to form, the material in this zone would simply act as a lubricant; no part of the zone would remain competent during faulting, i.e. the whole zone would be thoroughly mixed during the movement. Consequently, directions of movement should therefore be expressed at the contacting surfaces of the two moving masses, i.e. at the laminite roof and at the top of the unsheared coal. However, as no observations are possible at the top of the unsheared coal, the observations above the sheared coal are therefore taken to reflect all movement directions relating to this faulting.

It is further assumed that bedding plane faulting is a modified form of thrust faulting. The direction of slickensides is therefore considered to reflect the bearing but not necessarily the attitude of the maximum principal stress acting prior to and apparently during faulting.

The bedding plane fault has been folded and cut by later thrust faults. The following theoretical considerations may apply.

There appears to have occurred a re-orientation of the maximum principal stress. Initially this stress was inclined at an angle to the horizontal at the time of formation of the bedding plane fault. Later it was rotated to the horizontal by the time of the thrust faults, folds and related small scale structures were formed.

The other principal stresses are orthogonal to the maximum principal stress direction. This relationship in the case of thrust faulting illustrated in Figure 4.8 (modified after Price 1966).

NOTE : The fact that one direction of slickensiding is etched upon the other indicates that there was a time difference between two phases of movement. This time difference is not considered to be the result of two different periods of deformation, but reflects changing conditions during the overall time of the one period of deformation.

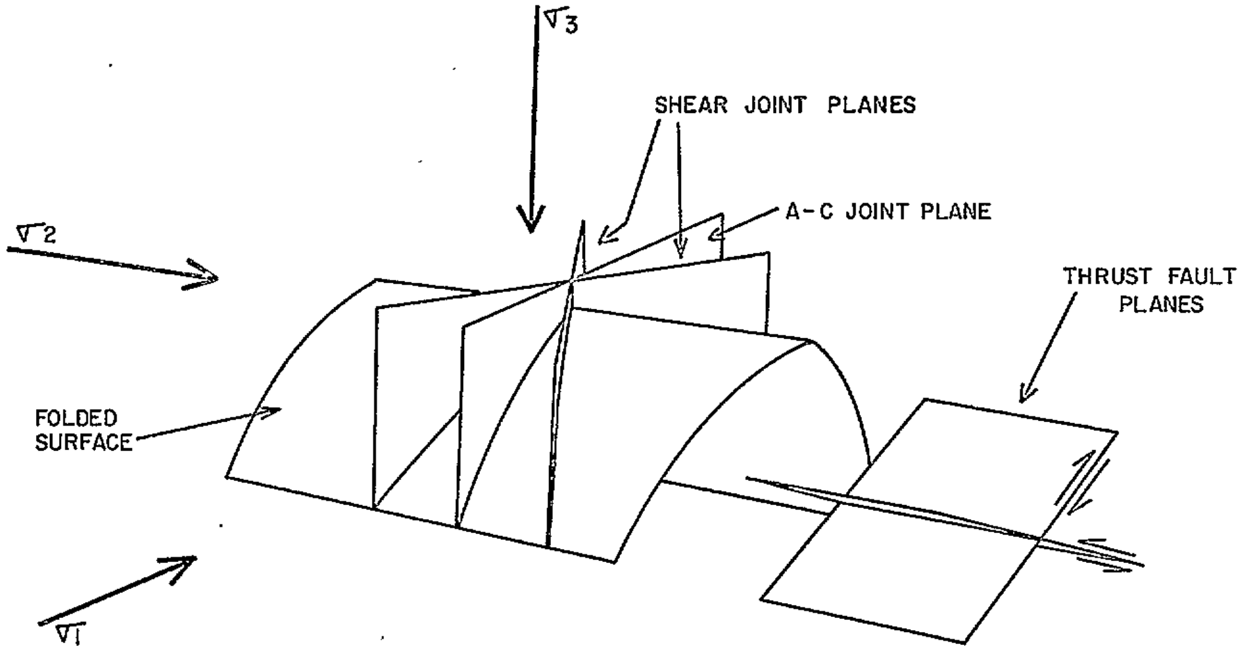
(iii) INTERPRETATION OF RESULTS

The following interpretations are drawn from the stereograms shown in Figure 4.10.

Stereogram A shows bedding planes measured at the surface in the immediate vicinity of Mine Site No. 1. This data has been measured on the floor of the Chamberlain Seam.

This plot defines a broad anticline with a vertical axial plane striking 130° and axis plunging approximately 10° southerly.

FIGURE 4·9



THEORETICAL RELATIONSHIP OF STRUCTURES TO THE GENERATING STRESS SYSTEM

REFERENCE

σ_1	PRINCIPAL STRESS DIRECTION
σ_2	INTERMEDIATE STRESS DIRECTION
σ_3	MINIMUM STRESS DIRECTION

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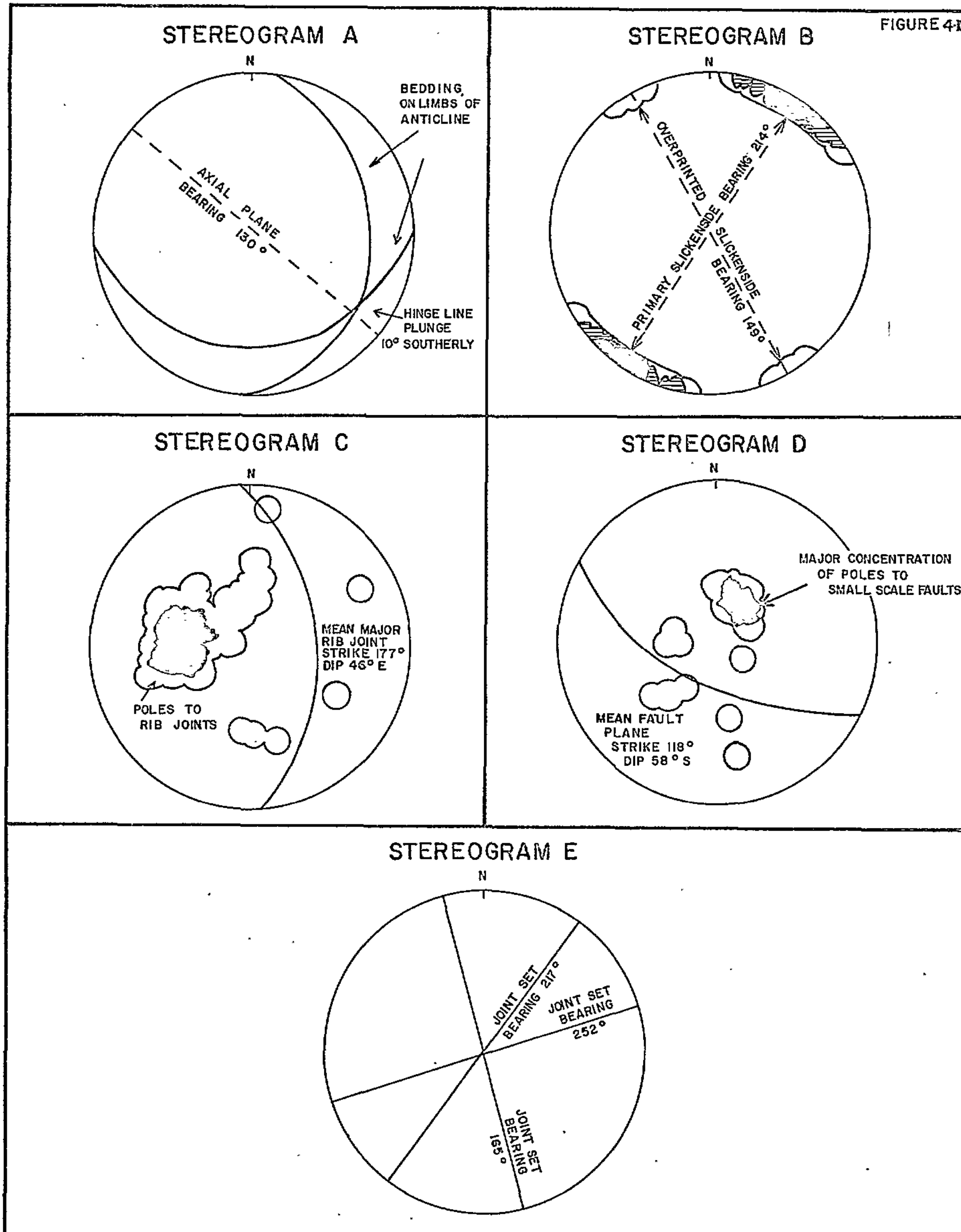
DRAWN BY : M.G.
DATE: January, 1973



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DRAWN BY : M.G.

DATE: January, 1973

The theoretical model, see Figure 4.9, of the principal stress system generating this structure has σ_2, the intermediate principal stress, parallel to the hinge line or B axis of this fold. In this case the minimum principal stress, σ_3, is normal to the B axis and contained within the surface of the axial plane. The maximum principal stress, σ_1, is normal to both of the other principal stresses and therefore, normal to the B axis of the anticline.

Stereogram B is a plot of the bearing of the first and second order slickenside directions inscribed on the Chamberlain Seam roof; the two directions are 214^{o} and 149^{o} respectively. The set bearing 214^{o} is observed to be the most obvious set.

The mean bearing of the major set of slickensides is inferred to reflect the maximum principal stress direction at the time of the major deformation, i.e. 214^{o}. Since it has been inferred that the primary slickenside set (214^{o}) represents the maximum principal stress direction at the time of generation, it can be anticipated that the trend of folding and the strike of thrust faulting would develop at right angles. The bearing of the fold axis would be expected to be close to 124^{o}. Comparison of this bearing with the trend of the major anticline (145^{o}) shows that there is a moderate agreement. However, the conclusions drawn at this stage are tentative as the area sampled is of limited extent.

Diamond drilling over the whole of the project area has shown that the major structures trend approximately parallel to a bearing of 145^{o}.

If the bearing of the overprinted slickensides does represent a change in the stress field, structures generated could be predicted to strike normal to 149^{o}, i.e. 059^{o}. In Section 4.3.5(iii) above, the thrust fault in the floor of the Chamberlain Seam was interpreted to have formed near the end of the phase of bedding plane faulting. This was indicated by the physical characteristics of the geology. The trend of this structure in fact is 065^{o}. Therefore, data from two different sources suggest that the thrust fault could be related to the overprinted slickenside direction. If this conclusion is accepted, the practical and theoretical trends are again seen to be similar.

Since there are so few structures that can be related to the overprinted slickenside direction, the conclusion is drawn that deformation at this time was minor. It is not anticipated that major structures related to thrust faulting in the floor will be encountered.

Stereogram D shows a plot of small scale thrust faults measured in the roof of the Chamberlain Seam. The maximum concentration represents a plane dipping 58^{o}S and striking 118^{o}. The theoretical direction for the maximum principal stress related to the system generating these structures lies close to the primary maximum principal stress direction. These structures are therefore thought to have developed during the earlier part of the deformation.

The remaining stereograms C and E show plots of joints in the coal and in the seam roof.

The mean bearing of the secondary trend, 149^{o}, may represent a change in the stress field late in the deformation stage. This set of slickensides is seen in the field to be etched upon those bearing 214^{o}.

While it may appear reasonable to conclude that, at the time of deformation, most of the tectonic movement is related to the maximum principal stress direction, i.e. 214°, it is too early in the investigation for such a conclusion to be substantiated. It is suggested that the project area as a whole could be divided into structurally discrete domains, each requiring separate analysis.

As has been pointed out by Dr. Rickard (Appendix B-1, para. 4), "The establishment of the relation of stress conditions to structure is a very difficult step".

<u>Stereogram C</u> is a plot of poles to joints in the coal seam measured on the rib, the mean of which represents a plane striking 177° and dipping 46°E.

<u>Stereogram E</u> shows a plot of poles to joints measured in the seam roof. The major density represents a vertical plane striking 217°. On either side of this concentration are two other weaker concentrations of poles bearing 165° and 252°.

Insufficient measurements are available for any conclusions to be drawn from the plots of joint directions at this stage in the data collection procedure. It is, however, relevant to note that the major joint directions in the coal seam (strike 177°, dipping easterly at 46°) and the roof rocks (strike 217°, vertical) differ by 40° in strike. It has been noted from field observations and particularly in colour photographs, that similar joints occur in both cases.

It is suggested that two factors could be operating which explain this apparent discrepancy. Firstly, and of prime significance, that until the mine workings commenced to dry out in January 1973 (with the introduction of heated air) the joints in the coal seam were barely discernable. Secondly, a subjective bias could have been operating during the joint measurement procedure. Further studies will clarify this.

It has been commonly observed that joints, although generated much later than the geological structures previously described (Stereograms A, B and D) are often geometrically related to these geological structures. A detailed study of joints may be of use to predict changes in gross geological structures.

The distribution of these joints may therefore be compared with any study carried out with respect to the present stress field and as mining proceeds, changes can be anticipated.

(iv) CONCLUSIONS

This phase of the geological programme has contributed a significant amount of data which will act as a base in the further evaluation of the structural geology of the property. Its prime objective, not yet realised, is to assist in the development of a series of parameters on which refinements to mine layout may be based.

The establishment of a relation between stress conditions and structure is difficult and complex. The stress pattern deduced as a result of measurements underground may not represent the pattern existing today, rather that which existed at the time of deformation. The measurements will, however, provide "a guide and form a basis" (Rickard, Appendix B-1) for rock mechanics studies, which are recommended elsewhere in this report.

It can be anticipated that residual stresses will exist in the area and that they will be active at all depths at which the mine will be worked. Dr. Rickard suggests that these stresses "will probably be horizontal", though at greater depths over 1000 feet, for example, there will be a "significant increase in the vertical stress due to the weight of the overburden".

The present stress field, as determined by a rock mechanics study, may be found to be geometrically related to the geological structures and therefore variations of the geology will probably reflect similar changes to the existing stress field. This data can then be used to predict varying mining conditions. The analysis of the geological data collected to December 19, 1972, has indicated that certain patterns exist and that these patterns may be related to some of the gross structural features with a reasonable degree of confidence. A number of parameters, such as change in floor dip, folding of roof strata etc. as discussed in Section 6.6, have been recognised which, while requiring confirmation, appear to be reliable indicators of poor roof conditions. Prediction of their occurrence has not as yet reached the required degree of confidence.

4.3.7 SUMMARY OF STRUCTURAL GEOLOGY

The following is a summary of the conclusions and inferences which have been drawn as a result of this aspect of the exploration programme.

(i) PLATE 2c

(a) The limits of Plate 2c have been accurately defined, as shown on Map 7A.

(b) The "splinter" fault off the Rim Fault has been proved not to exist at the level of the Chamberlain Seam.

(c) No evidence exists in D.D.H. C-45 for a zone of structural disturbance at the point where the extension of the Tip Fault and the "splinter" fault to the Rim Fault were postulated to possibly intersect.

(d) A minor fault with a drill hole throw varying between 20 and 40 feet has been identified as existing in the north-western corner of Plate 2c.

(e) The planning of mine headings must take into account the location of the inferred outcrop adjacent to the Skeeter Fault.

(ii) PLATE 3

(a) The earlier predicted favourable structural configuration of Plate 3 has been confirmed.

(b) The western margin of Plate 3 has been more accurately defined.

(c) A fault with throws of approximately 70 feet has been located as shown on Map 6A.

(d) The structural continuity of the coal seams at the north-western outcrop of Plate 3 has been strongly inferred. An entry point to the seams can be defined accurately from the 1971 outcrop stripping programme, provided that it is on the eastern end of the outcrop.

(iii) SMALL SCALE STRUCTURES AND UNDERGROUND MAPPING

(a) The sheared coal and rock, which varies up to 0.8 feet in thickness and occurs immediately over unsheared coal, has been identified throughout the current workings of Mine No. 1. It is interpreted as a bedding plane fault occurring at the junction of the Chamberlain Seam and the overlying roof rock.

The trend, but not the sense, is shown by the two sets of slickensides inscribed on the overlying strata.

(b) A feature, termed in this report as 'slip wedge' has been described in Section 4.3.4(ii)(b). It has also been identified underground and it is concluded that it is due to the lateral movement of a mass of roof strata over a wedge of equivalent roof strata.

(c) A structure which, as far as is known has not been reported in geological literature to date and termed a 'sigmoidal laminite' is identified as being related to a number of roof falls. This feature requires further detailed study to more fully evaluate its likely affect on mining and to determine a method of overcoming such affect.

(d) Of the two sets of slickensides, bearing 214° and 149°, identified as being consistent in the mine to date, it is inferred that the primary set (214°) represents the maximum principal stress operating at the time of deformation.

(e) It is not suggested that the stress field, relevant to the time of deformation, is still in existence as such, although there may be residual stresses. However, the definition of such a stress situation would form a positive basis for rock mechanics studies.

(f) The minor set of slickensides bearing 149° is etched on the major set bearing 214°. The two sets are considered as reflecting changing conditions during the overall time of one deformation, rather than two different periods of deformation.

(g) Surface data from the anticline for the restricted area at the pit top is inferred as being related to the primary slickenside direction for the primary stress field at the time of formation, but the sampling is too limited at this stage to be conclusive in any regional sense.

(h) A preliminary study of joints in the rib and in the roof has been made and some trends are apparent. Insufficient data is available at this stage for conclusions to be made.

(i) Small scale thrust faulting in the roof appears to be related to the primary stress field.

(j) A thrust fault on the floor of the Chamberlain Seam appears to be related to a secondary stress field based on the trend of this structure and the observed roof slickenside directions.

SECTION 5

ECONOMIC APPRAISAL

Volume 5 ?

5.1 INTRODUCTION

? indexed as 1971 D REPORT

This section of the report up-dates and confirms the data contained in Section 5 of the 1972 Report. Attention is drawn to Section 5.1 of that report wherein the reserve calculation prodecures are detailed. The same principles have been adhered to in this report.

? 5 A-1

Use was made of the radiation logs to verify coal seam thicknesses, as discussed in Appendix H of this report.

The detailed logging within the coal seams has again been confined to the use of "bright" and "dull" and combinations of these two terms with respect to the coal lithotypes. The Australian Standard defining terms for coal and coke (A.S. K149 - 1966) defines the terms vitrain, clarain and durain somewhat more specifically than the classification of Stopes, relating to humic coals.

"Bright" coals are composed of two lithotypes, vitrain and clarain, while "dull" coal is composed of durain.

While there is a macroscopic difference between clarain and vitrain, it is not considered practicable for such a distinction to be made during logging of the coal seams. Consequently, the terms "bright" and "dull" coal have been retained.

The same quality determinations have been made in this programme as in 1971 for the coal analyses, with the addition of routine testing of fluidity by the Gieseler Plastometer. The analytical results are included as Appendix A.

The seam thickness variations, reserve figures and quality data, as set out in considerable detail in the 1972 Report, is reproduced here in abbreviated form only except where variations to that data occur. Such variations apply to Plates 2c and 3 only.

The underground operations have afforded an opportunity to verify in part, the quality predictions resulting from the 1971 field programme. No alteration to those conclusions has been found necessary. Channel and bulk sampling was carried out, providing confirmatory data relating to the drill hole data.

Indexed as 1971 D Report

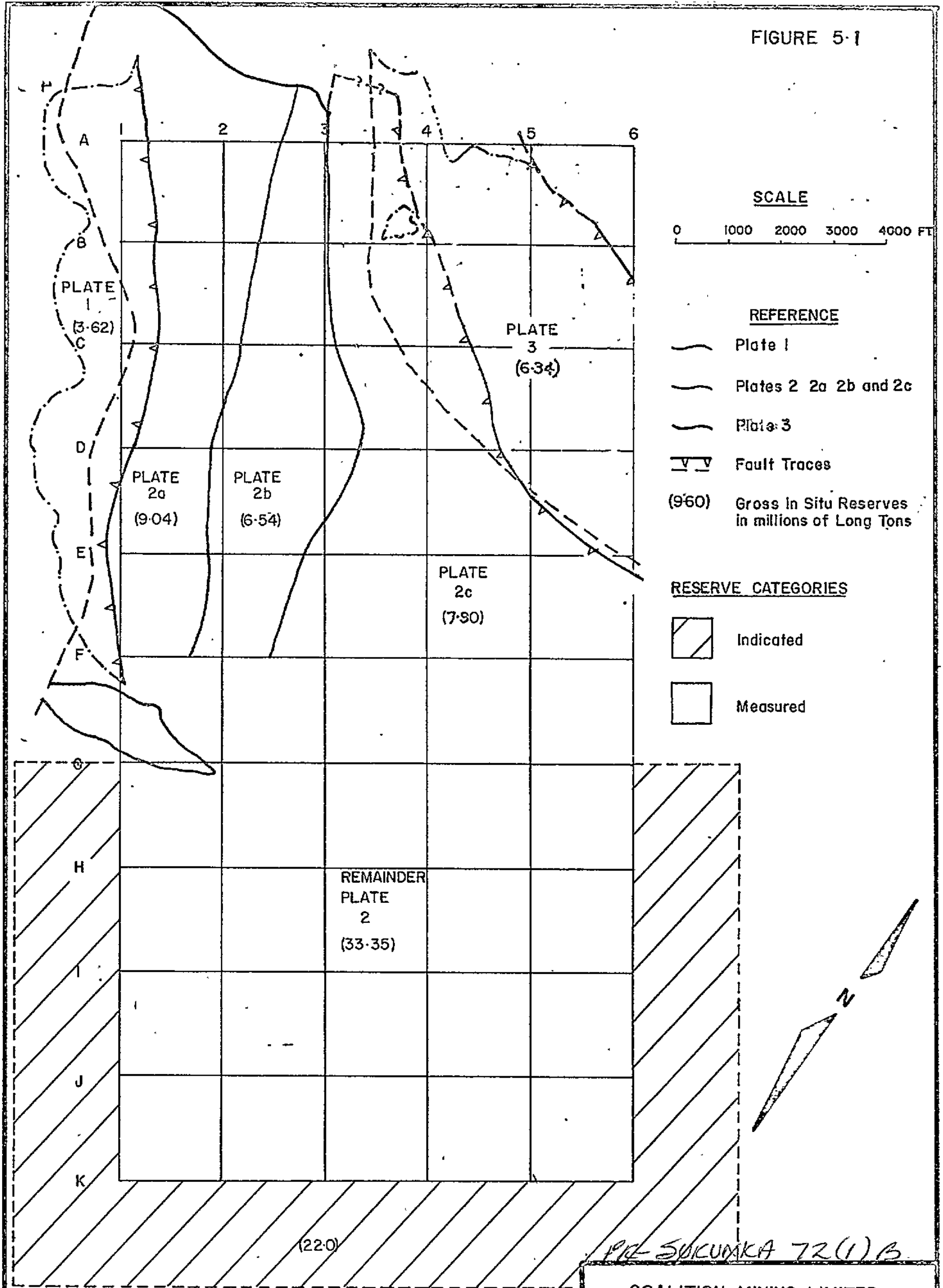
In the 1972 Report, the distribution and variation in thickness, reserves ~~and quality~~ for each seam was discussed under the two major headings - Chamberlain and Skeeter Seams (Sections 5.3 and 5.4 respectively). In this report, the discussion of these seams has been re-oriented so that the data for discrete mining areas, that is, the structural plates, are brought together for ease of reference. Consequently, that data referring to both the Chamberlain and Skeeter Seams for Mine No. 1 is collated under the section for Plate 2a. Since there are no significant variations in the quality of the seams with respect to separate structural plates, this aspect is treated under one heading, Section 5.3.

The reserve figures and categories are illustrated on Figures 5.1 and 5.2.

5.2 SUMMARY

The 1972 exploration programme has contributed additional data to the reserves of Plates 2c and 3 and confirmed the quality predictions in the 1972 Report.

FIGURE 5·1



PR-SUKUNKA 72(1)B

CHAMBERLAIN SEAM – PLATE BOUNDARIES AND AREAS OF RESERVE CALCULATIONS

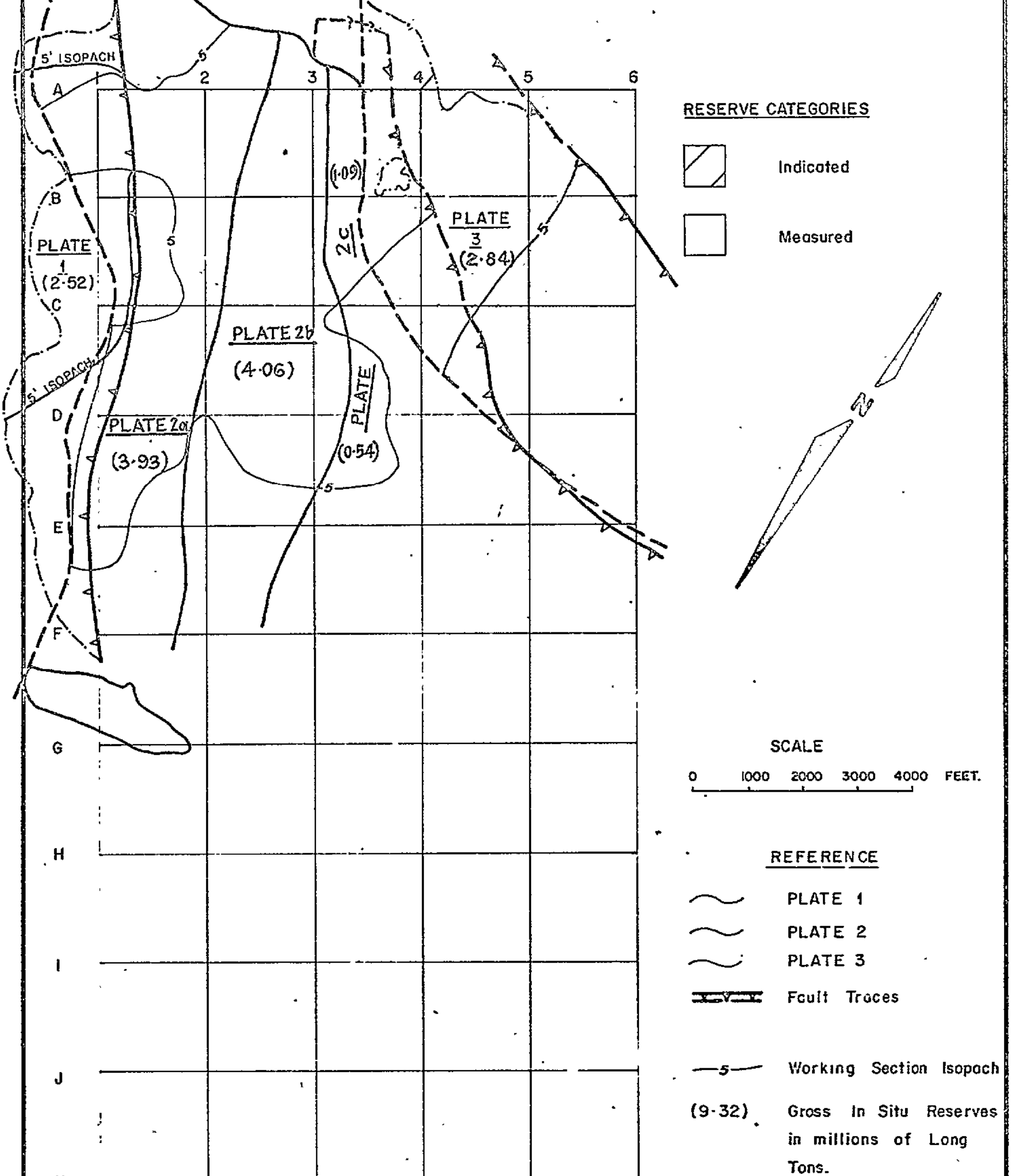
PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY. LTD.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February 1973.

FIGURE 5·2



PR-SUKUNKA 72(1)B.

COALITION MINING LIMITED

SUKUNKA COAL PROJECT

February 1973

SKEETER SEAM (WORKING SECTION)
PLATE BOUNDARIES AND AREAS OF
RESERVE CALCULATION

PREPARED BY CLIFFORD McELROY & ASSOCIATES PTY LIMITED.

In Plate 2c, the reserves were decreased for the Chamberlain Seam by 1.5 million long tons, gross and increased for the Skeeter Seam by 0.3 million long tons, gross, if the southern part of the reserve area is still included. For Plate 3, the reserve figures were up-graded from the Indicated to Measured category and reserves in both seams were increased by 0.79 million long tons, gross. The net effect of these variations is to reduce the total gross reserves by 0.46% or 0.39 million long tons. A total of 45 million long tons of washed coal is regarded as being available from the three plates and from within the grid area.

Additionally, totals of 22.0 and 46.0 million long tons, gross of Indicated and Inferred reserves, respectively, exist outside the exploration grid area.

A summary of the washed product figures is included in Table 5.1. No essential variations are proposed for the thickness or the predicted quality of the washed product for either seam.

The predicted ash content of the washed product from both seams will be less than 5.3% based on a washing gravity of 1.60; C.S. No. will be about 7½.

5.3 COAL QUALITY

5.3.1 CHAMBERLAIN SEAM

(i) BORE CORE DATA

The 1972 programme has provided further analytical data which has increased the level of confidence held in the predictions made as a result of the 1971 programme. The analytical results are tabulated in Appendix A-3 and A-4 and the means and standard deviations in Appendix A-1. A comparison of the results in Appendix 1 of this report with the similar data in the 1972 Report (Appendix A-2) illustrate the consistency of the results. The variation in the ash content of the washed product of the Chamberlain Seam is illustrated in Figures 5.3 and 5.4. Accordingly, the predictions made in the previous report for Plate 2 are not varied and may now be applied with increased confidence to Plate 3.

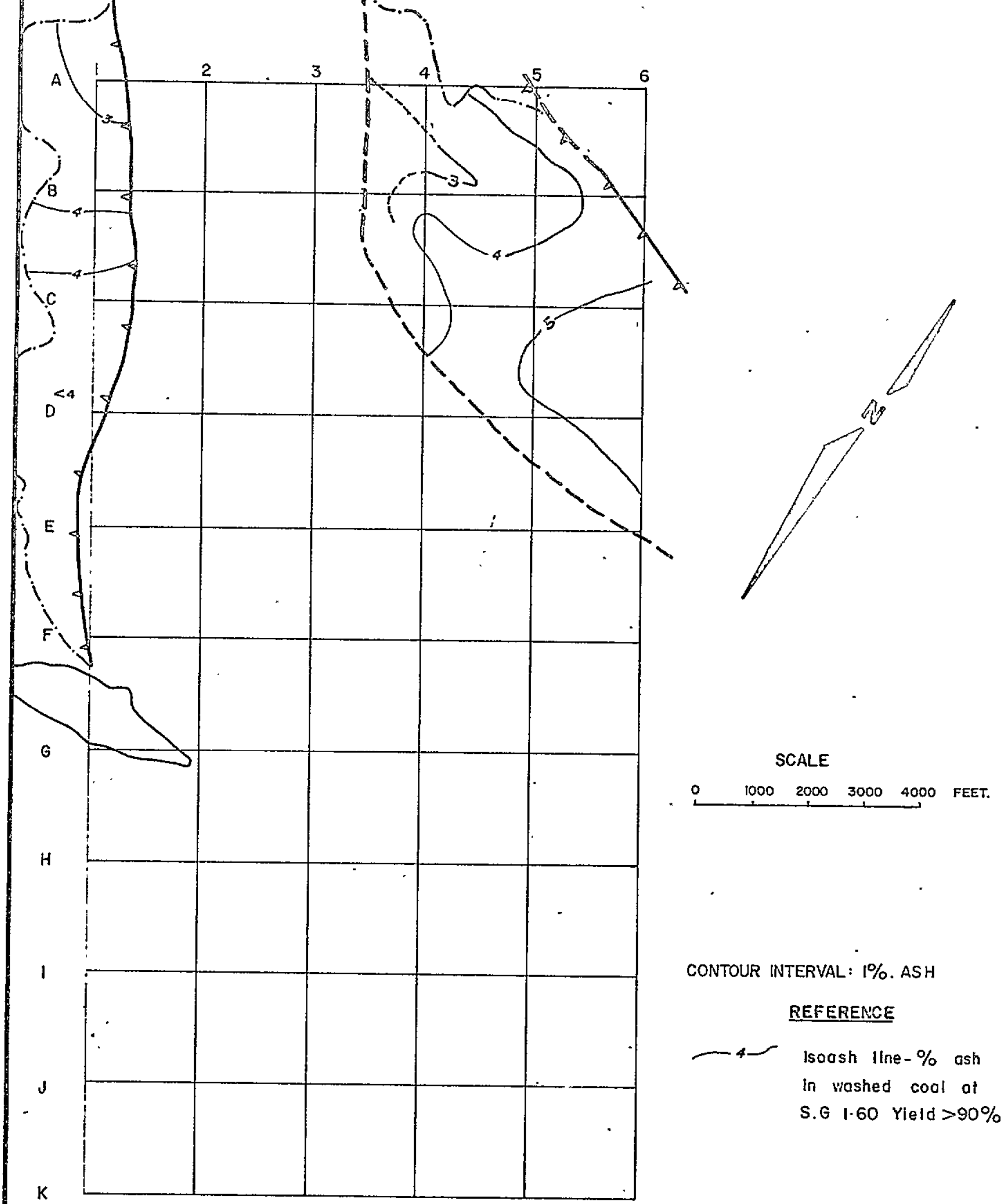
The washed product, at a washing gravity of 1.60, is predicted to have an average ash content of 4% and varying up to 5.3%; the C.S. No. will be between 7 and 7½ and volatile matter (D.A.F.) between 20% and 26%.

(ii) CONFIRMATION OF BORE CORE DATA

A channel sample 3 inches deep and 6 inches wide was taken underground 3 feet from the intersection of D.D.H. CM-1 in No. 3 cut-through adjacent to A heading.

The sample was split into two and half analysed each by Cargo Superintendents Co. in Sydney and by Commercial Testing and Engineering Co. (C.T.E.) in Vancouver. The results are included in Appendix A-5, with comparisons of these results in Appendix A-5.6. Reference should be made to that appendix for a full discussion.

FIGURE 5-3



SKETCH ISOASH MAP

CHAMBERLAIN SEAM
PLATES 1 and 3

PR - SUKUNKA 72(1)B

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SUKUNKA COAL PROJECT

February 1973.

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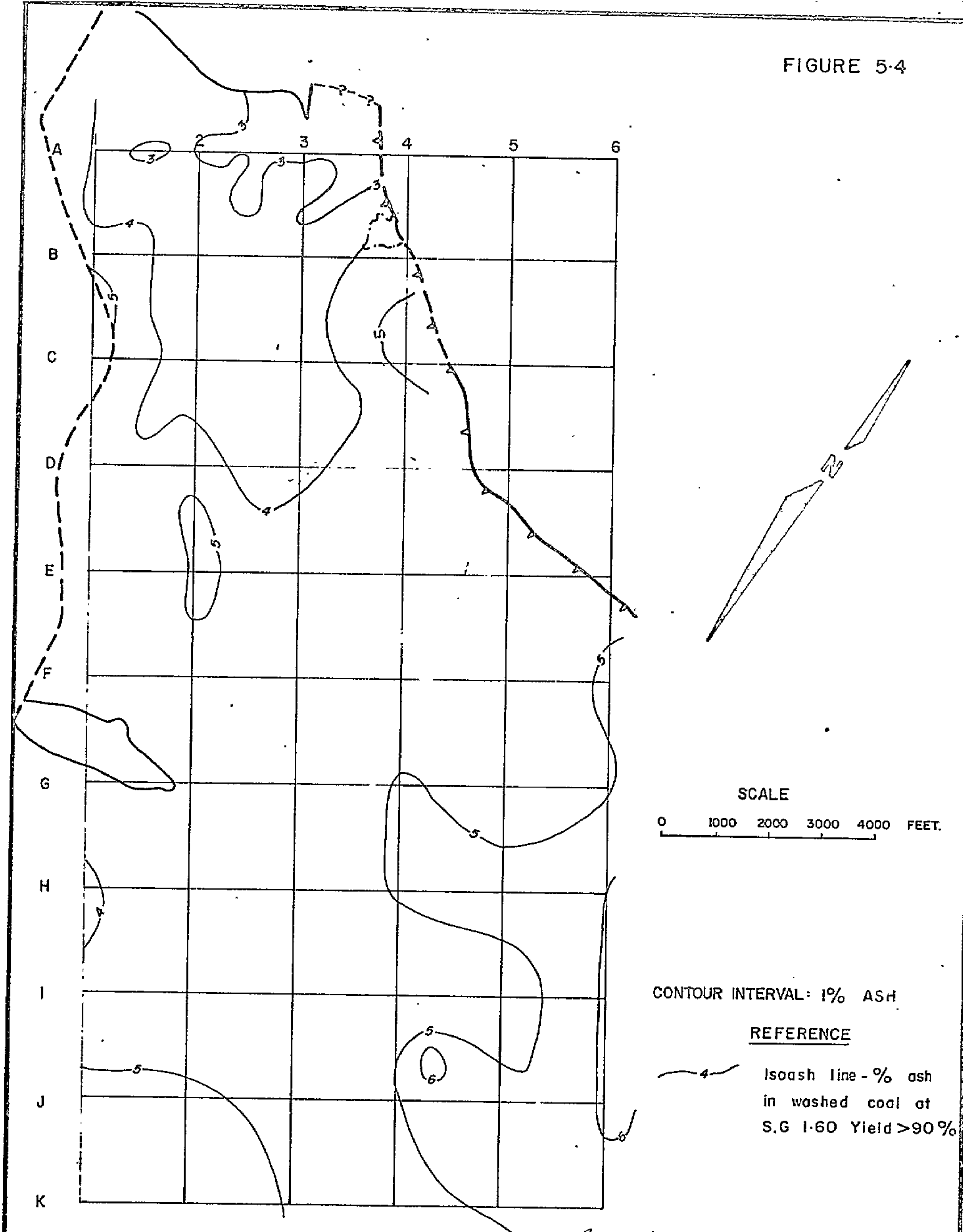
FIGURE 5·4



SKETCH ISOASH MAP

CHAMBERLAIN SEAM

PLATE 2

PR-SUKUNKA 72(1)B.

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In summary, the results are in excellent agreement, the bore core results being slightly on the conservative side. The ash of the bore core was 3.1% and from the comparable section of channel samples 2.8% (Cargo) and 3.2% (C.T.E.). The -30 mesh ash of the core sample was 4.2% as against 3.5% for both channel samples, which is considered to be in keeping with the general expectations due to the differential loss of the low S.G., low ash coal in the drilling process.

Appendices A-5.4 and A-5.5 contain the results of the analysis of two bulk samples (CML-1)and CML-2) collected from the run-of-mine coal. The ash and recovery figures are -

	CML-1	CML-2
Ash	2.74%	2.91%
Recovery at S.G. 1.60	78.6%	86.7%

The close agreement of the ash figure is apparent. The recovery figure is dependent on the amount of roof which falls or is cut down during the mining process, but indicates the validity of using 80% as a recovery figure in reserve calculations. It is important to remember, however, that only a very small proportion of the property has been sampled by Mine No. 1.

5.3.2 SKEETER SEAM

As for the Chamberlain Seam, no data has come forward which requires varying the predictions made in the 1972 Report.

The analytical results and Gieseler Plastometer test results are included as Appendix A-3.1 and A-3.2 respectively. The variations in the ash content of the washed product are shown in Text Figures 5.5 and 5.6. It is predicted that the washed product will have an ash content of 4.8% and a volatile matter (D.A.F.) of 24.9%; the C.S. No. will be 7½.

5.4 PLATE 1

Reference should be made to Section 5 of the 1972 Report for a complete discussion of the economics of this Plate, in conjunction with the following.

Within Plate 1, the Chamberlain Seam is economic throughout the whole of the plate and the Skeeter Seam is of a workable thickness throughout approximately 60% of the plate.

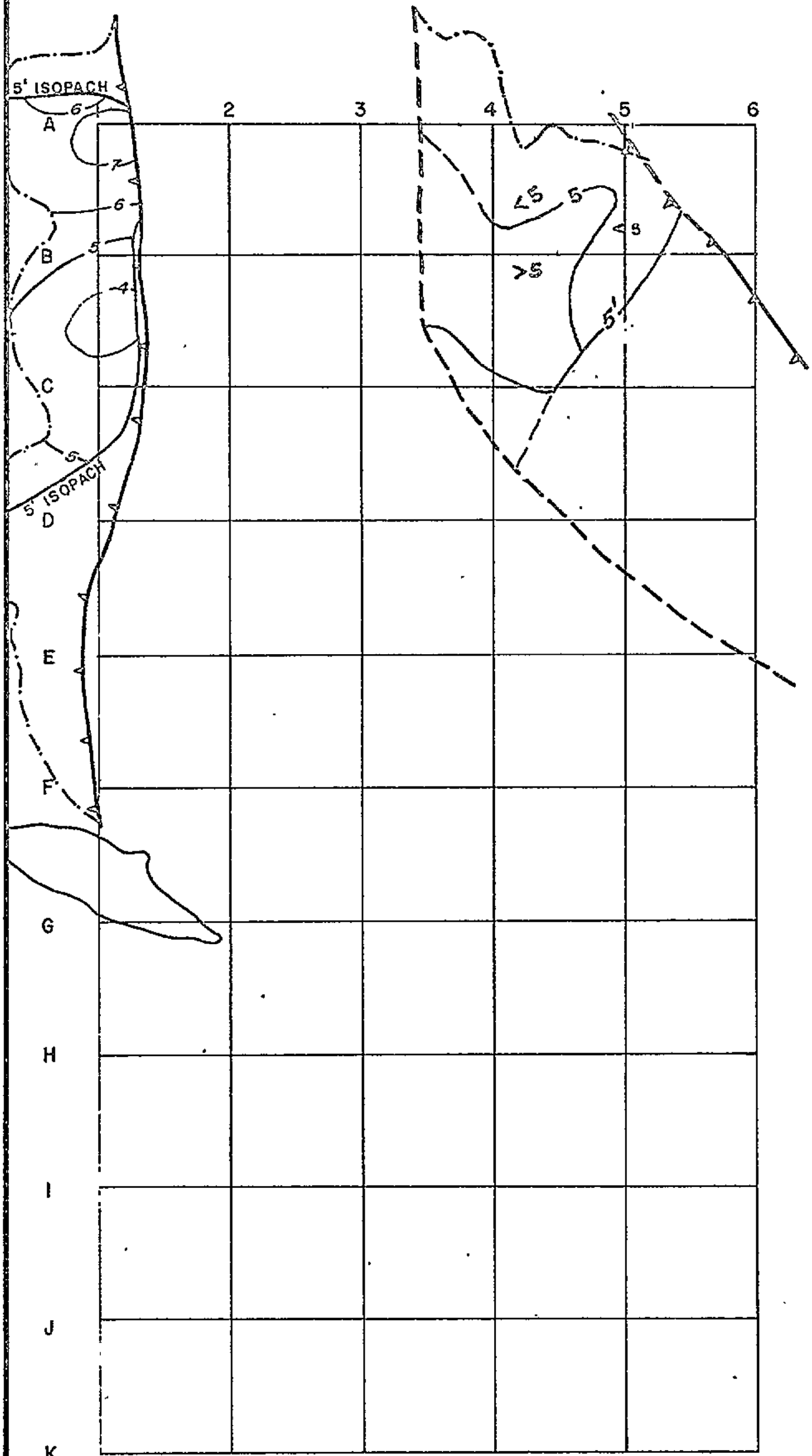
The Chamberlain Seam ranges up to 10 feet in thickness and over much of the plate is in excess of 8 feet. The Skeeter Seam has a workable thickness in this plate of between 5 and 7 feet in general, and varies up to 11.6 feet maximum.

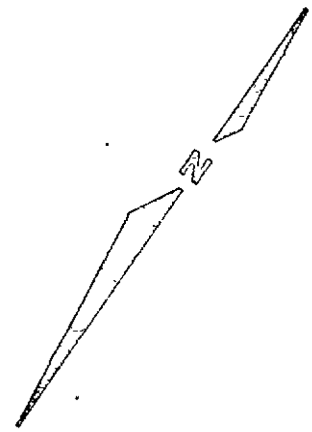
Reference should be made to Map 9A and Figure 5.7 for the isopachs of the Chamberlain Seam and to Map 15A and Figure 5.8 for the isopachs of the theoretical working section of the Skeeter Seam.

The Chamberlain Seam reserves in this plate are shown in Table 5.2. Using a figure of 80% recovery and 70% extraction, 2.02 million long tons may be produced from the 3.62 million long tons of gross reserves in this plate.

Based on a theoretical working section of greater than 5 feet, for the Skeeter Seam, 2.52 million long tons of gross reserves exist within Plate 1, of which 1.23 million long tons may be produced using a figure of 70% for both recovery and extraction.

FIGURE 5·5





NOTE:

Data refers to coal, upper and lower bands in Theoretical Working Section.

SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1%

REFERENCE

~4~ Isoash Line % ash in washed coal at S.G. 1·60 yield > 80%

~5~ Limit of Working Section

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ISOASH CONTOURS
SKEETER SEAM
PLATES I and 3

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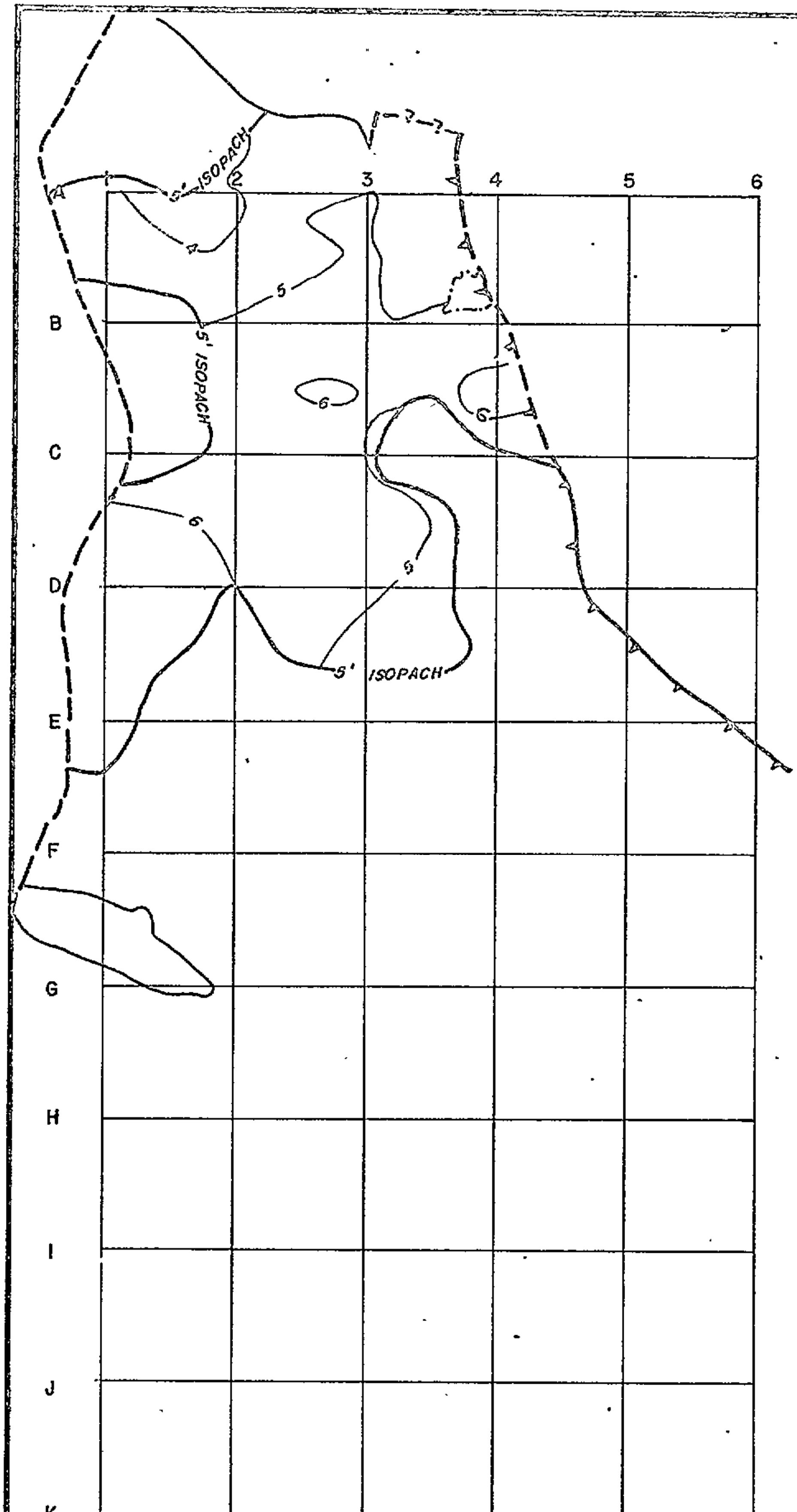
FIGURE 5-G



NOTE:
Data refers to coal, upper and lower bands in Theoretical Working Section.

SCALE

0 1000 2000 3000 4000 FEET.

CONTOUR INTERVAL: 1%

REFERENCE

—4—	Isoash line % ash in washed coal at S.G. 1·60 yield > 80%.
—5—	Limit of Working Section.

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ISOASH CONTOURS
SKEETER SEAM
PLATE 2

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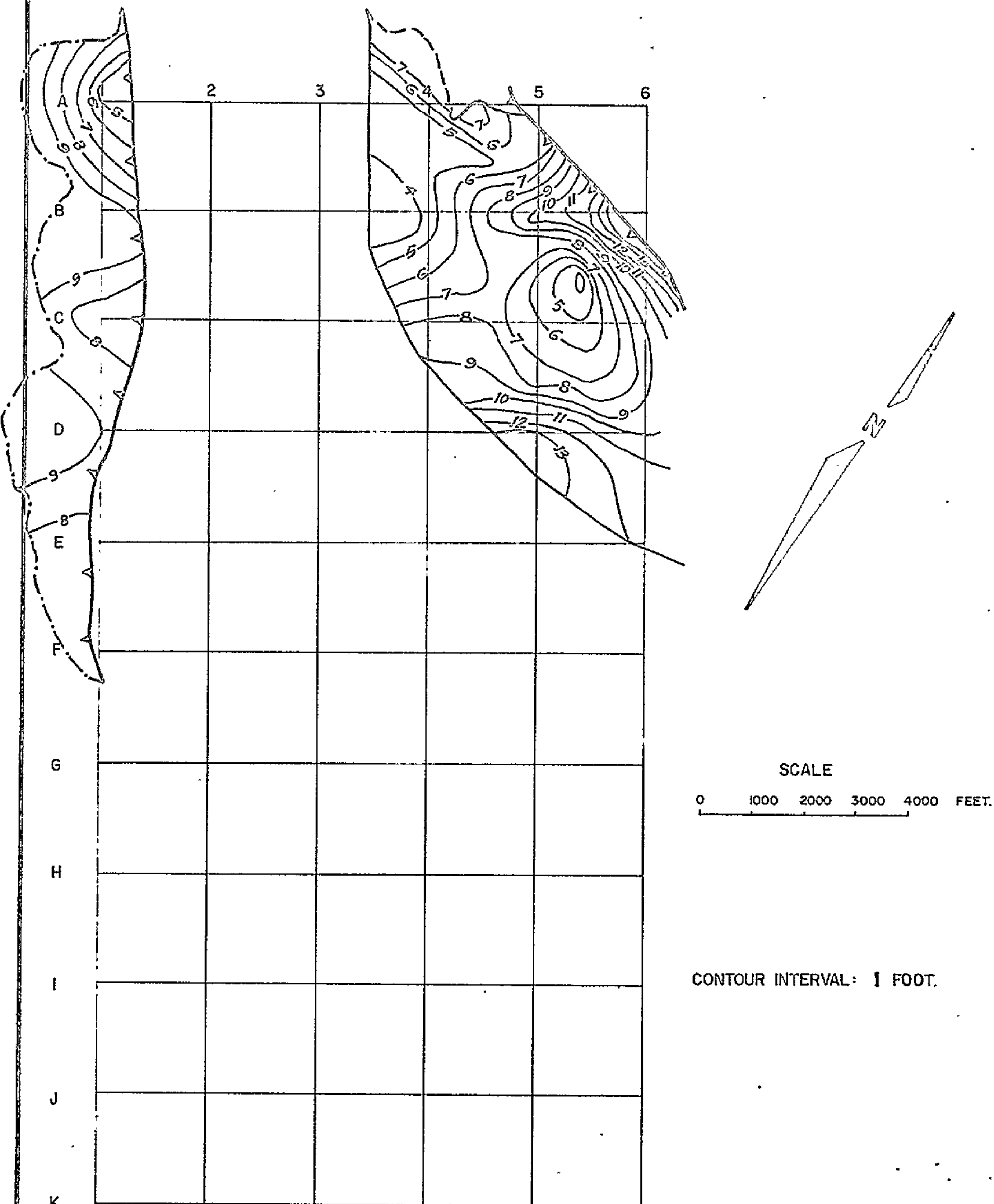
FIGURE 5·7



SKETCH ISOPACH MAP

CHAMBERLAIN SEAM

PLATES 1 &3

PR-SUKUNKA 72 (1)A.

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See also map 9A for details of contours at Scale 1" = 1000'

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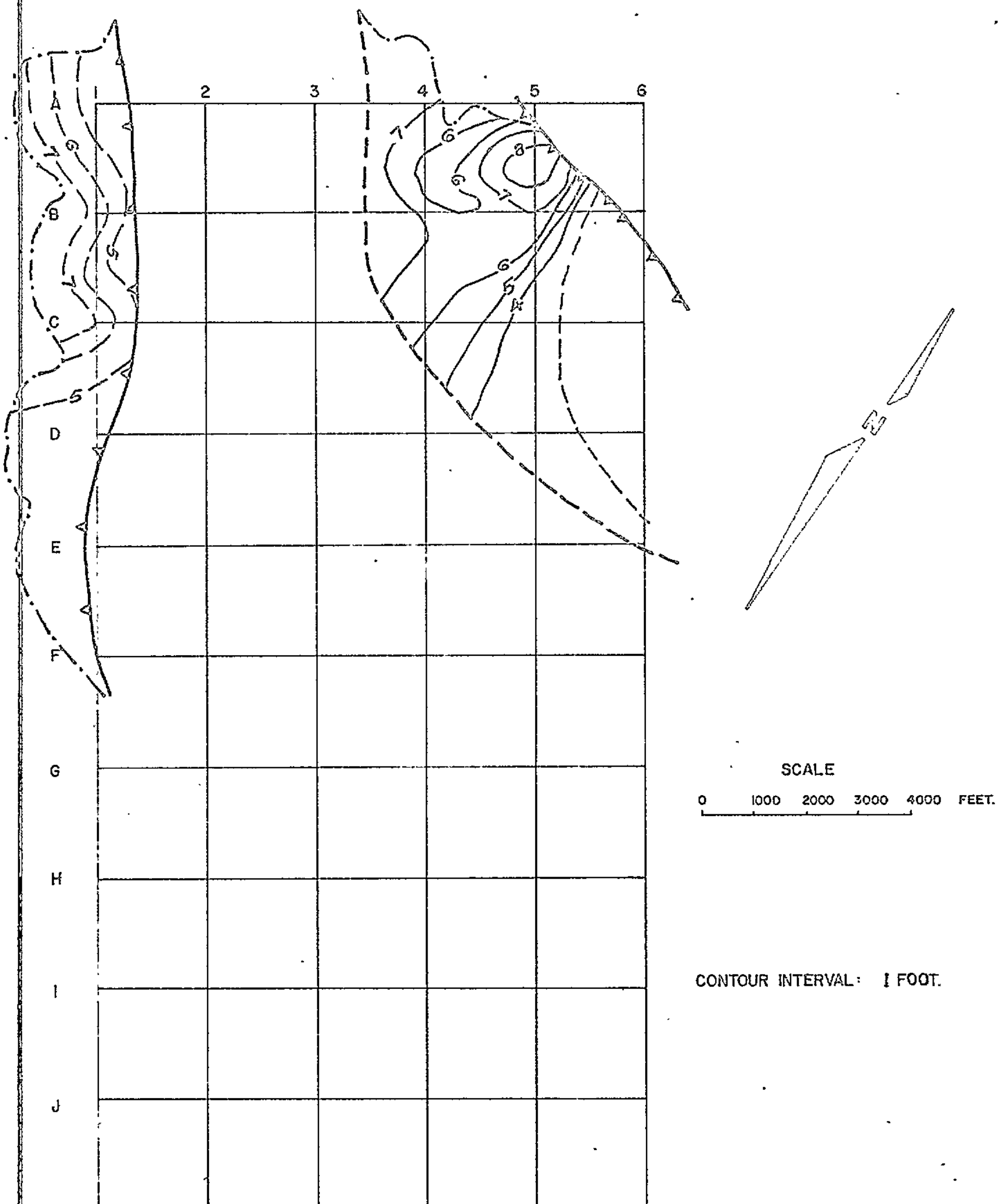
FIGURE 5·8



SKETCH ISOPACH MAP

SKEETER SEAM
THEORETICAL WORKING SECTION
PLATES 1 and 3

PR-SUKUNKA 72(1)B

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See also Map 15A for details of contours at scale 1" = 1000'

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TABLE 5.2

RESERVE CATEGORIES

CHAMBERLAIN AND SKEETER SEAMS

(Millions of Long Tons - Measured)

SEAM	PLATE 1	PLATE 2a	PLATE 2b	PLATE 2c*		REM. PLATE 2+	PLATE 3
CHAMBERLAIN							
Gross Reserves	3.62	9.04	6.54	8.12		33.35	6.95
70% Extraction	2.53	6.33	4.58	5.68		23.34	4.86
80% Recovery	2.02	5.06	3.66	4.54		18.76	3.89
85% Recovery	2.15	5.38	3.89	4.83		19.84	4.13
SKEETER				(North)	(South)		
Gross Reserves	2.52	3.93	4.06	1.09	0.54	-	2.84
70% Extraction	1.76	2.75	2.84	0.76	0.38	-	1.99
70% Recovery	1.23	1.92	1.99	0.53	0.27	-	1.39
75% Recovery	1.32	2.06	2.13	0.57	0.28	-	1.49

NOTE : For the Skeeter Seam the reserve figures are calculated for a theoretical working section of greater than 5 feet.

+ Rem. Plate 2 = Remainder of Plate 2, south of grid line F.

* Refer to Figure 5.2 for north and south reserve areas of Plate 2c.

5.5 PLATE 2a

No new data relating to this plate has accrued from the 1972 exploration programme. The following data is summarised from the 1972 Report.

The Chamberlain Seam thickness varies from less than 5 feet in the north to in excess of 10 feet in the vicinity of grid line B; most of the plate is in excess of 7 feet. Variations in the coal seam thickness in Mine No. 1 are shown on Map 31. It is not anticipated that the seam thickness will reach 7 feet until some 2,500 feet south of the outcrop. See Map 10A and Figure 5.9.

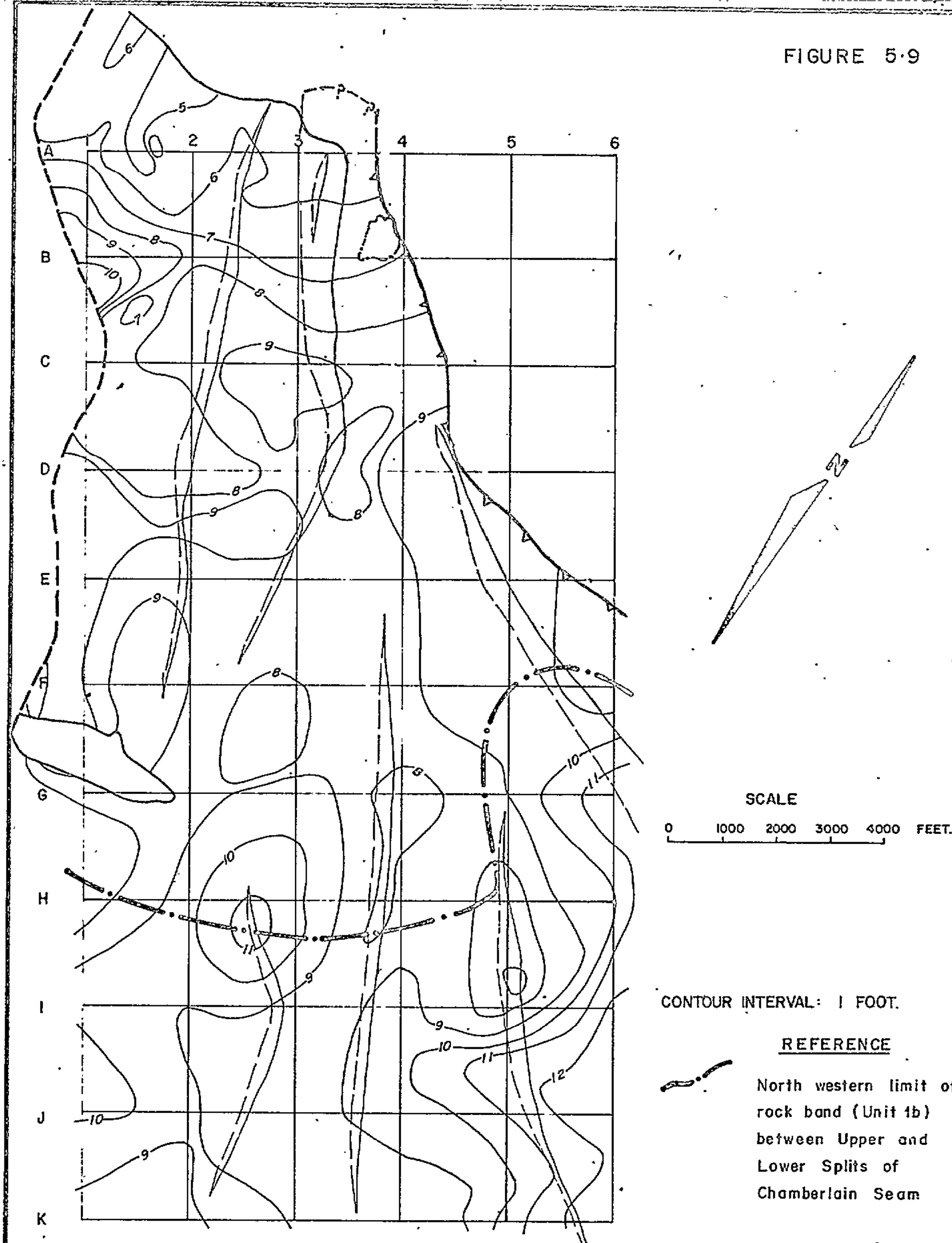
The theoretical working thickness of the Skeeter Seam varies from 4 feet in the north to 8 feet in D.D.H. S-34 to the south (see Map 16A and Figure 5.10). The majority of this plate will have a theoretical working section of greater than 6 feet; however, on the north-eastern edge of the plate the seam thickness is less than the theoretical working thickness. Consequently, between grid lines B' and C, the mining width of this section will be reduced to some 1,000 feet adjacent to the eastern edge of the plate.

The gross reserves of the Chamberlain Seam are 9.04 million long tons from which 5.06 million long tons of washed product may be produced using an extraction figure of 70% and a washing yield of 80%. From the Skeeter Seam 1.92 million long tons of washed product are available from the 3.93 million long tons gross, using a figure of 70% for extraction and recovery.

5.6 PLATE 2b

As the exploration programme carried out in 1972 was directed toward elucidating problems in Plates 2c and 3, no new data

FIGURE 5·9



PR- SUKUNKA 72(1)B.

SKETCH ISOPACH MAP

CHAMBERLAIN SEAM

PLATE 2

SHOWING LOWER SPLIT

ONLY IN SOUTH

See also Map 10A for details of contours at scale 1" = 1000'

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relating to Plate 2b is to hand.

The thickness of the Chamberlain Seam in this plate varies between 4.8 feet in D.D.H. C-6 in the northern part of the plate to 9.90 feet in D.D.H. S-37 on grid line E'. Throughout virtually all the plate the seam thickness is in excess of 6 feet, with the 7 feet isopach line being reached at 3,000 feet from the outcrop. Map 10A refers.

The Skeeter Seam is workable only as far as grid line E. However, it is in excess of 8 feet throughout this part of the plate, with the exception of an extremely limited area in the north-eastern corner of the plate, as shown on Map 16A.

The gross reserves in this plate are 6.54 and 4.06 million long tons in the Chamberlain and Skeeter Seams respectively. Using a figure of 70% for extraction and recovery figures of 80% (Chamberlain) and 70% (Skeeter) 3.66 and 1.99 million long tons of washed product are available, respectively.

5.7 PLATE 2c

The 1972 exploration programme was directed in part specifically towards the clarification of a number of problems in this plate. The limits of the plate have been slightly redefined as is shown on Map 7A and discussed in Section 4.3.2.

The Chamberlain Seam thickness varies from 6 feet in D.D.H. C-6 in the north to 9.39 feet in D.D.H. S-7 to the south, see Map 10A and Figure 5.9.

It will be seen from the structure contour map, Map 7A, that a small fault exists in the western edge of the plate. This fault, in relation to the inlier of sediment and coal at approximately grid point B-4, limits the width of access from the northern outcrop of the plate to the south to some 800 feet. As discussed in Section 6, it has been proposed that Mine No. 3 in this plate be used to gain access to the majority of the area south of grid line F from Plate 2c with relative ease. This southern part of the property is discussed below in Section 5.7.

The gross reserves of the Chamberlain Seam for this plate are 8.1 million long tons. Using figures of 70% and 80% for mining extraction and washing recovery, respectively, 4.54 million long tons of washed product can be produced.

The variations in the theoretical working section of the Skeeter Seam are shown on the isopach map, Map 16A and Figure 5.10. Plate 2c is divided into 2 areas of extractable coal by a zone approximately 1,500 feet in length between grid lines C'and D', where the working section of the seam is less than 5 feet.

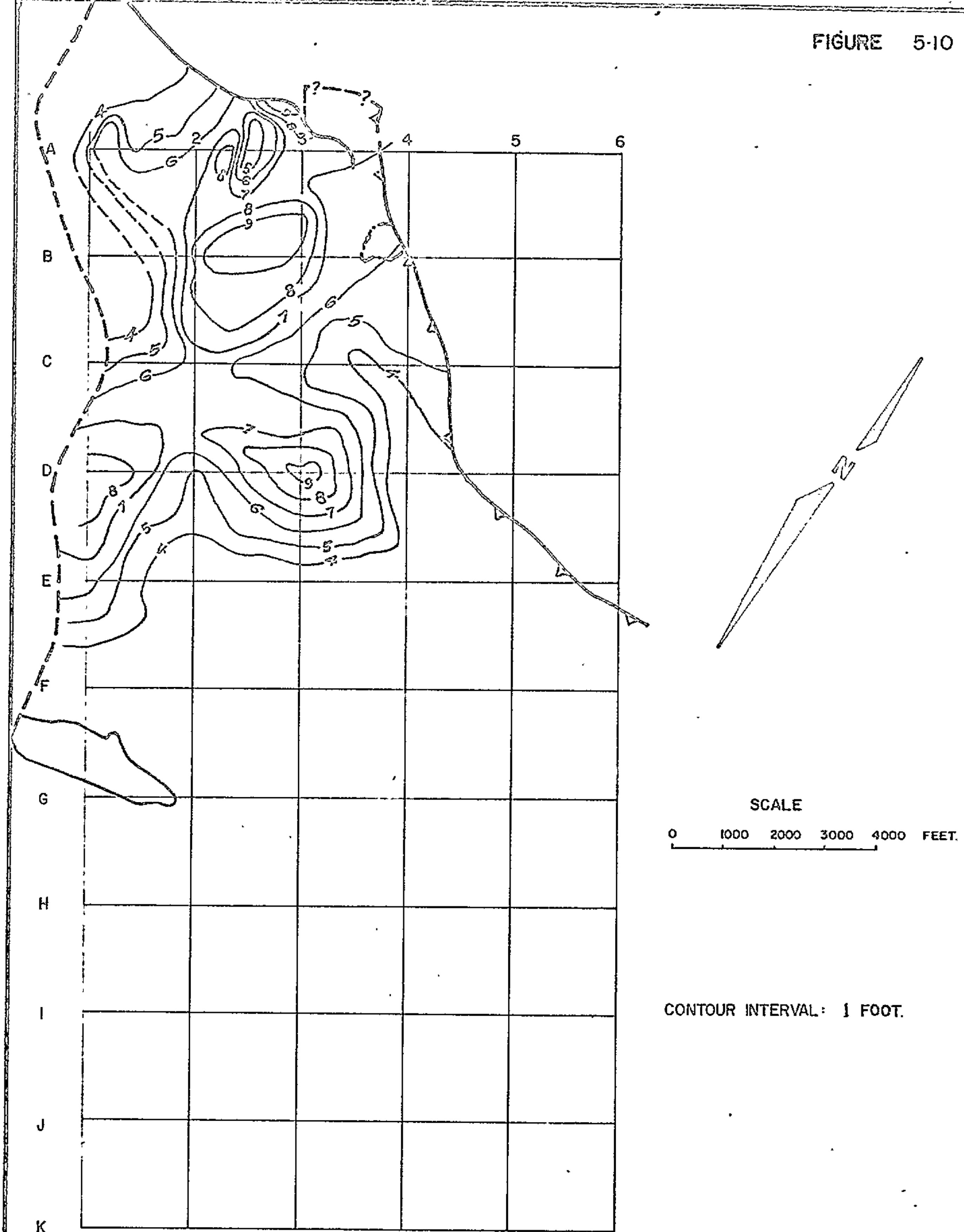
For the reserves in the southern section to be extracted, it would be necessary to drive headings in a seam height of approximately 4 feet over a distance of some 1,500 feet.

The reserves in the two areas are included in Table 5.2. The northern part of Plate 2c contains 1.09 million long tons gross and the southern part, 0.54 million long tons gross. From the two areas, 0.53 and 0.27 million long tons of washed product may be obtained respectively, using figures of 70% for mining extraction and washing recovery.

5.8 REMAINDER OF PLATE 2

No new data accrued from the recent exploration programme and consequently, the data set out below has been summarized from the 1971 Report.

FIGURE 5-10



SKETCH ISOPACH MAP

SKEETER SEAM
THEORETICAL WORKING SECTION
PLATE 2

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See also Map 16A for details of contours at scale 1" = 1000'

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The Chamberlain Seam is in excess of 8 feet for the whole of the area reaching a maximum of 12 feet to the south-east of the grid area. The reserves for the Chamberlain Seam total 33.35 million long tons,gross, of which 18.76 million long tons of washed product are considered to be available, using an extraction figure of 70% and a recovery figure of 80%.

The Skeeter Seam in this section of the project area is not economic and is, consequently, not considered further.

5.9 PLATE 3

Part of the 1972 exploration programme was directed towards verifying the generally good structural disposition of Plate 3, and of up-grading the reserves from Indicated to Measured. The structure of the area is fully discussed in Section 4.3.3.

The data which has accrued from the 7 drill holes which penetrated the seams in Plate 3 have fully confirmed the earlier predictions both from a point of structure and reserves.

Map 9A is an isopach map of the Chamberlain Seam in this plate and is reproduced as Figure 5.7. The thickness varies from 3.62 feet in D.D.H. S-6 in the centre of the plate, to 14.35 feet in D.D.H. C-48 on the eastern edge of the plate. In the north-western part of this plate, the seam thickness is less than 5 feet as indicated on Map 9A. Within this specific area, the following seam thicknesses are recorded -

D.D.H. C-39	-	3.19 feet
D.D.H. C-52	-	4.41 feet
D.D.H. C-46	-	4.50 feet

However, by far the greater part of the plate contains an economic seam thickness of between 7 and 10 feet.

The area enclosed by the 5 feet isopach and the small area around D.D.H. S-6, have been excluded from the reserve calculations.

The reserves in this plate have been upgraded from the Indicated category to Measured and have been increased from 6.51 to 6.95 million long tons,gross, with a consequent increase of 0.24 million long tons of washed product to 3.89 million long tons. Table 5.2 details these figures.

The variation of the theoretical working section of the Skeeter Seam in this plate is shown on Map 15A. The seam is considered to be extractable only in the north-eastern half of the plate.

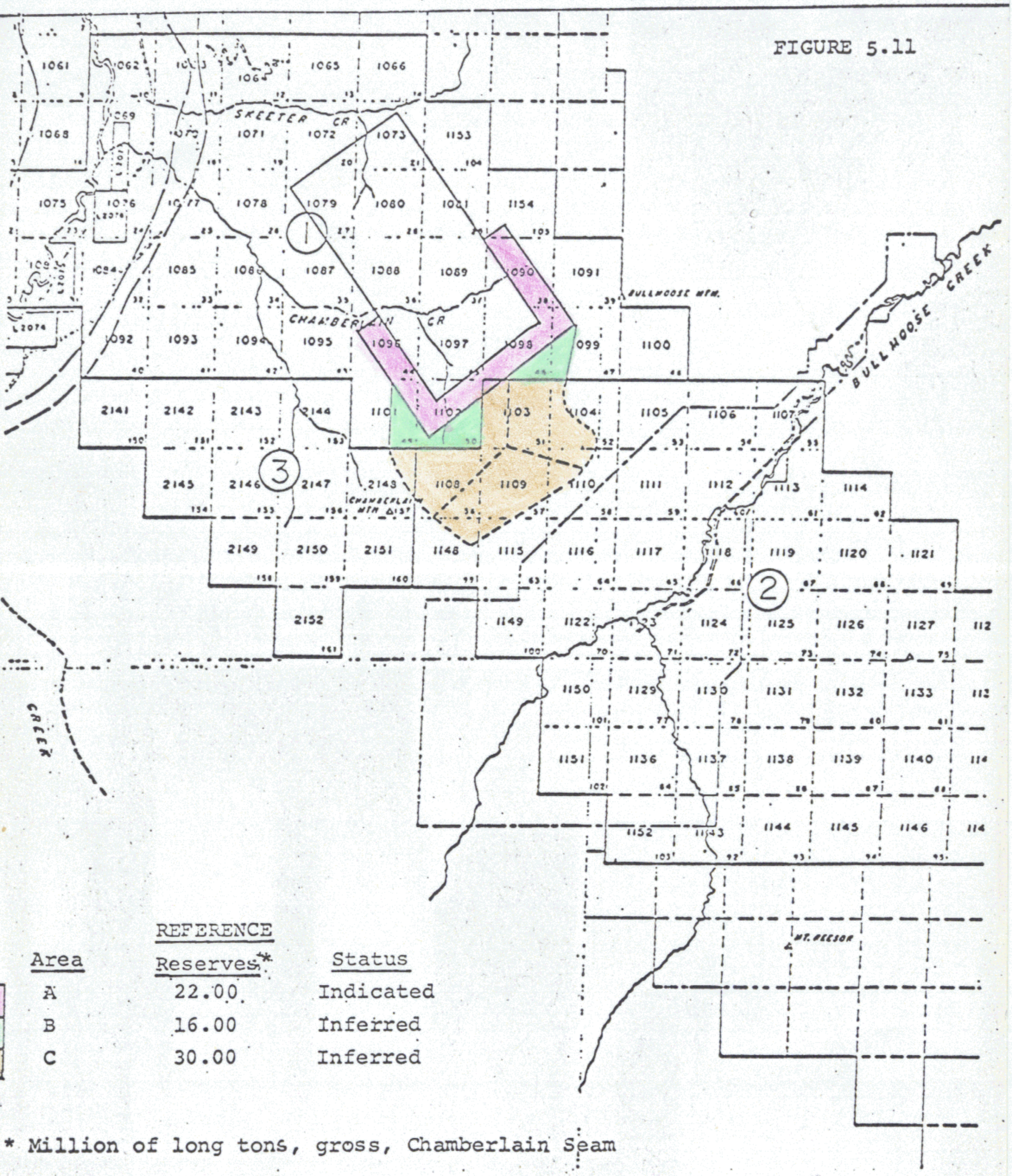
Within this area the working section reaches a maximum 8.7 feet in D.D.H. C-47, reducing the minimum working thickness to the south. The majority of the area of extractable coal in this plate will have a working thickness in excess of 6 feet.

The reserve figure of 2.84 million long tons gross (increased from 2.49 Indicated Reserves in the 1972 Report) is now classed as Measured. There are 1.39 million long tons of washed product available, using a 70% figure for extraction and recovery.

5.10 THE AREA EXTERNAL TO THE GRID AREA

Text Figure 5.11 shows three areas which may be considered external to the currently explored area. Within these areas, only the Chamberlain Seam is of economic thickness.

FIGURE 5.11



Area	REFERENCE Reserves*	Status
A	22.00	Indicated
B	16.00	Inferred
C	30.00	Inferred

* Million of long tons, gross, Chamberlain Seam

RESERVE CATEGORIES
External to Current Grid Area

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Area A is that area previously defined in Table 5.5 of the 1972 Report as that "zone externally marginal to the exploration grid area, ... for a zone conservatively restricted to a strip 2,000 feet wide around the eastern, southern and western perimeter of the exploration grid and south of grid line G". Within this area, 22 million long tons of Indicated Gross Reserves are considered to exist.

External to Area A, above and south to the boundary of the current 41 licence exploration area, a further 16 million long tons of Inferred Gross Reserves exist, shown as Area B on Figure 5.11.

Area C is that area within the Teck Corporation area and immediately adjacent to the southern boundary of the Coalition property. Inferred Gross Reserves of 30 million long tons are considered to exist within the area based on the limited information available to this company. Since further work has been completed in the 1972 field season, an upgrading and an increase of this reserve figure may be possible but no information is available at present.

SECTION 6

MINING CONDITIONS

6.1 REVIEW

This section of the report should be read in conjunction with Section 6 of the 1972 Report and with Section 4.3, Structural Geology of both that report and the present report.

In Section 6 of the 1972 Report, the geological structure, as it relates to geological details, was discussed in detail, the gross structure and the styles of faulting identified, along with predictions which were made regarding the roof and floor conditions which it was anticipated would be encountered in an underground operation at Sukunka. The depth of cover, interseam thickness, stress conditions and ground water were also discussed.

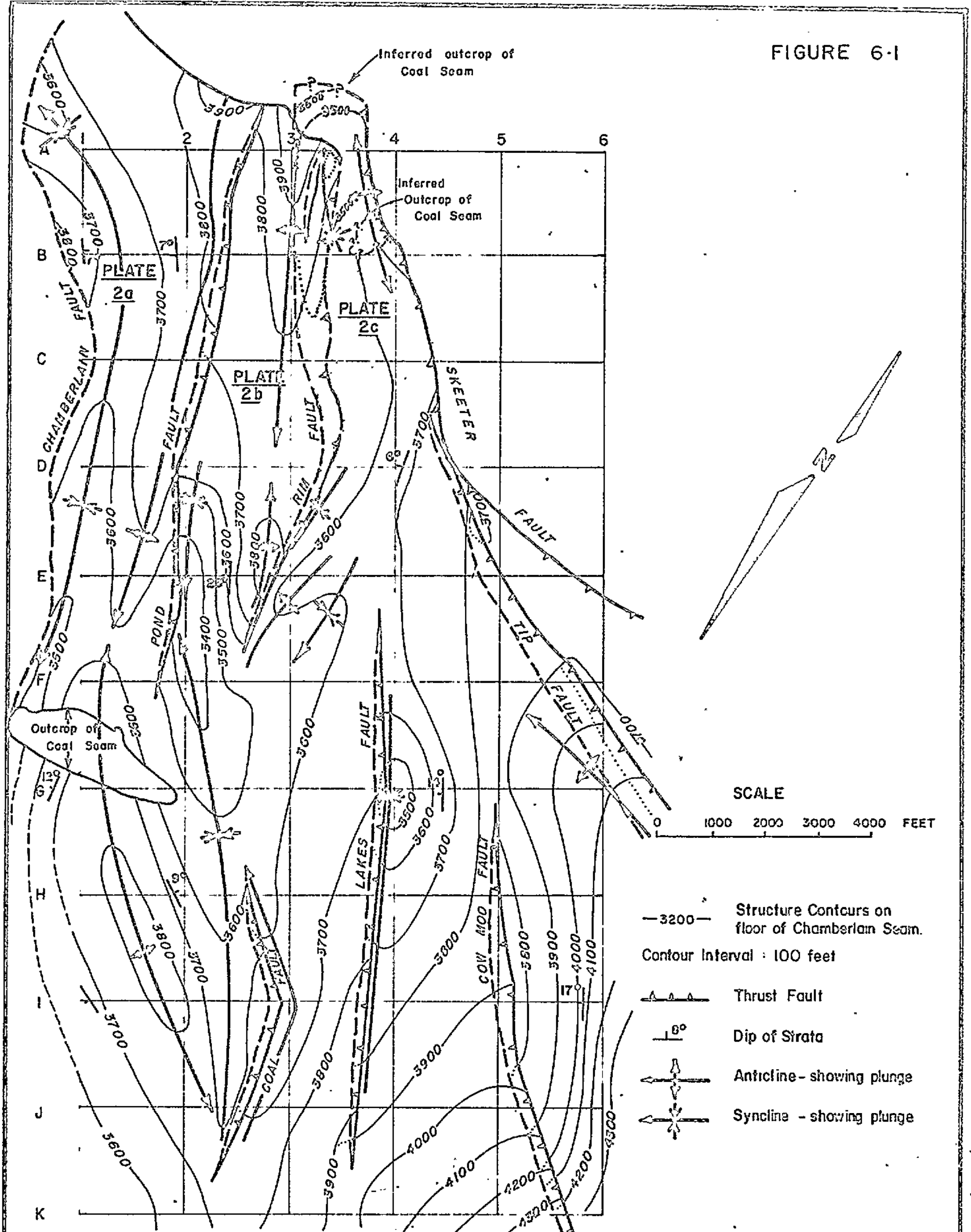
In the present report, the discussion is centred primarily on the new data which has come to hand as a result of the 1972 geological programme. This data relates specifically to Plates 2c and 3 and to the information which has accrued from underground mapping in Mine No. 1 (Plate 2a).

The following brief summary is included to provide a framework for this section.

The project area is divided into 3 gross features which have been termed "Plates" (Plates 1, 2 and 3) the boundary of these plates being defined by major over-thrust faults.

The northern part of the largest of the 3 plates, Plate 2, is divided into 3 sub-plates, Plates 2a, 2b and 2c, by two intra-plate faults. The southern limit of these plates has been set

FIGURE 6-1



PR-SUKUNKA 72(1)B.

SKETCH MAP

REGIONAL STRUCTURAL FEATURES
PLATE 2

AT CHAMBERLAIN SEAM LEVEL

SEE MAP 7A FOR DETAILED STRUCTURE CONTOURS

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at about grid line F. (See Figure 6.1).

The broad concept of mining as far as is known at present, is to regard Plates 1, 2a, 2b and 3 as separate mining areas being bounded by the relevant structural features. It is proposed to use Plate 2c as an entry to the southern part of Plate 2, that is, to the south of grid line F. This mine will be the one through which approximately half of the coal reserves will be extracted.

6.2 GROSS STRUCTURE

As in other sections of the report, the relevant aspects in relation to mining conditions are here brought together under sections dealing with a specific mine.

6.2.1 PLATE 1

The upthrown block of the Chamberlain Fault constitutes Plate 1. Hence the boundaries of this plate are the Chamberlain Fault trace to the north-east and the Chamberlain Seam outcrop to the south-west. Although the Chamberlain Seam can be mined from the whole of Plate 1, the Chamberlain Seam does not extend south of grid line D.

A report submitted to Coalition Mining Limited on 23rd February, 1973 entitled "Structural Geology of Plate 1, Sukunka Coal Project", Report Number 1/4/9, outlined the present status of knowledge relating to the gross structure, roof and floor conditions as well as the physical characteristics of the Chamberlain Seam in this plate.

For completeness, the conclusions of that report are quoted hereunder.

"Since the conclusions here are based largely on data originating from Brameda's 1971 exploration programme, they must be regarded, at least in part, as tentative; further field work including drilling is required before final conclusions can be drawn. The data is generally linearly oriented with only limited amounts of information available in a 3-dimensional sense. Additionally, outcrop exposures are minimal. Consequently, a degree of generalisation has been necessary.

6.1 The possible occurrence of cross-trending structures cannot be ruled out at this stage.

6.2 Inspection of drill logs in Plate 1 suggests and field evidence indicates strongly, that deformation of the roof and overlying strata tends to be greater in Plate 1 than in the overlapped area of the Plate 2 rocks immediately below. It appears characteristic of the style of deformation, for the upper plate adjacent to any one fault to tend to be more highly deformed than the underlying plate.

6.3 The evidence currently to hand indicates that the Chamberlain Seam is disturbed by shearing to an amount at least equal to the shearing experienced in Mine No. 1.

6.4 The data available suggest that dips in Plate 1 will lie between 8^{o} and 13^{o}. It is anticipated that the average dip will be 3^{o} to 4^{o} greater than that in Mine No. 1."

6.2.2 PLATES 2a and 2b

The Chamberlain Fault trace to the west and the Pond Fault trace to the east define the limits of Plate 2a; the Pond Fault trace and the Rim Fault trace further to the east define the limits for Plate 2b. The southern extent of these two plates is defined by grid line F in the vicinity of Chamberlain Creek and as shown on Map 7A and Figure 6.1.

A trial mining programme was undertaken in 1972 in Plate 2a resulting in the establishment of Mine No. 1. Underground mapping in that mine provided considerable structural data as outlined in Sections 4.3.5 and 4.3.6 above and further referred to below.

The plates consist of a series of anticlines and synclines plunging generally from the north to south. Within the confines of the respective plates, the configuration is such that the dips on the floor are suitable for continuous mining operations in both of these plates except for an area in the south of Plate 2b between grid lines D and E. This particular area has been discussed in Section 6.1.2 in the 1972 Report.

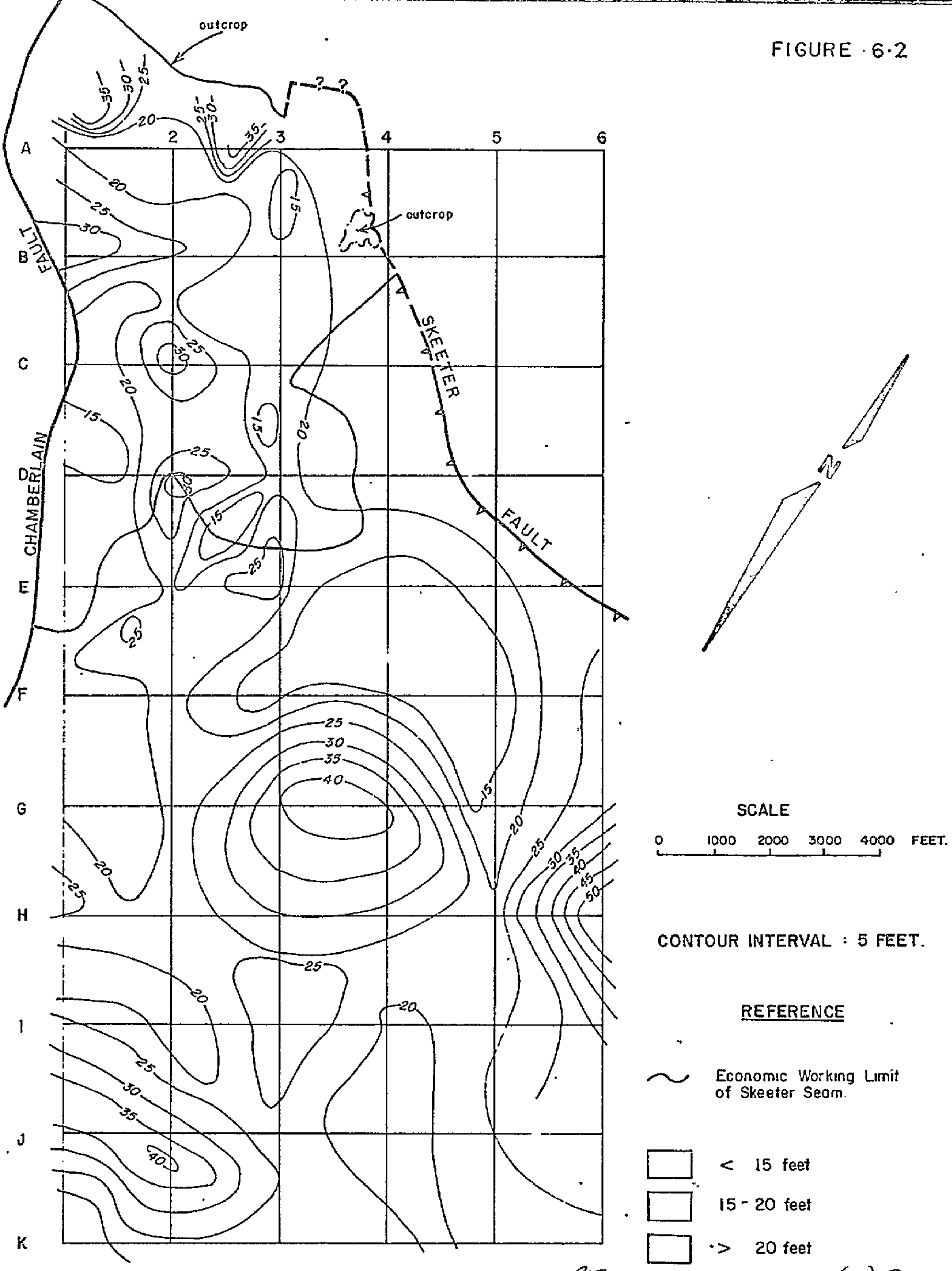
6.2.3 PLATE 2c

The structural configuration of Plate 2c has been further elucidated by the 1972 exploration programme, the data of which has been discussed in Section 4.3.2 of this report.

The boundaries of the plate, the Rim and Skeeter Faults, to the west and east respectively, have been established more precisely than at the end of the 1971 programme, as has also the internal structure within the plate, specifically a "splinter fault" to the Rim Fault and an extension of the Tip Fault. The minor adjustments made to the structure contour are shown in Map 7A and Figure 6.1.

A minor thrust fault has been identified adjacent to the Rim Fault and occurring in Plate 2c under the overlapping section of Plate 2b. The fault has a drill hole throw of 20 feet in D.D.H. C-6 and 40 feet in D.D.H. C-50. There is no evidence of this fault extending south of grid line B.

FIGURE 6·2



PR-SUKUNKA 72(1)B.

SKETCH ISOPACH MAP

INTERSEAM SEDIMENTS

BETWEEN

CHAMBERLAIN & SKEETER SEAMS

PLATE 2

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See also Map 21 for details of contours at scale 1" = 1000' (1972 REPORT)

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In view of the proposed mining plan, that is, to use Plate 2c as the major entry to the south of Plate 2, Plate 2c assumes a major role. Before development of a mine is commenced in this plate, further geological exploration is necessary to clarify a number of outcrop features of the plate.

The outcrop of the coal seam in the northern end of the plate is of an inferred status only and will require exposure, at least in part, by stripping if an entry is to be made at that location. An alternate proposal would be to use a drift starting at a point south of the outcrop. In this case, however, information regarding the depth of overburden would still be required.

Map 7A shows a small inlier of sediments adjacent to the Skeeter fault near grid line B, where the Chamberlain and Skeeter Seams are inferred to crop out.

The distance of approximately 800 feet between this inferred outcrop and the minor fault referred to above places a constraint on the number of main roadways which may be driven through this section of the plate to the south. In order to increase the number of headings to gain access to the southern end of the property, a proposal to create entries (for example, return airways) at the inferred outcrop has been put forward.

Before this proposal can be fully evaluated, further definition is required of this inferred outcrop area by shallow drilling and trenching. Recommendations are put forward for this in Section 7 of this report.

As the northern outcrop of the plate is ill-defined, and the depth of overburden unknown, shallow drilling and trenching is also necessary to provide data on these two points.

Apart from the constraint discussed above, the general configuration of Plate 2c is suitable for continuous mining operation. The dip of the strata is generally less than 5^{o} with a cross dip to the west at approximately 6^{o}.

That part of the property to the south of grid line F has been fully detailed in Section 4.3.4(i) of the 1972 Report. The three internal faults in this part of Plate 2, the Coal Fault, Lake Fault and Cow Moo Fault, will act as barriers in respect to the mine layout.

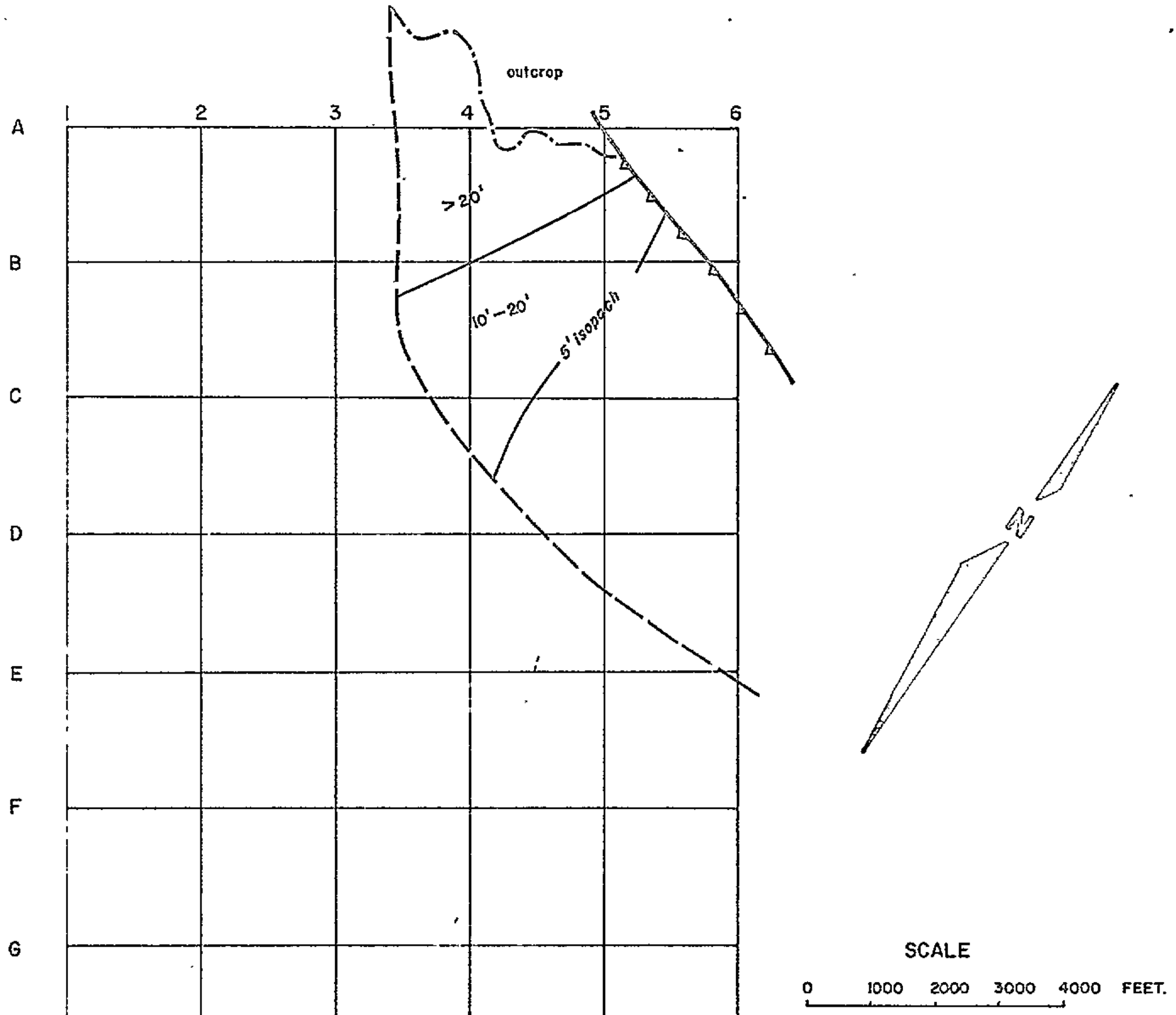
Attention is drawn to the alternative interpretation of the location of the northern end of the Cow Moo Fault, as shown on Map 8 of the 1972 Report. Recommendations are again put forward in this report for a drill hole to clarify the situation. It will be seen from that map that should the Cow Moo Fault trend to the west and intersect the Lake Fault in the vicinity of grid line F, a cross-measure drift would be required to enter the area of coal reserves between these two faults.

6.2.4 PLATE 3

As stated in Section 4.3.5 in the 1972 Report, the drill hole data from the 1971 programme provided limited data on the intra-plate structure of this plate, which is bounded to the south-west by the Skeeter Fault and to the north-west by the Bullmoose Fault Complex.

The eastern margin of this plate remains unchanged by the 1972 drilling. However, the western margin, the Skeeter Fault, has been more accurately defined, as shown on Map 6A. A small fault with drill hole throws of approximately 70 feet is shown to exist in the south-western part of the plate.

FIGURE 6·3



SKETCH ISOPACH MAP

INTERSEAM SEDIMENTS

BETWEEN

CHAMBERLAIN & SKEETER SEAMS

PLATE 3

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The fold structures of the plate consist of a broad shallow easterly plunging syncline. The dip along the axis of this feature to grid point C/5 is flat, steepening to the east to 4^{o}. The northern limb of the syncline dips at an average of $11\frac{1}{2}^{o}$ and the southern limb at its steepest point is 16^{o}. For half of the area of this limb, however, the dip is essentially flat.

In the recently completed programme, one cross trench was cut in overburden 29 feet thick over the Chamberlain Seam at the western end of the inferred outcrop. This trench, in conjunction with detailed mapping, has provided data to allow reasonable definition of the outcrop of the Chamberlain Seam, where it has not been exposed by stripping. Much of the outcrop of this plate at the northern end was exposed in 1971.

6.3 FLOOR AND ROOF CONDITIONS

6.3.1 FLOOR CONDITIONS

It has been confirmed that similar rock types form the floor of the Skeeter and Chamberlain Seams in Plate 3 as elsewhere in the project area.

The Chamberlain Seam floor in Mine No. 1, the fine-grained, carbonaceous sandstone, has behaved in the manner predicted in the 1972 Report. Traction by mining equipment on this floor appears to have been satisfactory but is governed by the type of machine used. Experience of this aspect of the trial mining programme has accumulated but is outside the scope of this report.

The prediction that only major thrust faulting was expected to cause a dislocation of the Chamberlain Seam floor has virtually been confirmed though it will be borne in mind that only a very small section of the project area has been sampled to date.

One very minor dislocation of the floor to date in Mine No. 1 is described in Section 4.4.5(iii) and is illustrated in Figure 4.8. The fault has a throw of 0.8 feet but the lateral movement could not be determined. No dislocation of the roof occurred nor could the fault be traced into the seam. In the roof, slickensided surfaces were noted which have a relationship to the fault and are fully described in the above mentioned section.

While no further data accrued in respect of the suitability of the Skeeter Seam floor, the degree of confidence in predictions related to the Chamberlain Seam floor has increased.

6.3.2 ROOF CONDITIONS

Additional data has been gained on the type of roof rocks which exist over the Chamberlain and Skeeter Seams, Plate 2c and 3. A detailed study was undertaken of the roof rocks of the two seams along the headings for Mine No. 1 for Plate 2a. The immediate roof strata in the drill holes was re-logged in detail and cross sections drawn of the variations in lithologies. This data is included in Appendix E to which reference should be made for more complete details. Detailed underground mapping has provided data relating to actual mining experience with the roof of the Chamberlain Seam. Map 31 illustrates not only the observed structural features but the varying roof conditions and is referred to below.

(i) Skeeter Seam Roof

Skeeter Seam roof is mudstone, carbonaceous in part, varying in thickness from 0.5 to 1.0 feet; it parts readily along bedding planes. It is overlain by well-cemented sandstone generally in excess of 20 feet. As is illustrated in Section E-2, Appendix E, a number of mudstone or siltstone lenses occur within this sandstone. While it is probable that, for this seam, the mudstone immediately over the floor of the seam will have to be taken during mining, the overlying sandstone should provide a most satisfactory roof. Where the lenses occur within the sandstone, however, problems may occur; this remains to be confirmed by actual mining experience.

(ii) Chamberlain Seam Roof

The regional variations in the Chamberlain Seam roof headings in Mine No. 1 in Plate 2a are illustrated in Section E-1 of Appendix E. In addition to these drill hole observations, experience in Mine No. 1 has shown that structural features are the cause of poor roof conditions rather than the inherent rock type. This aspect is discussed in more detail below.

Map 31 diagrammatically illustrates the roof conditions as encountered in Mine No. 1. Included in this is data up to December 19, 1972. The empirical division of the roof condition into 4 categories has been based on the detailed underground mapping and careful observations of structural features. The divisions are as follows -

CLASS	*MAP SYMBOL*	
Very Good	*(1)*	*The roof is planar, generally slickensided; joints widely spaced, usually in excess of 6 feet. Roof bolting on 4 feet centres, timber sets not normally required but sometimes used on a 6 feet centre.*

CLASS	*MAP SYMBOL*	
Good	*(2)*	*Roof may be planer but often contains minor unevening features, e.g., scallops; slickensides present; jointing close, usually 1.5 feet apart. Roof bolting and timber sets at 4 feet centres.*
Poor	*(3)*	*Used when less than 0.5 feet of the roof above the sheared coal and rock has fallen of its own accord. Joint spacing very close and irregular; slickensides and related numerous small thrust faults causing cuspate indentations.*
Fallen	*(F)*	*Collapse of roof over full width of roadway in excess of 0.5 feet.*

Categories (1), Very Good and (2), Good provide no roof problems. Category (3), Poor, has, in general, caused few production delays as the rock normally falls during the time the coal is being cut. Care needs to be taken during bolting operations under this category. Based on a linear measurement, 16.5% of the roof is classified as "poor".

As at December 19, 1972, 9.5% of the roof, based on linear measurement, had fallen. The 9.5% of "fallen" roof is accounted for in 6 falls, normally less than 5 feet, but in one case up to 10 feet above the seam. It is understood that one fall occurred before adequate bolting had been installed and another was aggravated by a machine mishap.

The roof falls to date have been associated with deformation affecting the roof rocks, rather than with rock types, though the laminite in the roof behaves differently from say, a massive sandstone under stress conditions.

Two structures which are responsible for the roof collapses have been described in detail in Section 4.3 and are, for convenience, defined again hereunder.

A "slip wedge" (Section 4.3.4(ii)(b)), is -

> "a wedge-shaped section of rock strata which has suffered lateral movement with respect to the underlying coal seam and it has been overlain by stratigraphically equivalent rock strata along fault planes coincident with the bedding."

The term "sigmoidal laminite" (Section 4.3.5(ii)), has been applied to -

> "slices of laminite dipping approximately 40^{o} to the bedding and striking perpendicular to the trend of the prominent slickensides direction etched in the roof".

While the sigmoidal laminite usually occurs as part of the slip wedge structure, it is not a necessary element of this latter feature. A number of slip wedges have been observed which do not contain the sigmoidal laminite; for example, the slip wedge in the coal seam exposure on the bench of Mine No. 1. Section 4.3.4 (ii)(b) refers.

Where such structures occur, the roof will have a low inherent strength and consequently require special attention in respect to support. In relation to the approximate 4,000 feet of underground roadway formed at the above date, the occurrences are limited though they have caused delays or stoppage in production. It is possible that such falls could be minimised during this trial mining phase by supporting the roof as soon as, and as close to, the working face as is practicable, until the full character of these features is more completely understood.

While it is anticipated that such falls will continue to occur, their frequency is not predictable with the limited amount of underground data collected to the present time. One can, however, predict that the presence of the "sigmoidal laminite" close to the seam can be expected to cause problems, since the planes of the "laminite" are oriented close to the optimum shear angle in relation to the maximum principal stress.

Further detailed work is essential if an attempt is made to fully understand these features and to develop a mine layout which will minimize the effect. Such a layout may well involve variation of the angle at which the cut-throughs intersect the headings.

During observations made in January 1973, it was noted that "fretting" of the laminite roof has occurred. Close to the outcrop and apparently as a consequence of the introduction of heated ventilation air to the mine, a rapid dehydration of the roof strata has resulted in "fretting" of the roof laminite up to a few inches. It is not possible at present to indicate whether this will continue stratigraphically or areally. It is probable that adjacent to the outcrop at the coal seam/strata interface, the moisture content of the laminite is abnormally high and the dehydration effect is atypical of conditions generally. Further observations are required however, to confirm this statement.

6.4 STRESS CONDITIONS

In discussing stress conditions reference should be made to Section 4.3.6(v) where the conclusions to the Analysis of Subsurface Structures are set out.

The prediction of stress conditions in a structurally deformed environment is very difficult; it is further compounded by the complicated structures at Sukunka. The stress field which may be deduced from observations made today may not be still in existence, but rather it may be relevant to the time of deformation. For example, the primary set of slickensides (214°) is inferred to represent the maximum principal stress, at the time of deformation; insufficient data is available at the present to indicate whether this stress is operative now. From the work to date, it appears that a residual stress, probably horizontal, may still be active at all depths. However, as the depth of cover increases, say over 1,000 feet, the overburden stress will become more significant.

In addition, residual stress conditions may perhaps be expected where more severe deformation has taken place in the strata, for example, the crests of anticlines, troughs of synclines and possibly on the extension of faults where little dislocation of the strata has taken place, but this strata has experienced a stress.

The total aspect of predicting the stress field which may be active today requires further detailed analyses including a rock mechanics study; recommendations are provided in Section 7 below.

6.5 PREDICTION OF STRUCTURAL FEATURES

The prediction of structural features may be divided into two fields, long range, i.e. over thousands of yards, and short range. In order for predictions to be made further data is required for analysis. This analysis must be related to structurally uniform domains, e.g. flat zones, steeply dipping zones and fault zones.

Given adequate sampling of data in each domain, long range predictions should be possible within uniform domains.

In a similar manner, short range prediction should be possible from data collected within the mine, provided that workings do not cross domain boundaries. Both the above objectives have yet to be achieved.

6.5.1 INDICATIONS OF POSSIBLE WEAK ROOF CONDITIONS

It is still too early in the collection and analysis of underground structures to allow predictions to be made on the basis of a theoretical stress system. However, a number of empirical observations have allowed the identification of a number of features which may be used as a guide to a possible deterioration of the roof ahead of the working face. It must be stressed that the following features require confirmation.

(i) Two "indicators" appear to be related to the sigmoidal laminite occurrences -

> (a) small scale folding of roof strata; and
>
> (b) calcite filled joints.

Both these features, when observed, should be regarded as a possible indicator of the presence of roof deformation above the seam.

(ii) A change in floor dip, from that existing prior to the point of change, could indicate the presence of a bedding plane fault cutting the roof strata. A change in roof conditions should be anticipated in this area.

(iii) The presence of an irregular or scalloped and polished surface is also an indicator of a possible deterioration in roof conditions.

6.6 GROUND WATER

Observations underground have indicated that while the mine is not abnormally wet, water from the roof rocks is significant. The Chamberlain Seam is itself dry, but the rocks within 5 feet of the roof contain water, primarily in the bedding planes and in structurally disturbed zones. Roof bolt holes generally provide a small flow of water until further holes are drilled inbye of them. It appears, due to the mine workings progressing down dip, that the ground water is being progressively drained out of the roof rocks as driving proceeds. This condition may be expected to continue for some distance due to the relative proximity to the outcrop and shallow depth of cover.

6.7 GASSINESS

The results of analyses on gas samples from nine coal cores. are included as Appendix D in this report. Carbon dioxide is less than 5% of the seam gas except in D.D.H. C-43 (1,920 feet) where it comprises 15.35% of the seam gas. The other more abundant constituents, nitrogen and methane, are present in the ratio of from 1:2.7 to 1:1 for the Chamberlain Seam and in the ratio 2:1 for the one Skeeter Seam sample.

The coal from which the samples were collected varies on the classification used by Dr. A.J. Hargraves from moderately gassy to highly gassy. Both the degree of gassiness and the composition of the seam gas show a random distribution when compared with depth of cover and distance from outcrop. Where the Skeeter Seam is worked out above and ahead of the Chamberlain Seam, the latter seam will be substantially degassed into the goaf of the Skeeter Seam.

SECTION 7

RECOMMENDATIONS FOR FURTHER FIELD INVESTIGATIONS

7.1 INTRODUCTION

As in previous sections of this report, much of the recommendations are collated under headings relating to each plate and these are given in Section 7.6.

Preceding that section are recommendations for more wide ranging aspects; geological mapping, rock mechanics studies and gas analyses.

Sections 7.7 and 7.8 deal with the long range recommendations which are considered applicable to Coalition Mining Limited.

7.2 GEOLOGICAL MAPPING

7.2.1 SURFACE MAPPING

(i) Surface mapping of all new outcrops as they are exposed is essential in order that all data which becomes available is recorded before being obscured by soil or rock slides or other processes.

(ii) Rickard (Appendix B-1) recommended that "The detailed structural analysis should be extended to cover all significant surface outcrops. Joint patterns underground should be evaluated. The patterns of structurally homogeneous domains of large extent could then be predicted and used to guide further studies in mining operations."

7.2.2 UNDERGROUND MAPPING

(i) A constant geological evaluation of new data from development mining as it becomes available is absolutely necessary in order that the application of criteria assessed to date continues to be refined. This involves geological mapping of all underground exposures. In some instances remapping of specific areas will be required after a period of time has elapsed to assess attributes brought to view by normal rib or roof flaking, fretting due to the drying out process and the like. This must be done before stone-dusting is carried out.

(ii) Because of their importance in regard to roof conditions the distribution pattern and structural geometry of the "slip wedges" and "sigmoidal laminites" must be determined.

(iii) Joint studies underground and those on the surface, must be carried out. The following specific aspects require evaluation -

(a) Separate domains, on a small scale must be mapped to enable local variations in trends to be studied.

(b) Joint groups should be examined to determine whether a group has particular distinguishing characteristics with respect to such features as continuity, spacing, fracture filling and surface features.

(c) Widely varying readings should be investigated for errors of plotting or subjective bias.

(d) Other expected sets of joints should be investigated.

7.3 ROCK MECHANICS

Rickard (Appendix B-1) has made the following recommendation -

"In view of the following unusual situations -

(a) the short stratigraphic interval separating the Chamberlain and Skeeter Seams;

(b) the relative weakness of the interseam strata due to the laminites and slip wedges, and

(c) the flat thrust situation,

it would be advisable to initiate a rock mechanics study at an early date. In situ measurements of stress in the different structural situations, combined with the structural analysis, should enable accurate predictions as to the state of stress and likelihood of roof failure. Such a study could well provide data which would be a major deciding factor in the overall mining feasibility."

7.4 COAL QUALITY

(i) The normal regular sampling checking of coal quality by sampling the R.O.M. coal should, wherever possible, be tied to a precise location for the more accurate assessment of quality trends.

(ii) Channel samples must be taken underground as near as possible to drill hole intersections. The analysis of these will allow an accurate comparison of the drill core analyses, as has been done for D.D.H. CM-1.

7.5 GASSINESS

Appendix D lists the analyses of the gas samples collected in the recent programme. As this field is outside the domain of the geologist it is recommended that a consultant be appointed locally to advise on the gassiness of the mine, but maintaining liaison with the geological staff.

7.6 RECOMMENDATIONS RELATING TO EACH PLATE

7.6.1 PLATE 1

The geological knowledge pertaining to Plate 1 was outlined in Report No. 1/4/9 submitted to Coalition Mining Limited on 23rd February, 1973. White it is understood that preparation of a bench for establishing this mine has been commenced, the recommendations in that report still apply and are reproduced here in full.

(i) Before final planning of the layout for Mine No.4 is undertaken in any detail, it is necessary that further exploration be undertaken. The broad requirements are outlined below.

(ii) Exposure of the coal seam outcrop on the western margin is important in order that an assessment of cross-trending structures may be made. This work can and must be planned such as to cause a minimum disturbance to the environment by exposing selected sections of the outcrop in the first instance, rather than the total length. Additionally, the northern margin of the plate would be stripped before the southern margin; sufficient data may become available to satisfy the objectives of the programme by this approach.

(iii) A series of diamond drill holes should be sited so as to provide further 3-dimensional checks on the structure.

(iv) The drill holes referred to in (iii) above, should be accompanied by a series of diamond drill holes along the proposed mine headings direction.

(v) Regarding the proposed entry for Mine No. 4, Figure 1, herein, shows the most probable location. This location will allow the main headings to be located on the axes of the anticline and syncline referred to earlier. Exposure of the seam at the site of the proposed entry is recommended.

(vi) Detailed geological logging of all exposures is necessary, as is a re-examination of the existing bore cores.

(vii) If further consideration is to be given to strip mining of the northern part of Plate 1, further assessment will be required and can be detailed in a separate report.

Regarding recommendations (iii) and (iv) above, an estimated 2,000 feet of diamond drilling in 6 holes would be required.

7.6.2 PLATE 2a

Mine No. 1 is currently operating in this plate. The regional structure is currently being confirmed by this mine and the effect of the major thrust faults will be evaluated as mining progresses.

Paragraphs (ii) and (iii) in 7.2.2 above, are of the utmost importance. Out of such a programme of data collection and evaluation will be established the necessary criteria on which mine planning can proceed.

7.6.3 PLATE 2b

(i) It is not anticipated that the mine planning for this plate will present any serious problem. The continuing evaluation of underground data in Mine No. 1 will materially assist in predicting the likely conditions to be encountered in this, as in other mines.

(ii) The regional aspects are well defined except for one area, see (iii) below. However, a series of mine heading diamond drill holes may be required, dependent on the later analysis of the success of prediction of the structural configuration in this plate.

(iii) The area between the Pond and Rim Faults between grid lines D and F are recommended as an area requiring further drilling. That recommendation is reproduced below -

> Present indications are that the extraction of coal from this area will not be economically possible, due to dips of up to 25° on the Chamberlain Seam floor. It is suggested, however, that drilling in this area may not be entirely successful as it is probable that a high angle normal fault may well explain the steep dips.

A structural analysis by computer carried out by Dr. A.C. Cook (Appendix B-2) has confirmed the presence of the structural discontinuity in this area. In his report, he tentatively suggests that drill hole targets be sited on the anomalies located by the computer analysis.

7.6.4 PLATE 2c

(i) Percussion or open-hole drilling is necessary to economically define the outcrop of the two seams at the northern outcrop of Plate 2c.

(ii) Dependent on the depth of overburden, outcrop stripping may be required in this area.

(iii) In the unexpected event that the overburden proves to be too great for economic removal to allow the establishment of a mine bench, a drift would possibly provide suitable access. Under these circumstances detailed shallow diamond drilling would be essential.

(iv) It is essential that the outcrops of the inlier adjacent to the Skeeter Fault in this plate be accurately defined if entries are to be made in this area. This would be most economically carried out by shallow open-hole drilling in the first instance, followed by outcrop stripping by bulldozer.

(v) If the mine in Plate 2c is used as the entry to the southern part of the property, a series of mine heading diamond drill holes is essential in view of the restricted distance for main roadways at grid line B.

(vi) Map 8 of the 1972 Report shows an alternate interpretation for the trend of the Cow Moo Fault between grid lines H and I. One drill hole is recommended to clarify the problem.

7.6.5 PLATE 3

Dependent on the mining plan, the northern outcrop of Plate 3 may require further definition by shallow drilling. Outcrop stripping of part of the plate would be a logical prerequisite to the establishment of a mine bench.

7.7 ADDITIONAL RESERVES OF COAL

Drilling along and just outside the exploration grid indicates that the Chamberlain Seam, in Plate 2, is continuous to the south-east towards the area held under option by Teck Corporation Ltd. Stratigraphic studies have shown that while the Chamberlain Seam is split by a rock band to the south-east, the Lower Split constitutes a working section of coal that is of essentially uniform quality.

There are indicated gross reserves of 22 million long tons of coal in the Chamberlain Seam in an area marginal to the exploration grid shown on Figure 5.11 in Section 5 of this report. An extended drilling programme is recommended to more accurately establish the resources of coal and to more fully ascertain the structure at the level of the Chamberlain Seam.

A further 16 million long tons of coal are inferred to exist within the group of 41 coal licences held by Coalition Mining Limited, in the area shown on Figure 5.11. The results of the extended drilling programme recommended above should be assessed before drilling is extended to the boundary of the coal licence area.

Preliminary unpublished results available from Teck Corporation Limited indicate that about 30 million long tons of coal are inferred to exist in the Chamberlain Seam in an area immediately adjacent to the Sukunka Project Area. It is understood that lateral changes further to the south-east result in the development of numerous splits of the Chamberlain Seam.

7.8 REGIONAL APPRAISALS

Recommendation 7.3.1 in the 1972 Report emphasised the desirability of undertaking at least a reconnaissance geological mapping programme of additional coal bearing areas in the Peach River District. In September 1972, our report entitled "Provisional Exploration Programme - Brameda Option Areas" recommended that exploration of the Burnt River and Gething Creek Groups of coal licences be undertaken to establish the nature and quality of the coal seams and to establish the structural setting of these areas.

Information made available to Coalition Mining Limited on an area on the Peace River held by Cinnabar Peak Mines Ltd., suggests the presence of two seams of coal that are of similar quality to Sukunka coal, though not all of the area appears suitable for underground mining methods. Should the opportunity exist, it is recommended that evaluation of that area be undertaken.

To properly assess the potential resources of coking coal in the Foothills Belt of British Columbia an extensive regional geological reconnaissance mapping programme should be undertaken after completion of a search of available literature and with the aid of a photogeological study. Such a comprehensive survey would take several years to complete.