STRUCTURAL MODELLING OF PARTS OF THE NORTHERN DOMINION COAL BLOCK (PARCEL 73), SOUTHEASTERN BRITISH COLUMBIA (82G/10)

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INTRODUCTION

The Dominion Coal Block consists of two parcels of land owned by the Federal Government in the Crowsnest Coalfield, or Fernie Basin, of southeastern British Columbia. Although these 20 235 hectares were not conveyed to the Federal Government until 1905, their acquisition was guaranteed in the Crows Nest Pass Act of 1897 (Ollerenshaw, 1981). Thus their creation was intimately related to the original development of the Crowsnest Pass area and its abundant coal deposits.

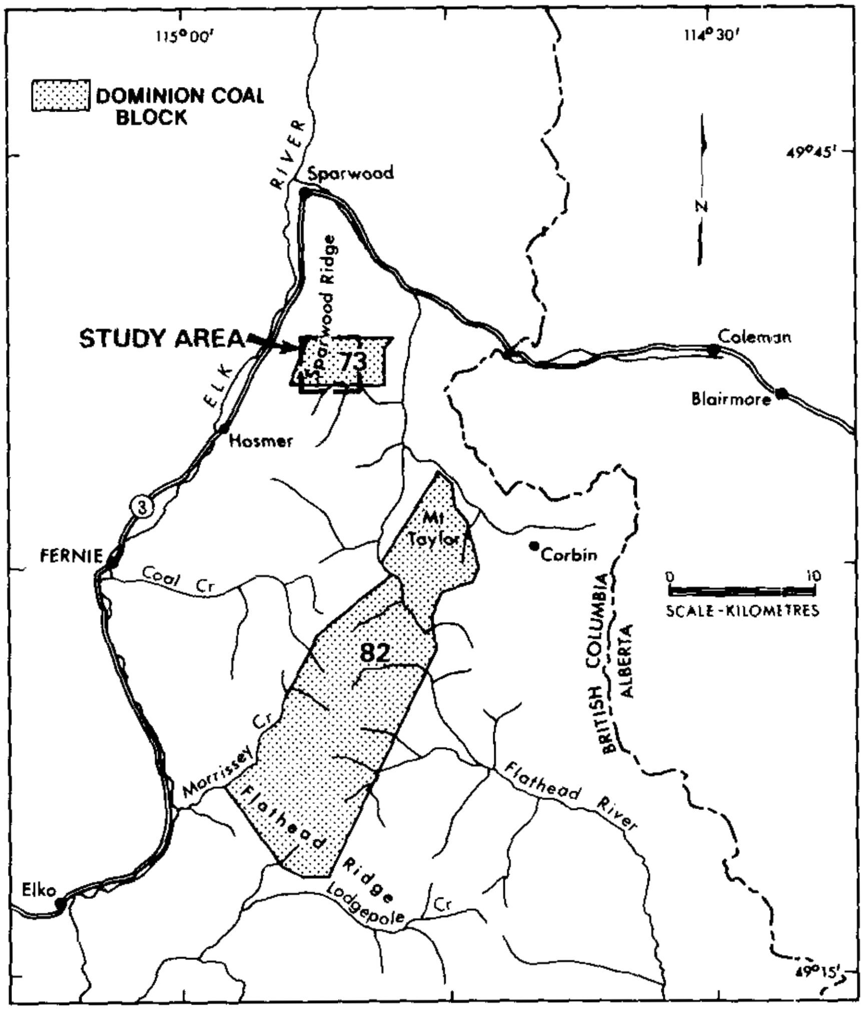

Figure 9. The Crowsnest Coalfield area, showing the locations of Parcels 73 and 82 of the Dominion Coal Block.

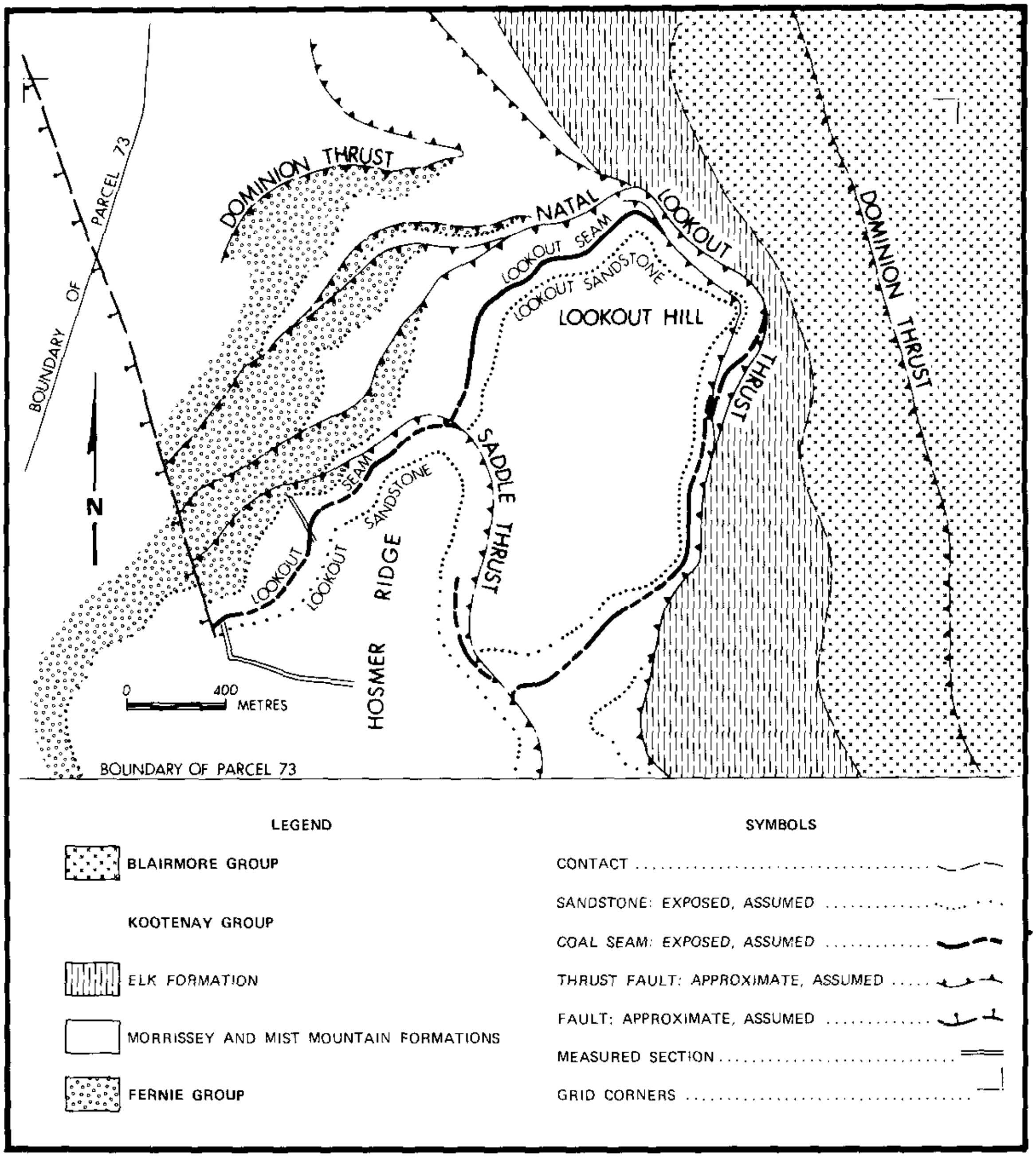

Figure 10. Generalized geology of the southwest portion of Parcel 73 (modified after Olleranshaw, et al., 1977).

Restrictions on development of coal resources within the block were contained in the Act. For example, any coal produced was to be sold for not more than $2.00 per short ton. The recent passing of the *Western Grain Transportation Act* (Bill C-155) removed this anachronistic condition, and thus removed a major obstacle to development of the block.

Parcel 73 is the more northerly of the two parcels (Fig. 9), and at 2 023.5 hectares is also the smaller. It lies at the south end of Sparwood Ridge and north end of Hosmer Ridge, 10 kilometres south of Sparwood. Elevations range from 1 380 to 2 280 metres; local relief is as extreme as anywhere in the Crowsnest Coalfield. It is surrounded by Freehold coal lands held by Westar Mining Ltd.

Provincial coal licences on Parcel 73 were held at one time by Kaiser Resources Ltd. (now Westar Mining); later these were revoked. Kaiser Resources carried out exploration between 1969 and 1971, including geological surveys, eight rotary drill holes, twelve adits, and two test pits.

A geological investigation involving both the British Columbia Ministry of Energy, Mines and Petroleum Resources and the Geological Survey of Canada was carried out in 1975 and 1976 (Ollerenshaw, 1977; Ollerenshaw, *et al.*, 1977). One product of this work was a 1:10 000-scale geological map plotted on an orthophoto base (Ollerenshaw, *et al.*, 1977). This map was used as the basis for computer modelling of portions of Parcel 73 as described in this report. A minor amount of fieldwork was carried out in 1984 to supplement results of the earlier investigation.

This study focuses on the portion of Parcel 73 which appears to have potential as an open-pit mine. This area is located on Lookout Hill, named for an abandoned Forestry lookout tower (Fig. 10).

STRATIGRAPHY

Economic coal seams of southeastern British Columbia are contained in the non-marine Mist Mountain Formation of the Jurassic-Cretaceous Kootenay Group. The Mist Mount Formation conformably overlies Morrissey Formation sandstone, and is overlain by clastic sedimentary rocks and thin coal seams of the Elk Formation.

Parcel 73 is underlain not only by all three formations of the Kootenay Group, but also by the underlying Fernie Group and overlying Blairmore Group (Fig. 10).

Approximately 490 metres of the Mist Mountain Formation are preserved on Hosmer Ridge (Fig. 10); the uppermost 100 metres were eroded. The thickness of Mist Mountain Formation rocks on Lookout Hill is less than 200 metres.

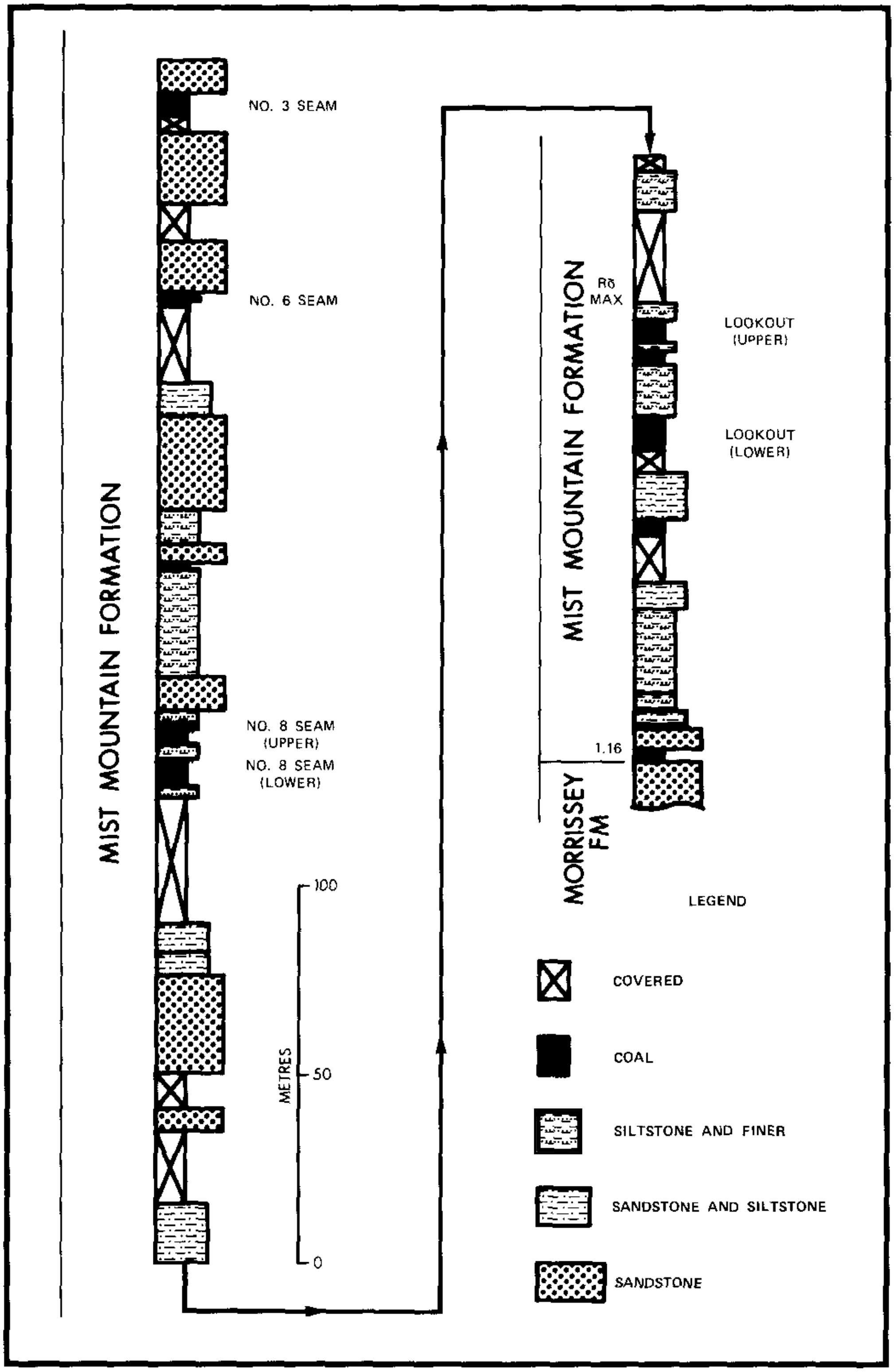

Figure 11. Measured stratigraphic section of Mist Mountain Formation on Hosmer Ridge (see Fig. 10 for location).

The section exposed on Hosmer Ridge contains in excess of 45 metres of coal in six zones. The most prominent coal zone, dubbed the 'Lookout seam' by Ollerenshaw (1977), lies near the base of the section. It constitutes the bulk of potentially economic coal resources throughout the study area, particularly on Lookout Hill (Fig. 10). At the position of the measured section it consists of 19 metres of coal in three distinct benches that are separated by interbedded coal and shale (Fig. 11); all occur within 35 metres of section.

A prominent sandstone, which overlies the Lookout seam by an average of 10 metres, was named the 'Lookout sandstone' by Ollerenshaw (1977). It forms a dip-slope cap on Lookout Hill, where it has protected the Lookout seam from erosion.

STRUCTURE

The study area lies on the western limb of the Fernie Basin, a complex synclinorium. This portion of the basin is affected by a series of imbricate, southwest-dipping thrust faults and splays (Fig. 10). The major faults are named, from top to bottom, the Saddle, Natal Lookout, and Dominion thrusts.

From an economic point of view the Natal Lookout thrust is the most significant. Its trace divides Parcel 73 into two distinct areas, and, in the hangingwall, coal seams of the Mist Mountain Formation lie in close proximity to the surface on Lookout Hill and Hosmer Ridge (Fig. 12).

Movement on the Saddle thrust was documented by Ollerenshaw, *et al.*, (1977); its displacement is minor and it has not been included in any of the analysis that follow. Coal seams line up very well across the Saddle thrust (Fig. 12). The structure of the strata above the Natal Lookout thrust is best described as monoclinal and with mean orientation of 182/13.5 (DIP-DIRECTION/DIP). Data from the whole area suggests a regional fold axis orientation of 165/12 (TREND/Plunge). Examination of the map data (Ollerenshaw, *et al.*, 1977) shows that the Natal Lookout and Saddle thrust have similar orientation, about 216/17 (DIP-DIRECTION/DIP).

COAL RANK DISTRIBUTION

Coal rank, expressed as $\bar{R}_o$ max or maximum vitrinite reflectance in oil, was determined on 15 samples. Values for samples corresponding to the basal part of the measured section are shown on Figure 11. They range from 1.16 per cent for the seam immediately overlying the Morrissey Formation, to 1.06 per cent for the upper bench of the Lookout seam. Seams higher in the section on Hosmer Ridge have reflectance values ranging from 1.04 to 0.99 per cent (not shown on section since sample sites did not correspond with the section location).

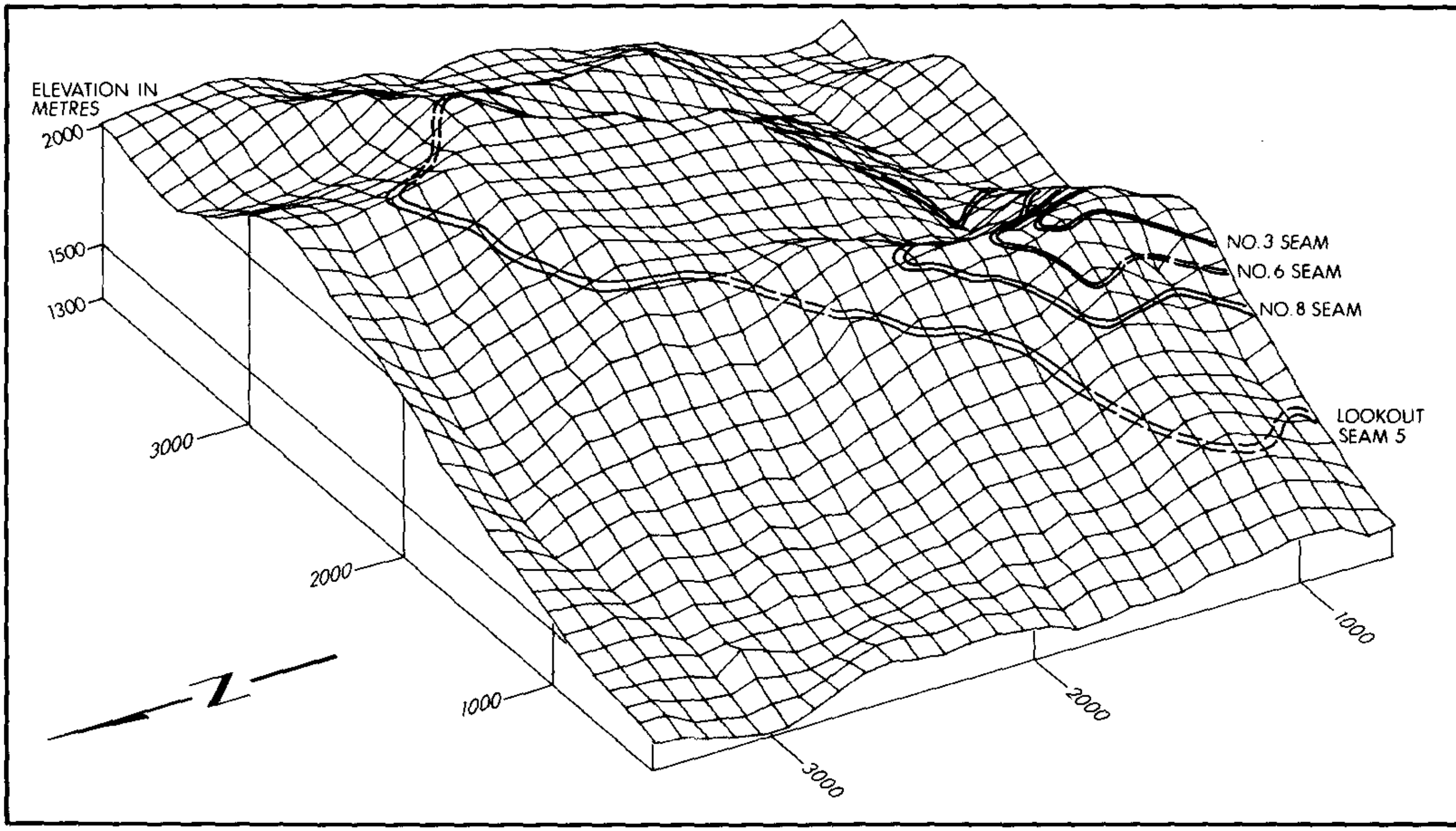

Figure 12. Isometric diagram of the surface topography of the study area with coal seams displayed. Each net square is 100 metres on a side. The view is that seen by looking down on the deposit in a southeasterly direction.

The division between ASTM rank categories high-volatile bituminous and medium-volatile bituminous is in the vicinity of 1.1 per cent $\bar{R}_o$max. Thus the Lookout seam at the location of the measured section falls near the boundary between high and medium-volatile rank as determined petrographically; the upper seams on Hosmer Ridge are all of high-volatile rank. Actual volatile matter contents of the Lookout seam may be somewhat lower than expected from these results, because seams from the lower part of the Mist Mountain Formation have relatively high inertinite content (Cameron, 1972).

Within the study area the rank of the Lookout seam appears to decrease toward the northeast and increase toward the southwest. For example, reflectance of a sample of the Lookout seam from the north spur of Lookout Hill is 0.91 per cent, while the basal seam in the Mist Mountain Formation at a point 650 metres south of the southwest corner of Parcel 73 has a reflectance of 1.26 per cent. In the latter case the Lookout seam might reasonably be expected to have a reflectance in the neighbourhood of 1.2 per cent. The difference in elevation between these two points is approximately 770 metres, suggesting that the contrast is at least partly due to down-dip rank increases, as was noted to be the case at several other locations in the Crowsnest Coalfield (Pearson and Grieve, in press). This change in rank with elevation (0.038 per cent/100 metres) is, in fact, only slightly higher than that established at Coal Creek, 15 kilometres to the south, for purely down-dip rank increase (0.035 per cent/100 metres).

The relatively low rank of coals above the Dominion thrust fault compared with those of adjacent areas was noted by Pearson and Grieve (in press). The Balmer seam, which lies at approximately the same stratigraphic position as the Lookout seam on Sparwood Ridge, has reflectance values of approximately 1.4 per cent. The lower rank of coals within the study area makes them attractive under present market conditions.

DEPOSIT MODEL

Calculation of coal resources contained in the Northern Dominion Coal Block was one of the main objectives of this study. To this end a computer deposit model was constructed. Given the appropriate software, computer deposit models are easier to construct and evaluate than those made by traditional manual deposit analysis techniques involving multiple plans and sections. A computer deposit model also has the advantage of being readily available to answer a wide variety of questions about the deposit. This deposit is areally small and, on the basis of the data available, geologically straightforward.

Equipment used for modelling consisted of a KAYPRO II portable micro-computer, an EPSON MX-80 printer, and a ROLAND DXY-800 plotter. All equipment is portable and relatively inexpensive; the total cost of all hardware is less than $4500. Software used was the GRID HANDLER module of the GEOLOGICAL ANALYSIS PACKAGE, designed by Cal Data Ltd., and on loan to the Ministry.

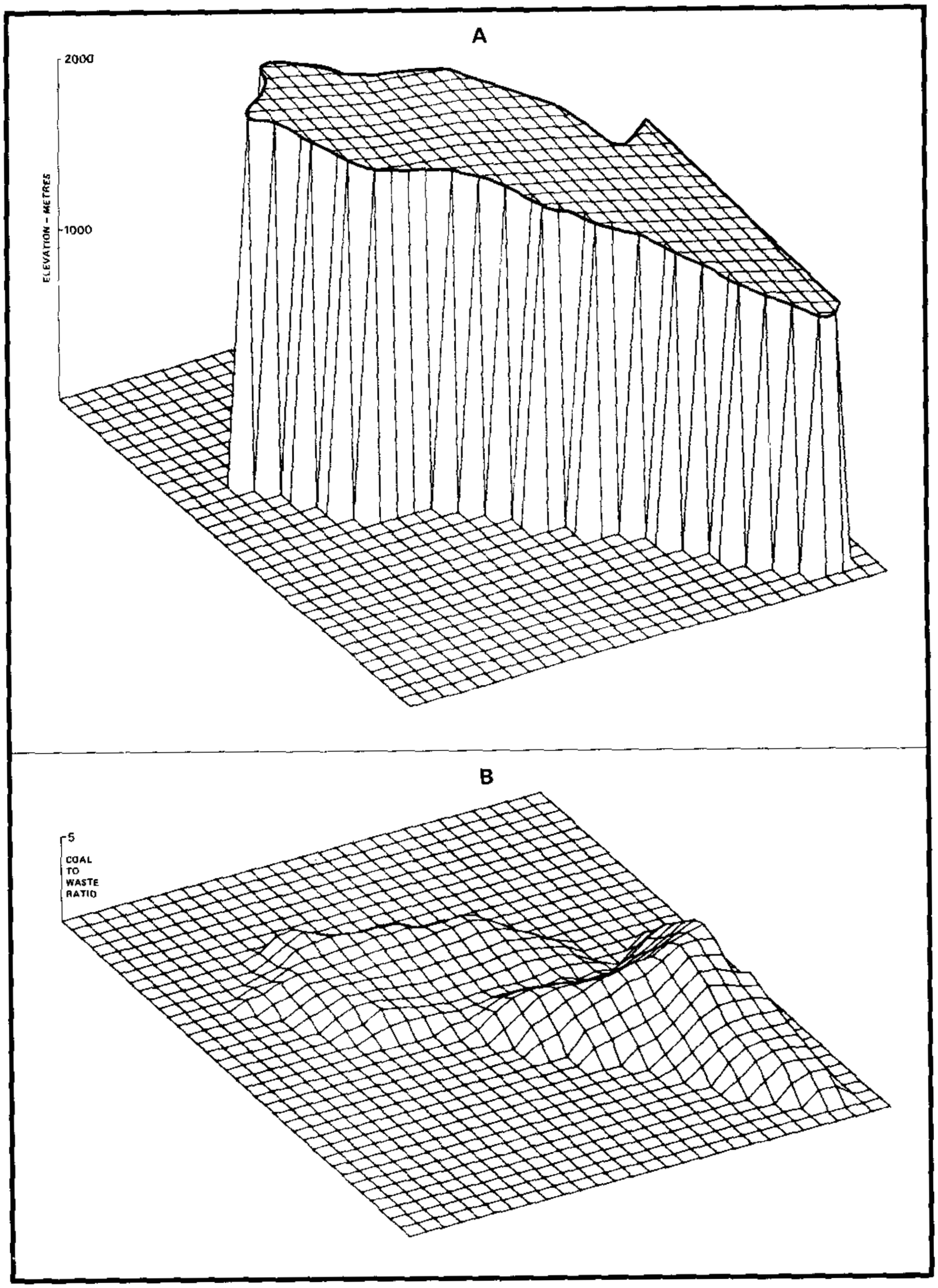

Figure 13. Isometric net diagrams related to the upper Lookout seam. (a) Display of the seams structure contour grid. The vertical drop-off marks the outcrop edge of the seam. (b) View of the amount of material above the seam.

The computer model produced consisted of a series of digital surfaces, each defining a specific parameter of the deposit, such as topography and seam position. Each digital surface is in the form of a grid that covers the study area; the value of the desired parameter is determined and stored for the centre position of each grid square. By numerically overlaying various grids, calculations such as overburden ratios and tonnages can be made.

The selected grid outline, which is shown on Figure 10, covers only the area of the coal block containing the Natal Lookout thrust sheet. The grid is 2.9 kilometres in an east-west direction and 3.7 kilometres in a north-south direction. A grid spacing of 100 by 100 metres was selected because it provided reasonable resolution of the deposit features. Available data did not warrant a finer grid and a larger grid spacing would have insufficient resolution to provide an accurate assessment of the resource potential of the property.

Digitial surfaces were calculated by a variety of methods. The topographic grid was obtained by hand digitizing an enlarged 1:50 000-scale topographic map with 100-foot contours. A network of points corresponding to the centres of the grid squares were superimposed on this map. The elevations from each point were manually interpolated from surrounding contour lines and the data entered and stored in the appropriate format in the computer.

Coal seam structure contour surfaces were obtained by a down-plunge projection technique similar to the method described in Gold, et *al.* (1981). The positions of seam outcrops and borehole intersections, if available, were projected parallel to strike lines or the fold-axis orientation onto the computer screen. The projection direction was interactively adjusted until the best projection direction was determined. This best projection direction was the orientation which superimposed widely spaced data from the same horizon in a form that was geologically acceptable to the examiner. Upon obtaining a satisfactory projection direction, all seam data are plotted onto a section oriented normal to the projection direction (*see* SECTION - A Micro-computer Program, this volume). The profile was then geologically interpreted; that is, the trace of each seam was drawn on the profile. The trace was then digitized by hand and the data input into a program which projected the trace parallel to the projection direction over the model area and calculated the elevation of the surface at each of the grid centres. In cases such as the Lookout and No. 8 seams, where two seams are stratigraphically very close together, the lower seam position was calculated by subtracting the stratigraphic interval between the two seams from the structure contour grid calculated for the upper seam in each pair. In this manner six seam surfaces were defined: No. 3, No. 6, No. 8 upper, No. 8 lower, Lookout upper, and Lookout lower.

Once the positions of the seams were established, the seam structure contour grids were then compared with the topographic grid. Where the

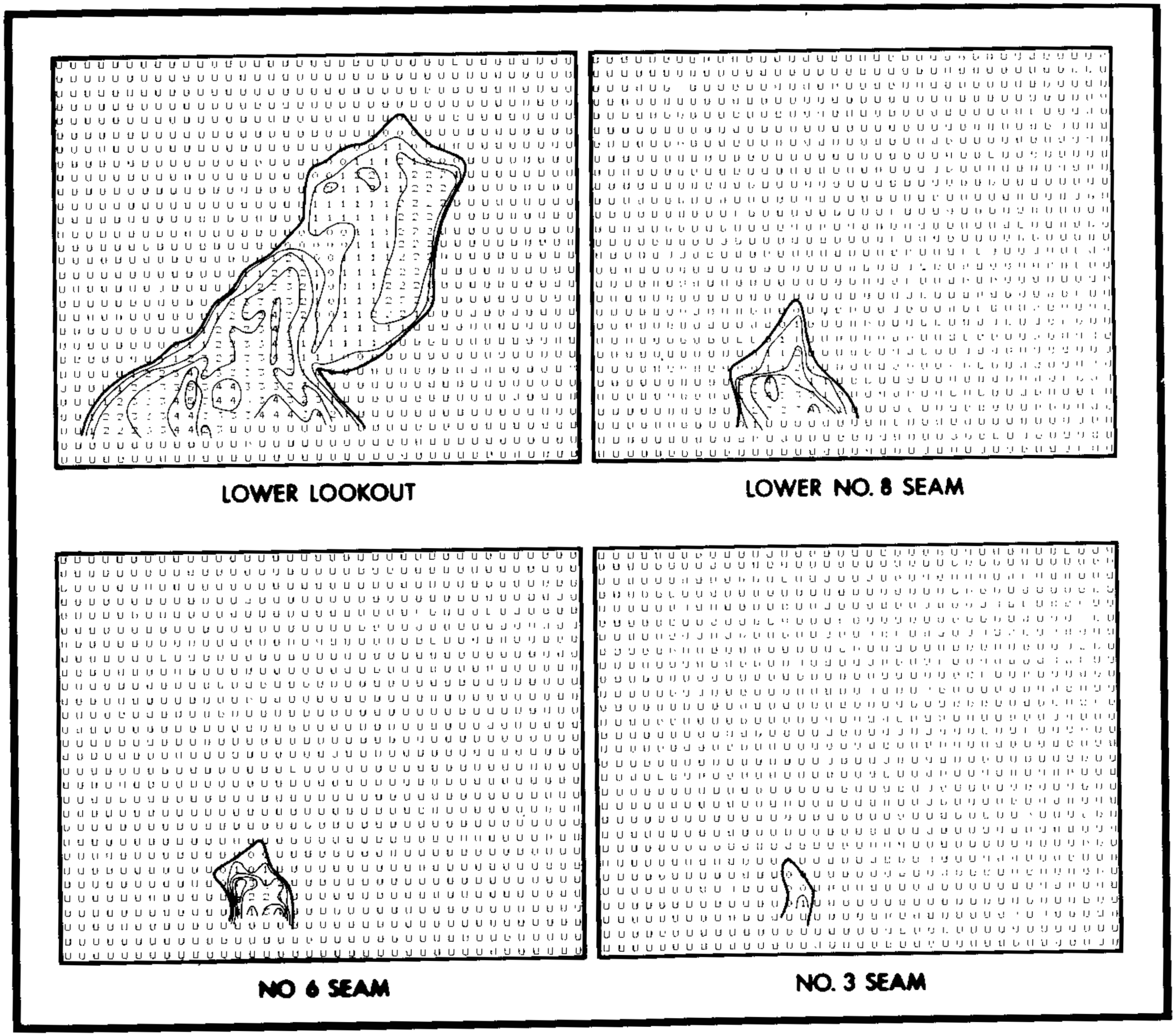

Figure 14. Map displays showing the distribution of the waste to coal ratio values cumulated to the base of four coal seams. u = undefined; 0 = 0 to 2 m; 1 = 2 to 4 m; 2 = 4 to 6 m; 3 = 6 to 8m; 4 = 8 to 10 m.

seam elevations were greater than the topographic elevations, the relevant grid positions were flagged, trimmed, so as not to be used in future calculations. As a check on the accuracy of the method, the seam outcrop trace obtained by this method was compared with the same trace observed on the geological map. In places discrepancies of up to 300 metres, three grid squares in map view, were present. Therefore the seam structure contour grid was modified so the model seam outcrop trace matched the observed trace. The most likely cause of these discrepancies was the poor topographic control. Figure 13a contains isometric displays of the upper Lookout seam structure contour grid after trimming at the outcrop. Each square is 100 metres on a side. Figure 13b is an isometric view of the difference between the topographic grid and the upper Lookout seam structure contour grid - an illustration of the cover on this seam.

Several interpretation assumptions were built into the model, usually due to a lack of data:

(1) The Saddle thrust was not incorporated in the model because at the resolution of the model its effect on the geology was insignificant.

(2) The Lookout seams were assumed continuous in the northeast and southwest portions of the model even though complications were apparent from the published geology map. In both cases faulting was indicated and the seams were not represented on the published map (Ollerenshaw, *et al.*, 1977), but in both areas the seam would be present but with some displacement due to the faulting. Thus the total coal calculation would appear similar in any case.

(3) All seams were considered to be of a uniform thickness, the thickness values used were those obtained from the measured section (Fig. 11).

(4) It was assumed that the coal seam positions could be described by a line moving parallel to the projection direction, 115/0, and joining all known outcrops of a seam. The projection direction did not correspond with the fold-axis orientation for the area, but with the data available the chosen direction proved to most accurately describe the known position of the seams. The coal seam positions will require modification when additional information from the interior of the deposit become available.

(5) The coal was assumed to be of a constant specific gravity in each seam and across the deposit. No information was available to allow assessment of this assumption.

(6) No dilution or recovery factors were assumed, all calculations were strictly on an in-place basis.

The model contains seven digital surfaces; the topographic grid, and the surface elevation grids of six coal seams. A seam thickness is known for each seam and a specific gravity value can be estimated. With this information nearly all resource assessment questions are answerable.

Table 1 contains a tabulation of the volumes and tonnages of coal determined for each of the six seams. Also noted on the left side of the table are the amounts that these totals would fluctuate if the seam thickness varied by 10 centimetres or if one grid square were included or excluded from the calculations. As seen from these calculations, a total resource of greater than 75 million tonnes is estimated to be in place; several small seams and seams whose positions are not well understood at present are excluded from these calculations. Table 2 contains a summary of waste rock to coal ratio for each seam, as well as the cumulative waste to coal ratios for the whole deposit starting with the uppermost seam and working downward. Thus if the whole deposit were to be mined to the level of the lower Lookout seam, the overall mining ratio would be 4.7:1 (BCM:tonne); 389 million cubic metres of waste rock would have to be moved. Figure 14 contains map displays of these mining ratios in a cumulative fashion from the upper to lower seam. It is obvious from these maps and Figure 13 that there is a considerable amount of low mining ratio coal in the north and east portions of the deposit.

TABLE 1
POTENTIAL COAL RESOURCES ON PARCEL 73

Seam	Area (sq. m) (x 10 000)	Thickness metres	S.G.	Tonnes	Range ± /10 cm	Range ± /grid sq.
No. 3	7	6.1	1.32	563 640	9 240	80 520
No. 6	19	1.5	1.32	285 000	25 080	19 800
No. 8 upper	41	4	1.32	2 164 800	54 120	52 800
No. 8 lower	41	7.3	1.32	3 950 760	54 120	96 360
Lookout (U)	277	9.754	1.32	35 664 525	365 640	128 752
Lookout (L)	277	9.14	1.32	33 419 496	365 640	120 648
				76 048 221		

TABLE 2
INDIVIDUAL AND CUMULATIVE WASTE-COAL RATIOS

Seam	Total Coal (Tonnes)	Total Waste (BCM)	Ratio	Cumulative Ratio
No. 3	563 640	760 502	1.35	1.35
No. 6	285 000	5 082 400	17.83	5.5
No. 8 upper	2 164 800	29 752 400	13.74	9.67
No. 8 lower	3 950 760	33 001 700	8.35	4.4
Lookout (U)	35 664 525	306 976 000	8.61	7.08
Lookout (L)	33 419 496	389 799 000	11.66	4.7

CONCLUSION

The Northern Dominion Coal Block, Parcel 73, contains significant coal resources. Greater than 75 million tonnes of *in situ* coal are extractable by open pit methods at a mining ratio of less than 5:1. Coal rank is medium to high-volatile bituminous with $\bar{R}_o$max values in the 1.16 to 0.91 per cent range. The deposit is ideally situated with respect to all required infrastructure.

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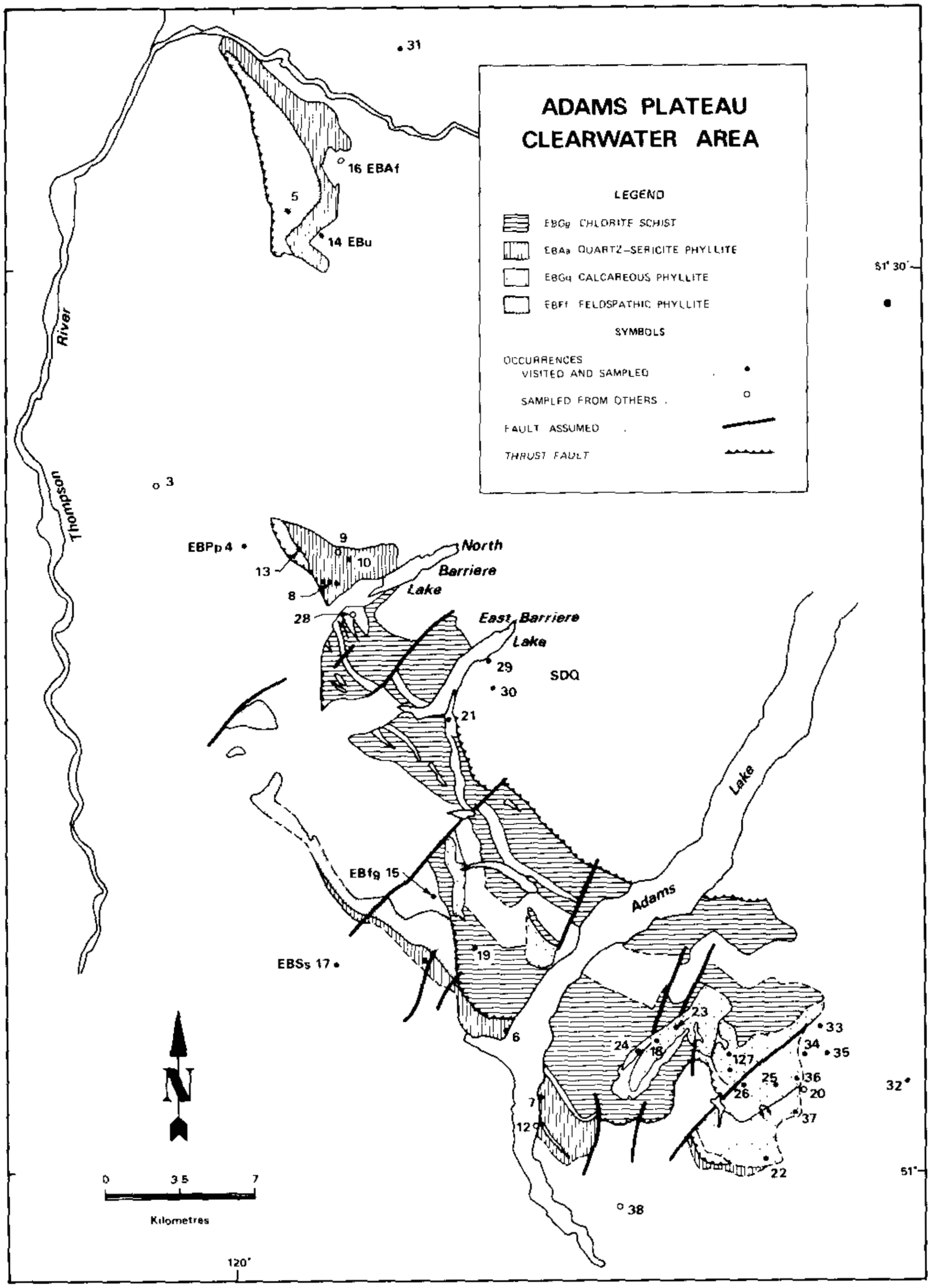

Figure 15. Regional geology of Adams Plateau-Clearwater area (after Schiarizza, et al., 1984) with sample locations and showings (Table 1). Lithologic units are described in Table 2. Birk Creek area (Figs. 16 and 18) is centred around showing No. 5.