ESTIMATE OF INFERRED RESOURCES OF COAL IN THE PLAINS REGION OF ALBERTA TO A DEPTH OF 400 METRES

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EXECUTIVE SUMMARY

In the plains region of Alberta, major deposits of mineable coal are present in three geological units: the Ardley coal zone, the lower Horseshoe Canyon Formation and the Belly River Group. Since 1979, the Alberta Energy and Natural Resources has had a contract with the Alberta Research Council for a coal evaluation program of the Alberta plains. Major objectives of the program are met by separate reports detailing the geologic character of each unit, and include sets of resource maps and representative cross-sections. This report describes the size of resources for each unit.

Coal resources have been calculated from a computer database. The database consists of information obtained from wells drilled by the oil and gas industry, and wells drilled by the Alberta Research Council. The size of resources is represented in a graph form. Curves plotted on each graph give the total size of resource for minimum seam thicknesses between 0.5 and 4.5 m. Generally, the thicker the minimum seam thickness, the lower the coal resource calculated because fewer seams and fewer townships can be used in calculations. Representing resources in this manner allows for easy comparison to coal resources of other areas.

Present calculations are for resources from near surface to a depth of 400 m. With a distribution of 2 to 3 wells per township ($100km^2$), these calculations are considered to fall under the category of "inferred resources". The Geological Survey of Canada regards coal seams over 1 m thick in the Alberta and Saskatchewan plains as being of "future interest" if they are shallower than 450 m. On this basis, inferred resources of the Ardley coal zone, the lower Horseshoe Canyon Formation and the Belly River Group are calculated as 105 billion tonnes, 125 billion tonnes and 93 billion tonnes, respectively.

This study is regional in nature and has not been restricted to the presently designated coal fields. A major purpose was to delineate deposits of coal that could be early targets for underground mining in

the province. Resource estimates made by the Research Council are substantially larger than those of the Alberta Energy Resources Conservation Board. In a large part, the higher resource figures reflect a wider geographic area studied.

The present study is important in that it has delineated huge coal resources previously poorly understood. The findings of this assessment should be particularly useful in the future designation of coal fields for underground mining.

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1. INTRODUCTION

Since 1979, Alberta Energy and Natural Resources (AENR) has had a contract with the Alberta Research Council for a coal evaluation program of the Alberta plains. Objectives for this program were to:

"(a) evaluate the resources and identify commercial occurences of coal in the plains region, south of Township 64, from near surface to depths of about 400 m (1,200 ft.)

(b) develop techniques, through sedimentologic and stratigraphic research, to predict distribution, thicknesses and continuity of coal seams. These techniques will contribute immensely to our capabilities of estimating coal reserves and for the exploration of new coal deposits. From this research we can also interpret the quality and potential mineability of coal."

In partial fulfillment of these objectives, an assessment of the coal resources of the important coal-bearing units will be discussed in this volume.

In the plains region of Alberta, major deposits of mineable coal are present at the base of the Paskapoo Formation (Ardley coal zone), in the lower Horseshoe Canyon Formation, and in the Belly River Group. The stratigraphic positions and relative ages of these units are shown in figure 1. The geographic distribution of each coal-bearing unit is shown in figure 2. Separate reports detail the geologic character of the coal zones and include sets of resource maps and representative cross-sections.

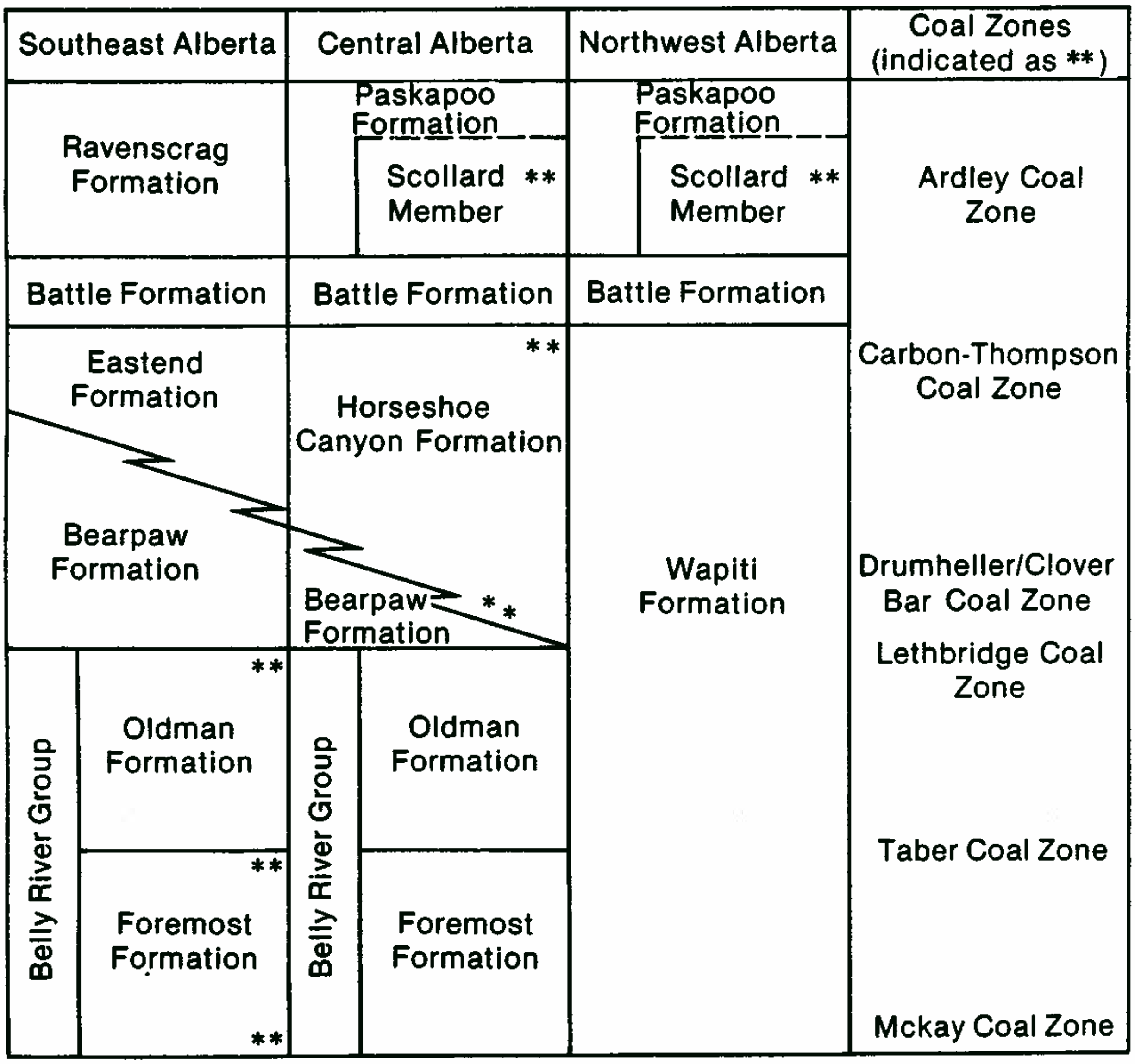


Figure 1. Stratigraphic nomenclature of the Upper Cretaceous and Tertiary in the southern and central plains area, showing the position of the major coal zones.

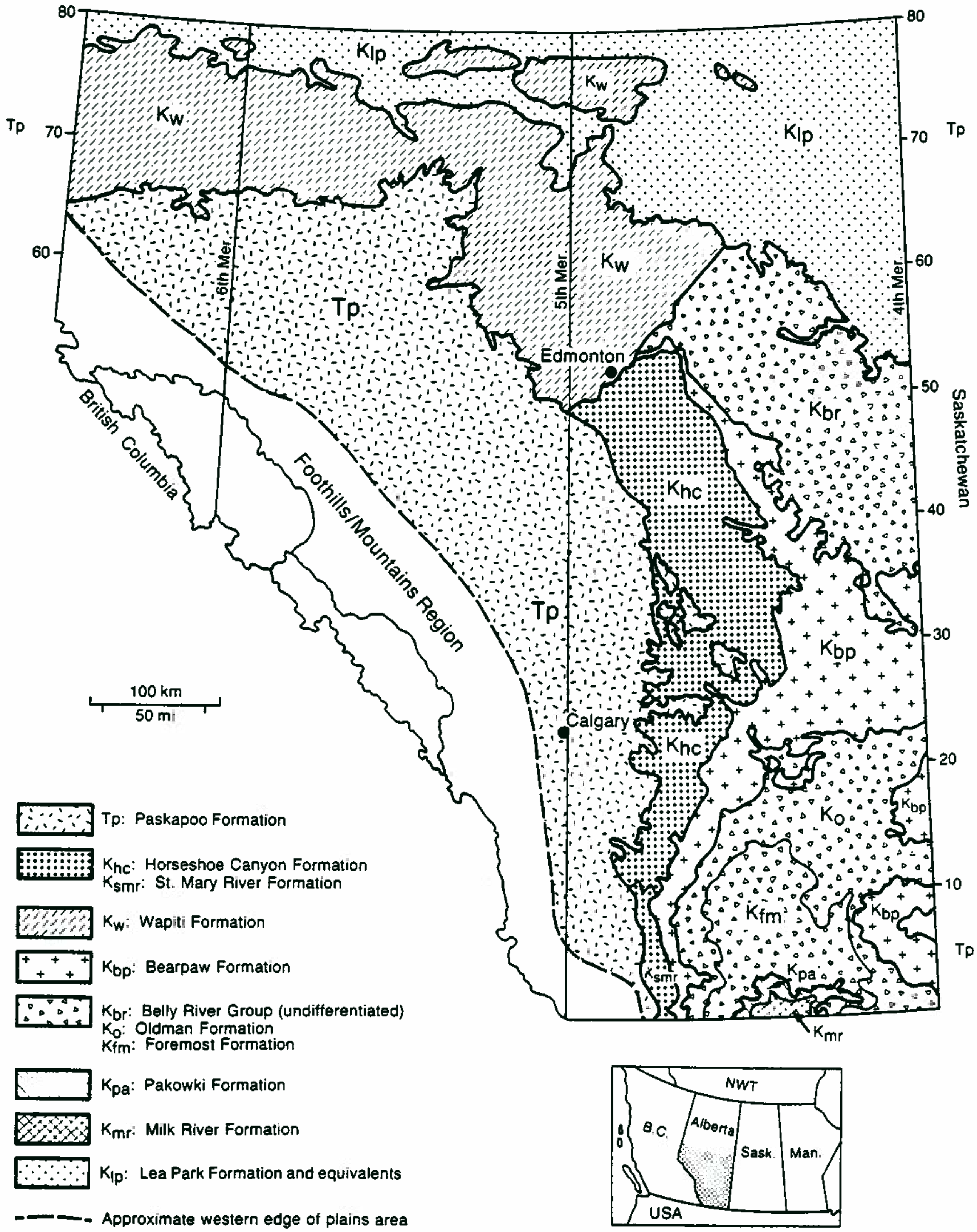


Figure 2. Geologic map of the plains area of southern Alberta.

2. AREA STUDIED AND NATURE OF THE DATA BASE

The coal resources have been assessed for each coal-bearing unit, in the plains region of Alberta, from near-surface to a depth of approximately 400 m. Limits of each study area extend from the respective outcrop edge to about 100 km to 150 km west (downdip) of the outcrop edge (figure 2).

The size of the study areas (Table 1) varies from 474 townships, 490 townships and 1202 townships for the Ardley coal zone, the lower Horseshoe Canyon Formation and the Belly River Group respectively. Relative sizes of each study area must be kept in perspective. When comparing resource calculations, the ratio between total resources to the number of townships is an important consideration.

Data collected by the Alberta Research Council are based on wells drilled by the oil and gas industry, and wells drilled by the Alberta Research Council. The number of wells of each study area is shown in Table 1. Wells drilled by the Alberta Research Council give information about coal zones at relatively shallow depths. Over the past 9 years, wells were drilled on a one hole per township basis parallel to the outcrop of each coal bearing formation. Depending upon the location drilled, maximum depths range from 150 m to 300 m. Oil and gas well data are used where coal zones are deeper within the basin, generally at depths greater than 200 m. Use of oil and gas well data enables the delineation of coal resources beyond the depths of conventional coal exploration drilling.

Most previous assessments of coal resources were based on data from presently designated coal fields. These are areas tens of kilometres wide, that parallel the outcrop edge where it would be possible to extract the coal using surface mining techniques.

In contrast, the assessments made by the Alberta Research Council, in this study, cover a much larger area and include deeper coal resources.

	Ardley coal zone	Lower Horseshoe Canyon Formation	Belly River Group
Number of townships in study area	474	490	1,202
Number of oil and gas wells	1,402	812	2,192
Number of Alberta Research Council wells	98	108	125

Table 1. The number of townships ($100 km^2$) and number of wells used in the Ardley coal zone, lower Horseshoe Canyon Formation and Belly River Group studies.

2.1 Identification of Coal Seams and Thickness Criteria

A combination of a sonic or density log, natural gamma ray log and normal resistivity log forms the basis for identification of coals in this study. Figure 3 illustrates typical geophysical log responses in a coal zone.

The following is a list of criteria for geophysical responses used for each log:

(1) The density log, which measures electron density of a formation, shows a much lower density response for coal than for surrounding lithologies and typically records values of less than 1.8 gm/cc.

(2) The sonic log, which measures the interval transit time of an acoustic wave through a formation, shows a higher transit time for coal than for surrounding lithologies and typically records values greater than 120 microseconds/foot.

(3) The natural gamma ray log, which measures the natural radioactivity of a formation, records a much lower radioactivity level for coal than for surrounding lithologies and typically measures values approaching zero A.P.I. units.

(4) The normal resistivity log, which measures the resitivity of a formation to an electric current, typically measures a much higher resistivity response for coal than for surrounding formations.

(5) The caliper log, which measures borehole diameter, often shows large washouts in coal zones.

The method for picking coal seams on oil and gas well logs differ from that used on Alberta Research Council well logs. For oil and gas well logs, the top and base of each coal seam is consistently picked at the inflection point on the natural gamma ray curve (large X's in figure 3). For Alberta Research Council well logs, the top and base of each coal seam is consistently picked at the inflection point on the density curve. The reason for the difference in picking methods is due to an exaggerated density response in coal zones of oil and gas wells, caused by washouts, as a result of higher mud circulation pressures applied. Picks for coal seams made on the natural gamma ray curve on oil and gas well logs appear to be more consistent and more reliable than picks made on the density curve. The normal resistivity log is used to confirm the presence of coal in each case.

The top and base of each coal seam for both the Alberta Research Council and oil and gas well logs are estimated to the nearest 0.33 m or nearest foot (1 ft.), depending upon the log scale. Most coal seams are split by mudstone layers, known as partings. In this study, partings less than 0.5 m or 1 1/2 ft. are ignored because of the difficulty in resolving such thin layers on the oil and gas logs. No coal seams less than 0.5 m or 1 1/2 ft. are entered into the database. Thickness estimates given for coal seams are considered to be conservative because of the method used but the inability to exclude thin partings is a deficiency.

2.2 Computer Database

Data entered for each well consists of location co-ordinates (using the Dominion Land Survey system), the Kelly bushing elevation and the estimated depths to the top and base of each coal bed. For the Belly River Group, in which several coal zones are present, an identifier code was used so that each coal zone could be assessed independently. For the other studies, an identifier code was not needed because the coals are present in only one zone.

Every attempt was made to establish a regular and random distribution of data points in each study. Generally, one to three wells per township ($100 km^2$) were used.

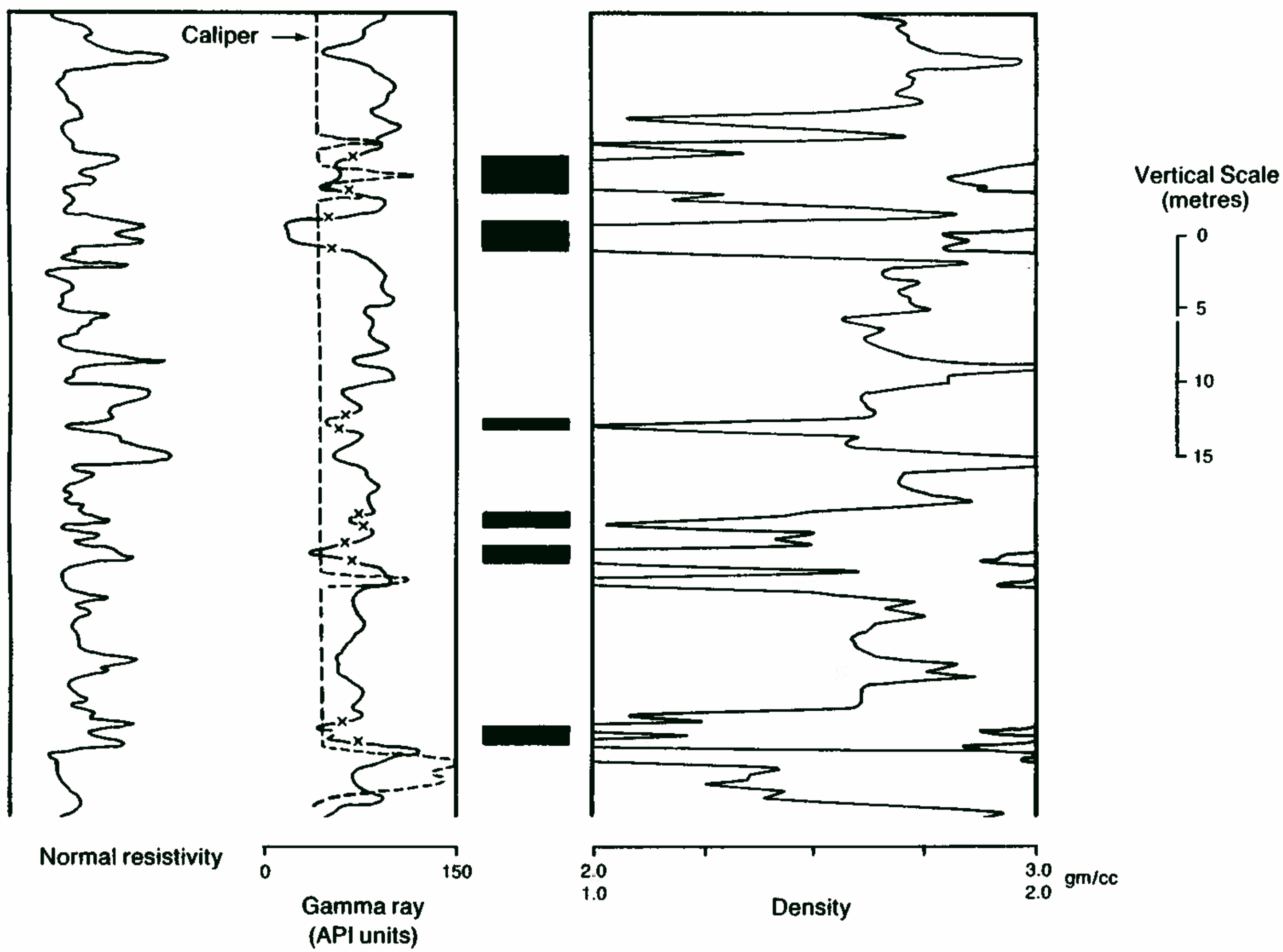


Figure 3. Example of coal seams picked from geophysical logs.
See text for details of methods used.

3. RESOURCE TERMINOLOGY

Because of the confusion surrounding the concepts of reserves and resources, and because of the many classification schemes in place for resource assessment, we need to define the terms used in this report precisely. Ideally, the methods used in estimating coal resources should be standardized so that comparable estimates by different workers could be calculated from similar data. This is not always the case because of the nature of studies (regional versus site specific areas) and because of limitations and uncertainties of each database. Details of the Canadian resource classification scheme and definitions of all terms used in this paper will be presented.

3.1 Resource vs. Reserve Estimates

The concept of a resource estimate is to define a quantity of in-place coal, any part of which is or may become economic depending upon the method of mining and economic assumptions that are or will be used (Wood et.al., 1983). Stated more simply, resource figures are measurements of coal in the ground and makes no assessment as to whether it is economically viable to extract.

The concept of a reserve estimate is to define a quantity of in-place coal which must be considered to be economically producible at the time of classification, but facilities for extraction need not be in place and operative. The United States Geological Survey (USGS) reserve calculations are made for bituminous coal and anthracite 0.7 m. (23 in.) or more thick and subbituminous coal 1.5 m (5 ft.) or more thick that occurs at depths to 300 m (1000 ft.) and lignite 1.5 m (5 ft) or more thick that occurs at depths to 150 m (500 ft.) (Wood et. al., 1983). In Canada, the term "reserve" is not as precisely defined as in the United States. Alberta's Energy Resources Conservation Board (ERCB) defines reserves as those resources that can be identified as being potentially economic under present market conditions.

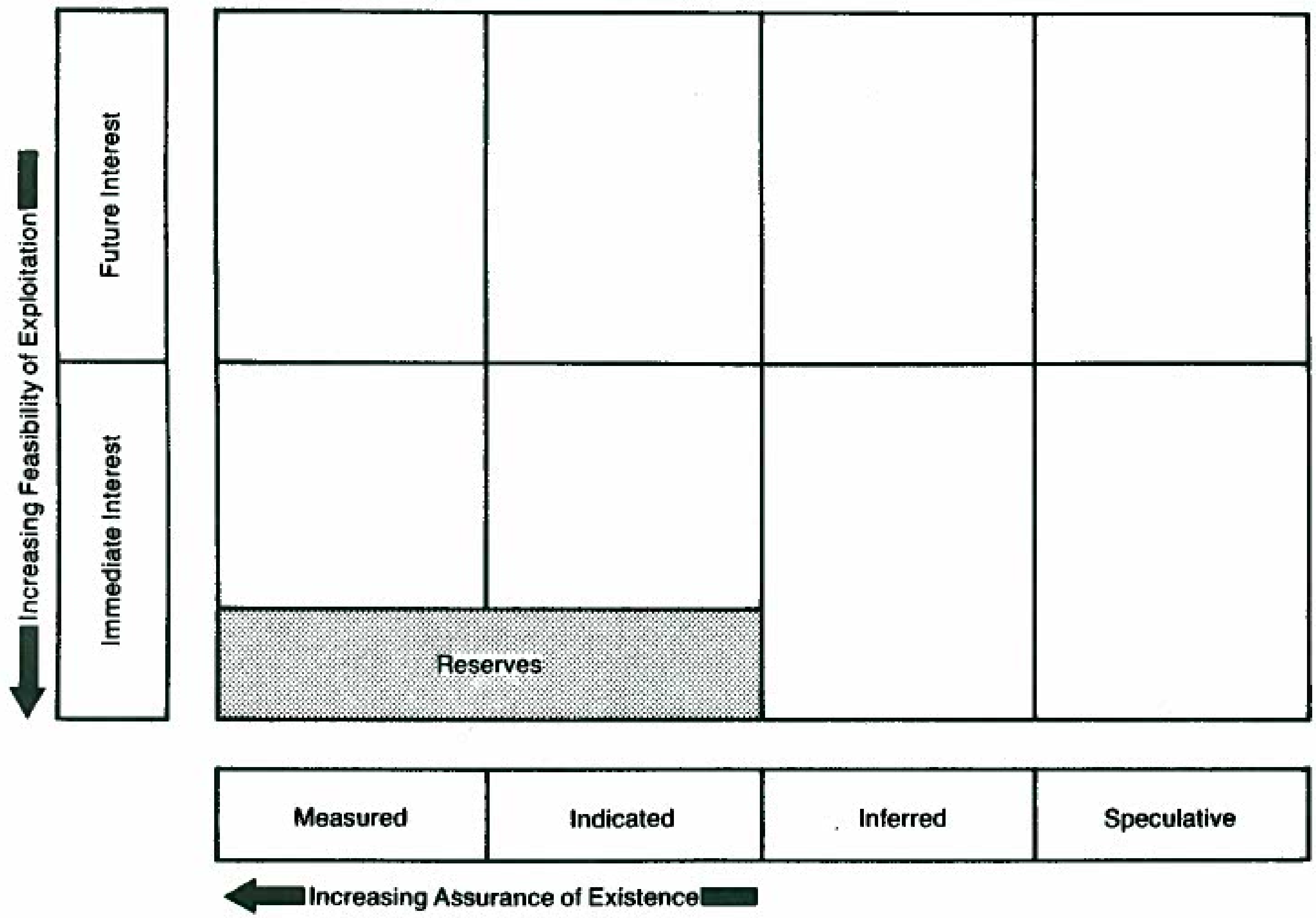


Figure 4. Canadian coal-resource classification diagram (after Irving, 1981).

Criteria for distinguishing reserves consequently vary through time. The ERCB calculates the size of reserve only in areas where extensive data are available and where the extent of the coal deposit is known in considerable detail. The Geological Survey of Canada (GSC) classifies a reserve as that portion of a resource estimate which has a high degree of geologic assurance and a high degree of immediate economic interest (see figure 4).

3.2 The Canadian Coal Resource Classification Scheme

A detailed coal resource classification scheme should take into account two basic considerations: (1) geological assurance of the existence of coal and (2) the economic feasibility of mining the coal.

Degree of geologic assurance is determined by the inter-relations of (1) the proximity or closeness of measuring or sampling sites, (2) concepts and models of the depositional patterns, thickness variation and aerial extent of coal seams and (3) knowledge of associated structural features which control the distribution, extent, thickness, depth of burial and metamorphism of coal resources.

Economic feasibility is judged by determining the inter-relations of (1) seam thickness, (2) thickness of overburden, (3) rank and quality of the coal, (4) the costs of mining, processing, labour, taxes and associated expenses, (5) distance to markets and (6) supply and demand.

Most geologists and engineers who classify resources are not experts in economics, transportation, processing and marketing of coal. As well, the economic conditions change with time so that the economic viability of coal is relatively fluid. For these reasons a simplified method of resource assessment is used. Criteria such as thickness of coal, amount of overburden, quality, heat value, rank and distance between points of measurement are major considerations. Four reliability categories are used to give the degree of relative geologic assurance (horizontal axis of figure 4) and two economic categories are used to give the degree of relative feasibility of exploitation (vertical axis of figure 4).

3.3 Geologic Assurance

The geologic assurance categorized as measured, indicated, inferred and speculative indicate the relative reliability of tonnage estimates for a coal deposit as related to distance from points of known seam thickness (usually well data). See the horizontal axis of figure 4.

Measured Resources - This category has the highest degree of geologic assurance. Sites for thickness measurement are so closely spaced and the geologic character is so well defined that the average thickness, aerial extent and depth of coal seams are well established (see figure 5). For the plains region of Alberta the maximum distance between points of control for measured resources is 800 m (Irving, 1981).

Indicated Resources - This category has a moderate degree of geologic assurance. Geologic assurance is lower than measured resources, but high enough to assume continuity between points of measurement (see figure 5). For the plains region of Alberta, indicated resources can be calculated when the distance between points of control is 800 m to 1.6 km (Irving, 1981).

Inferred Resources - This category has a low degree of geologic assurance. Quantity estimates are based largely on a broad knowledge of the geologic character of the coal beds and on the inferred continuity of data beyond measured and indicated resource limits (see figure 5). It is appropriate to calculate inferred resources for much of the plains region of Alberta, where distance between points of control is generally greater than 1.6 km. Although a maximum distance between points of control for inferred resources is not specified under the Canadian resource classification scheme, a maximum distance of 9.6 km is suggested by the U.S. Geological Survey (Wood et. al., 1983).

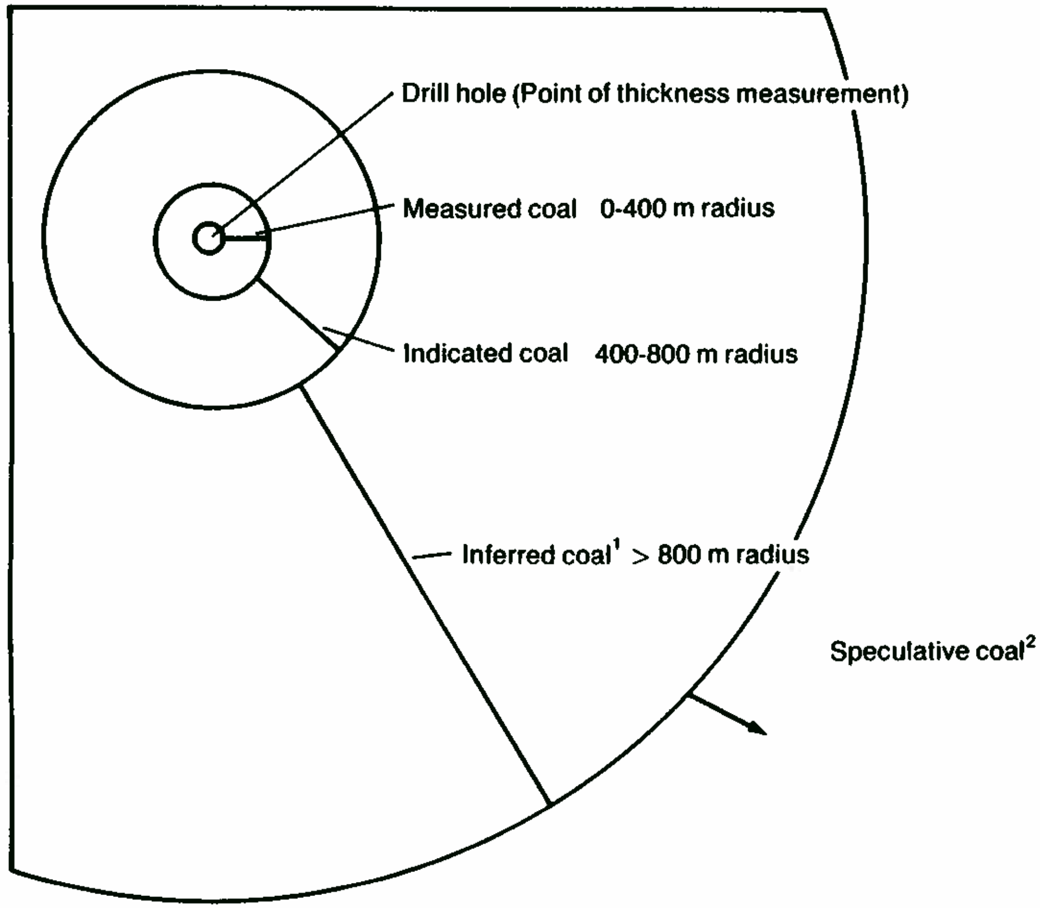
Speculative Resources - This category has the least degree of geologic assurance. Quantity estimates are calculated from a few scattered data points and are beyond the limits of inferred resources (see figure 5). For the plains region of Alberta, speculative resources could be determined where the distance between points of control exceeds 9.6 km. A maximum distance between points of control is not specified under the Canadian resource classification scheme.

3.4 Feasibility of Exploitation

The feasibility of exploitation is categorized as (1) coal resources of immediate interest and (2) coal resources of future interest (see the vertical axis of figure 4).

Coal Resources of Immediate Interest - Estimates are summed for identified and undiscovered deposits of bituminous and subbituminous coal that have a minimum seam thickness of 1.5 m (5 ft.) to a depth of 230 m (750 ft.) and lignites that have a minimum seam thickness of 1.5 m (5 ft.) to a depth of 45 m (150 ft.). (Irving, 1981).

Coal Resources of Future Interest - Estimates are summed for identified and undiscovered deposits of coal (no rank specified) that have a minimum seam thickness of 1.0 m (3.3 ft.) to a depth of 450 m (1,475 ft.). (Irving, 1981).



1. Estimates based largely on a broad knowledge of the geologic character of the region and for which few measurements of seam thickness are available.

2. Estimates based on information from a few scattered occurrences. Geologic assurance is beyond the limits of inferred resources.

Figure 5. Distance Parameters for Geologic Assurance Categories Plains region of Alberta.

3.5 Criteria Used by the U.S. Geological Survey to Define "Resource"

Tonnage estimates for coal resources by the United States Geological Survey (USGS) are determined by summing the estimates for identified (measured, indicated and inferred) and undiscovered (speculative) deposits that are 35 cm (14 in.) or more thick for anthracite and bituminous coal and under less than 1800 m (6,000 ft.) of overburden. For lignite and subbituminous coal, resource estimates are done for coals that are 75 cm (30 in.) or more thick and under less than 1,800 m (6,000 ft.) of overburden (Wood et al., 1983).

4. PRESENT STUDY - METHOD OF RESOURCE ESTIMATION

A computer search was done to identify all townships in which a coal seam of a minimum thickness (for example, 1 m) had been identified in the database. For each township, the total thickness of all coal seams over the minimum thickness was summed for all wells (1 to 4 wells per township) and then divided by the number of wells to give an average coal thickness for the township. Given the density of 2 to 3 wells per township, and spacings of 1.6 km to 9.6 km, the estimates obtained from this database fall under the category of inferred resources.

The volume of inferred coal resources for each township was then calculated by multiplying the average coal thickness by the area of the township. Volume of coal was then converted to tonnes (1,000 kg) using a conversion factor of 1.37 tonnes/m^3. A series of calculations were done to measure the size of the resource for minimum seam thicknesses at half metre intervals between 0.5 and 4.5 m. Results were plotted with minimum seam thickness and resources on the horizontal and vertical axes respectively (see figure 6).

The resource graphs can be used to calculate the size of the resource present in seams over a given thickness. The thicker the minimum seam thickness, the lower the coal resource calculated because fewer seams and fewer townships can be used in the calculation.

Calculations of resources on a per township basis (this study) differ from methods used by the USGS. In the USGS system, the area of intersecting circles with radii of 4.8 km is used in the volume calculations. A comparison between both is shown in figure 7. Note that although the full area of a township may not be incorporated into the intersecting circles, the radii of circles entered into adjoining townships where there may be no data points. The degree of confidence between both methods of calculation appears to be quite similar in terms of the area covered by circles with radii of 4.8 km and the area covered on a per township basis with 1 to 3 wells. This intersecting circle method is important in trying to document coal resource of an area in detail, especially when calculating measured or indicated resources. The present study is, however, a first cut assessment of the resources of a large area. The time consuming method of calculating areas of intersecting circles was not warranted because several factors may affect the accuracy of the measurement to a much greater degree. These factors are discussed under the section "Degree of Reliability".

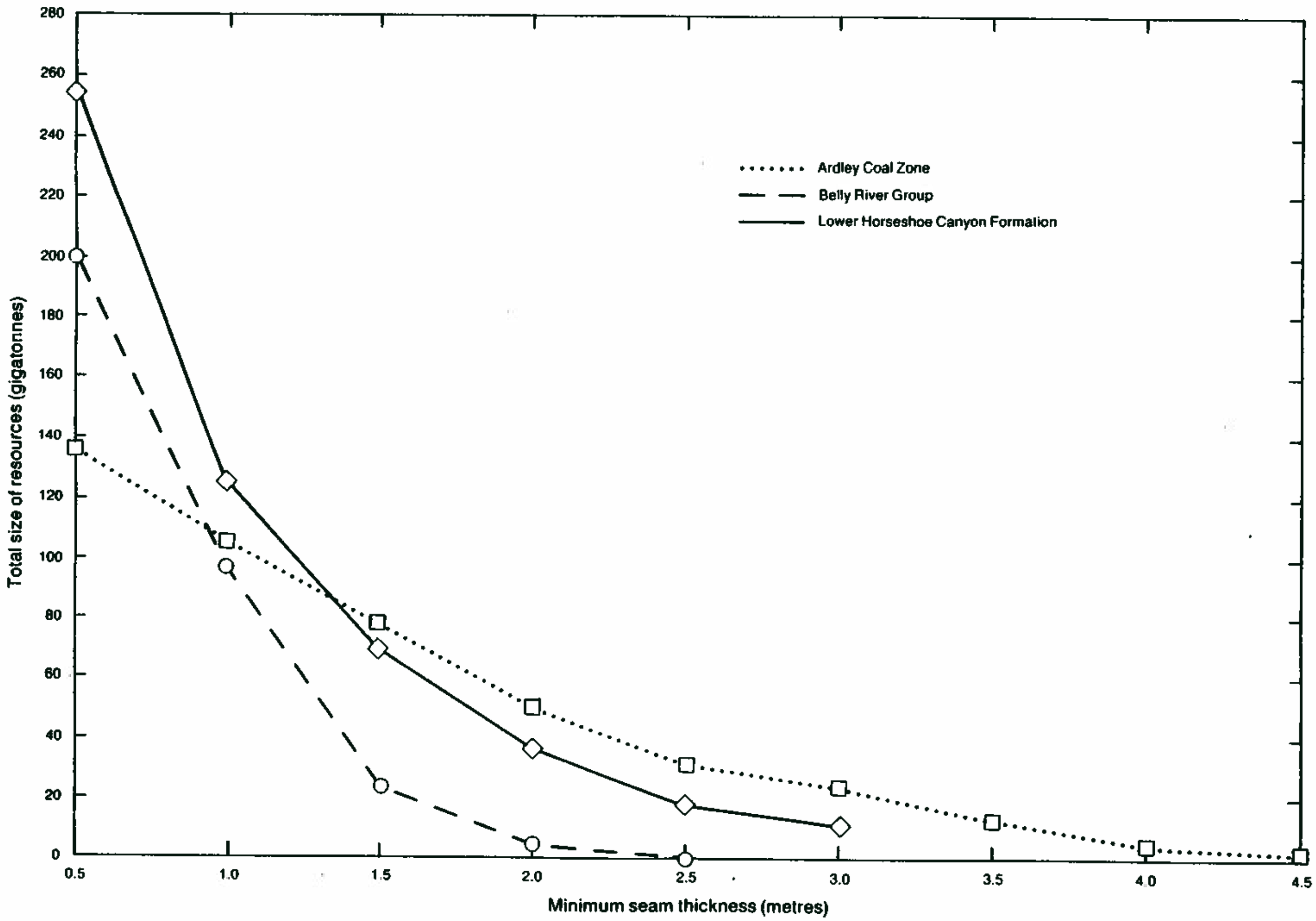


Figure 6. Coal resources to a depth of 400 m for the Ardley coal zone, lower Horseshoe Canyon Formation and the Belly River Group.

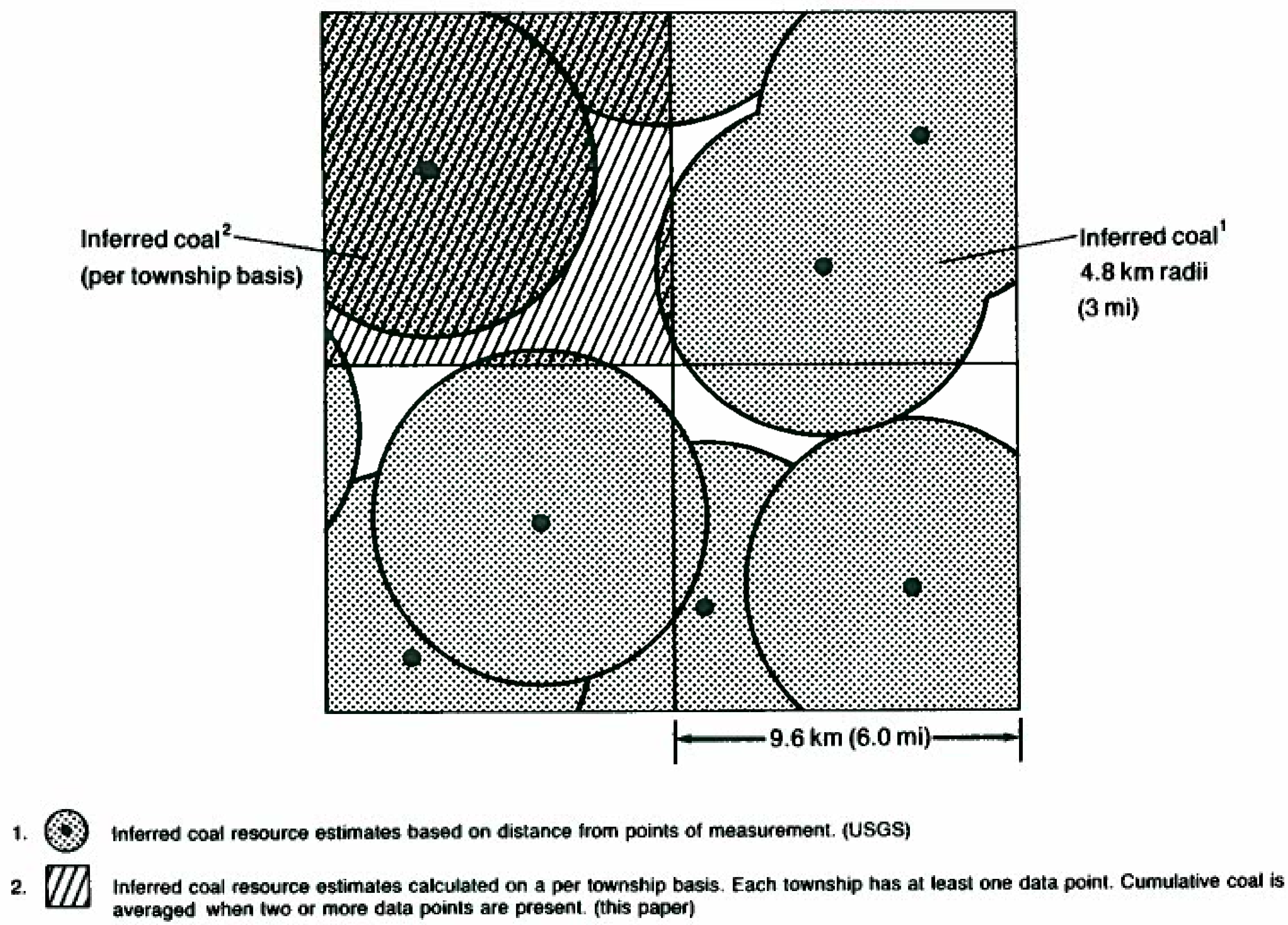


Figure 7. Comparison between areas used in the calculation of inferred resources of four hypothetical townships by the intersecting circle method versus the per township method used in this report.

5. DEGREE OF RELIABILITY (UNCERTAINTIES)

Estimates for the magnitude of coal resources and reserves vary considerably over time and between agencies making such estimates. Much of the variation is due to differences in methods of calculation and the nature of the data bases. In many instances the variable estimates reflect the many different assumptions and degrees of accuracy used. By far the most important control governing reliability, accuracy and precision of any estimation is the distribution and spacing of data points.

Seam by seam methods of calculation are more accurate and have a lesser amount of uncertainty than the methods used in this paper. Accurate seam correlation, however, is generally not possible for regional resource studies. Because of the regional nature of the study, the resource calculations are limited to summing all seams, of a given minimum thickness, within a designated coal zone.

The density of coal varies with rank, ash content and the amount of each macerals group (such as vitrinite, inertinite and exinite) in the coal. Ideally, the density in resource estimations should be averaged on a seam-by-seam basis or, at least, for each rank of coal. For this study an average conversion factor (density) of 1.37 tonnes/m^3 was used regardless of rank, ash content or maceral content variation of these coals.

Continuity of seams and variation of seam thickness are major sources of uncertainty. Splitting of single seams into several seams is common and may occur abruptly. Discontinuities of seams due to faulting, non-deposition or post and penecontemporaneous channelling may occur. None of these geologic uncertainties are directly considered for the inferred resource calculations. Averaging calculations over distances of 1.6 km or more gives a relatively low degree of geologic assurance. Inferred resources, therefore, are estimates given that do not take all geologic uncertainties into consideration. The general lack of precision allows for a high margin of error that can bump estimates up or down.

Several factors inherent in the nature of the present data base may cause the present calculations to be substantially in error. However, it is felt that because there are factors which both raise and lower the calculated resources, the present figures are still reasonable estimates.

5.1 Why estimates could be on the low side:

1. The data base consists of information from a large number of boreholes but such information is lacking for large parts of the study area. The density of coal exploration wells, used to delineate shallow coal resources, is much lower than the density of oil and gas wells, used to delineate deeper coal resources. As a result, there are substantial numbers of townships with shallow coals for which there is no information. There are also gaps of limited data in areas of large lakes, Indian reservations, cities and parklands. Because of the relatively large number of townships for which no resource estimates could be made, the resource figures calculated may be underestimated.

2. Average thickness values obtained from some of the wells may be less than the true thickness due to undetected portions of coal zones. Alberta Research Council wells drilled near the outcrop edge to delineate shallow coal resources, commonly had arbitrary cutoff depths. Because of this, the entire coal zone was not always penetrated by every drill hole. In addition, because of the interference by casing, sometimes down to a depth of 250 m (800 ft.) or more, upper portions of coal zones present in oil and gas wells may have been undetected.

3. In the Belly River Group study, only the coal seams of an identified coal zone are entered for calculation of resources. The addition of estimates from coal beds between designated coal zones may increase coal resources slightly.

5.2 Why estimates could be on the high side:

1. Given the limited resolution of oil and gas well data and the regional nature of the data base, partings less than 50 cm thick were ignored. According to the U.S. Geological Survey, partings in a coal bed greater than 1 cm should be excluded from thickness measurements when estimating coal resources (Wood et al., 1983). Allowing for undetected and unrecognized partings 1 cm to 50 cm thick in the data base, inferred resources may be exaggerated.

6. RESOURCE ESTIMATES FOR THE THREE MAJOR COAL-BEARING UNITS

6.1 Ardley coal zone

The size of the inferred coal resources of the Ardley coal zone, for minimum seam thicknesses between 0.5 and 4.5 m is shown in figure 8. The current Energy and Natural Resources/Alberta Research Council contract calls for an assessment of coals to a depth of 400 m. Resources to this depth are shown on the lower curve. The Geological Survey of Canada defines resources of "future interest" in the plains area as resources with coal seams over 1 m thick. On this basis the inferred resources to 400 m depth are approximately 105 billion tonnes.

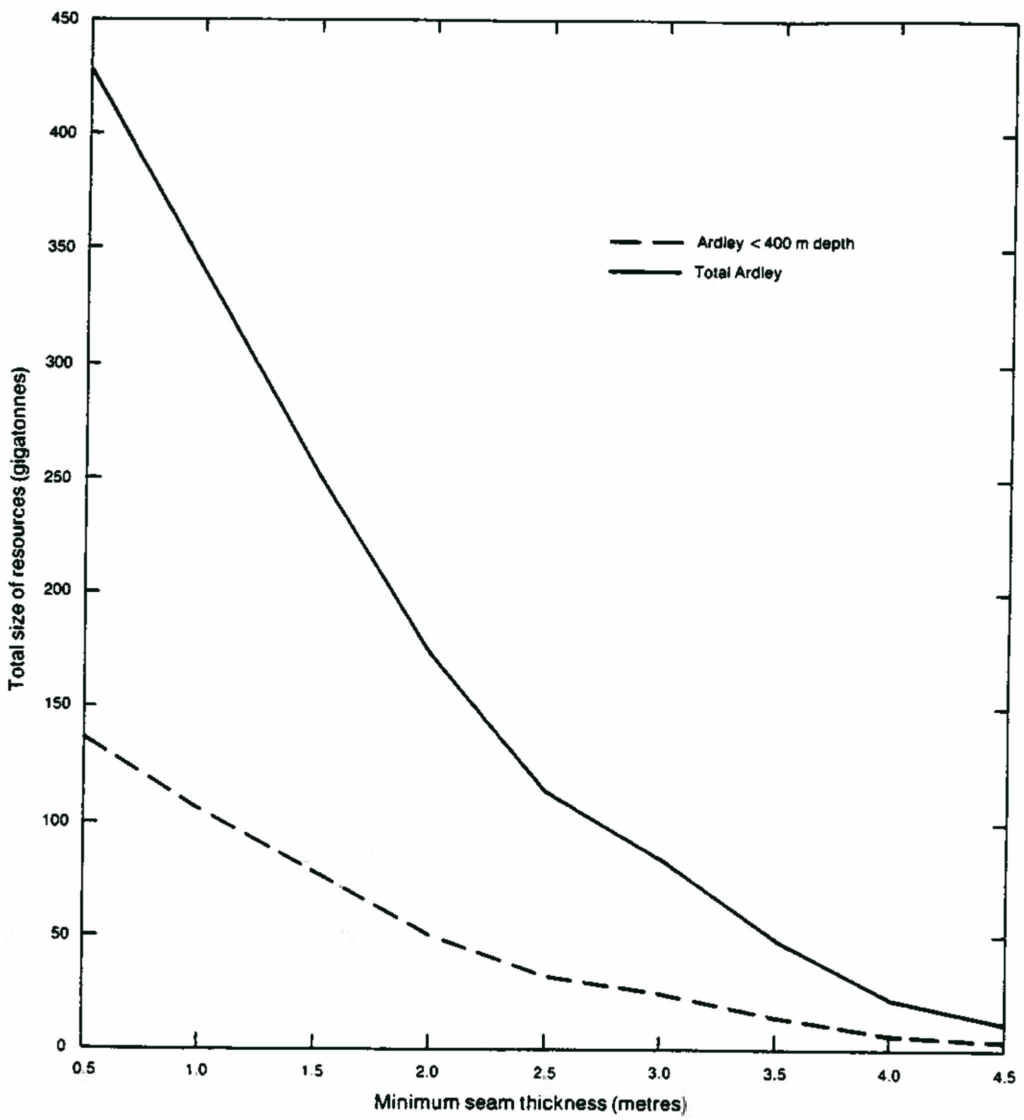


Figure 8. Resources of the Ardley coal zone. Lower curve shows resources to 400 m depth. Upper curve shows resources for all the area covered under the geological study: see text for details.

In order to make a more complete geological assessment of the Ardley coal zone, the present study was extended deeper than 400 m over much of the area, with maximum depths of over 800 m. The upper curve on figure 8 shows the total amount of coal resources documented in the study. It should be noted that this curve does not represent resource calculations to a uniform depth throughout the area. Although the area covered by the full study is somewhat less than double that of the restricted area (to 400 m depth), the resource figures are more than three times as large. This reflects the fact that over much of the area Ardley coal seams are thicker and more numerous with increasing depth.

6.2 Lower Horseshoe Canyon Formation

The size of the inferred coal resources of the lower Horseshoe Canyon Formation, for minimum seam thicknesses between 0.5 and 3 m is shown in figure 9. This figure shows how this type of graph can be helpful in making comparisons between present resource estimates and those calculated for other areas or by other agencies. The U.S. Geological Survey, for example, calculates inferred resources for sub-bituminous coal beds over 30 in. (0.76 m) thick and inferred reserves for coal beds over 5 ft. (1.52 m). Based on these criteria, the present study indicated inferred resources (A on figure 9) for coal in the lower Horseshoe Canyon Formation of 175 billion tonnes. Assuming that the coal could be economically extracted, inferred reserves (B on figure 9) would be 66 billion tonnes. The Geological Survey of Canada defines resources of "future interest" in the plains area of Alberta and Saskatchewan as any coal seam over 1 m thick to a depth of 450 m. On this basis, the inferred resources of coal (C on figure 9) in the lower Horseshoe Canyon Formation are approximately 125 billion tonnes.

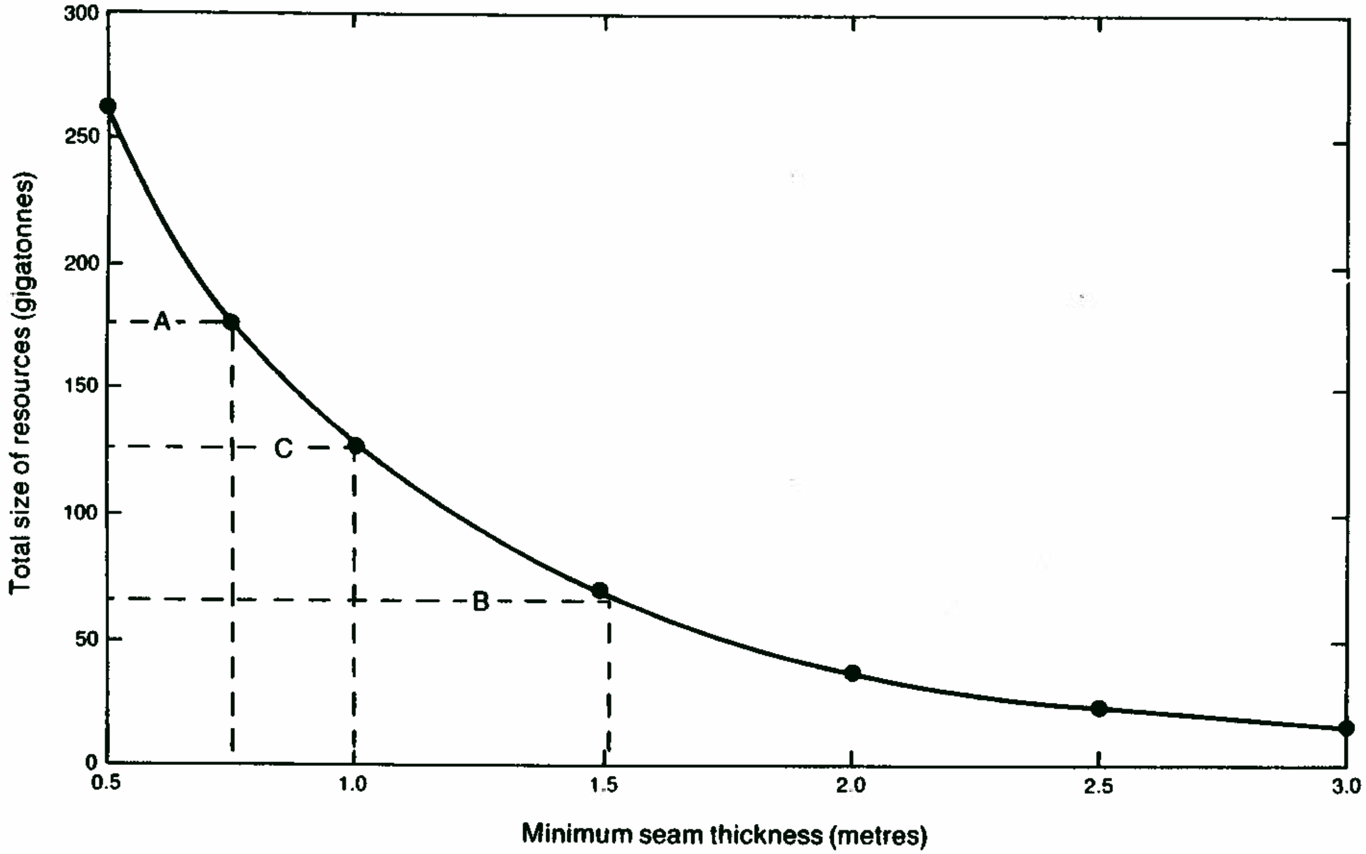


Figure 9. Resources of the lower Horseshoe Canyon Formation to 400 m depth.

6.3 Belly River Group

The size of the inferred coal resources in the Belly River Group, for minimum seam thicknesses between 0.5 and 2.5 m is shown in figure 10. This figure gives the cumulative inferred resources for the Lethbridge, Taber and McKay coal zones. Inferred resources of "future interest" of all three coal zones in the plains area to 400 m depth are approximately 93 billion tonnes.

In figure 11, the inferred resources of the three coal zones within the Belly River Group are compared. It is interesting to note that the McKay and Taber zones contain about the same amount of coal resources. Both coal zones are at relatively deep stratigraphic levels, and the data are obtained from areas of essentially the same size. In contrast, the Lethbridge zone is at a relatively high stratigraphic level (near surface), and the data is limited to a much smaller geographic area. Much of the Lethbridge zone, therefore, is cased off or eroded, so there is less data available for calculation than for the more deeply buried coal zones. It is worthwhile pointing out that the Lethbridge coal zone has at least 5 billion tonnes of inferred resources in seams greater than 1.5 m in thickness and is known to contain seams up to 4.9 m thick in the area north of Lethbridge. This example points out some of the limitations and possible misconceptions of using graphs such as figure 11. The relatively low inferred resource estimates given for the Lethbridge zone, for example, is not a reflection of its present economic value.

7. RELATIONSHIP BETWEEN MODAL SEAM THICKNESS AND GEOLOGICAL MODELS

Some important geologic information can be interpreted from the shape of the curves for the inferred resources of each coal

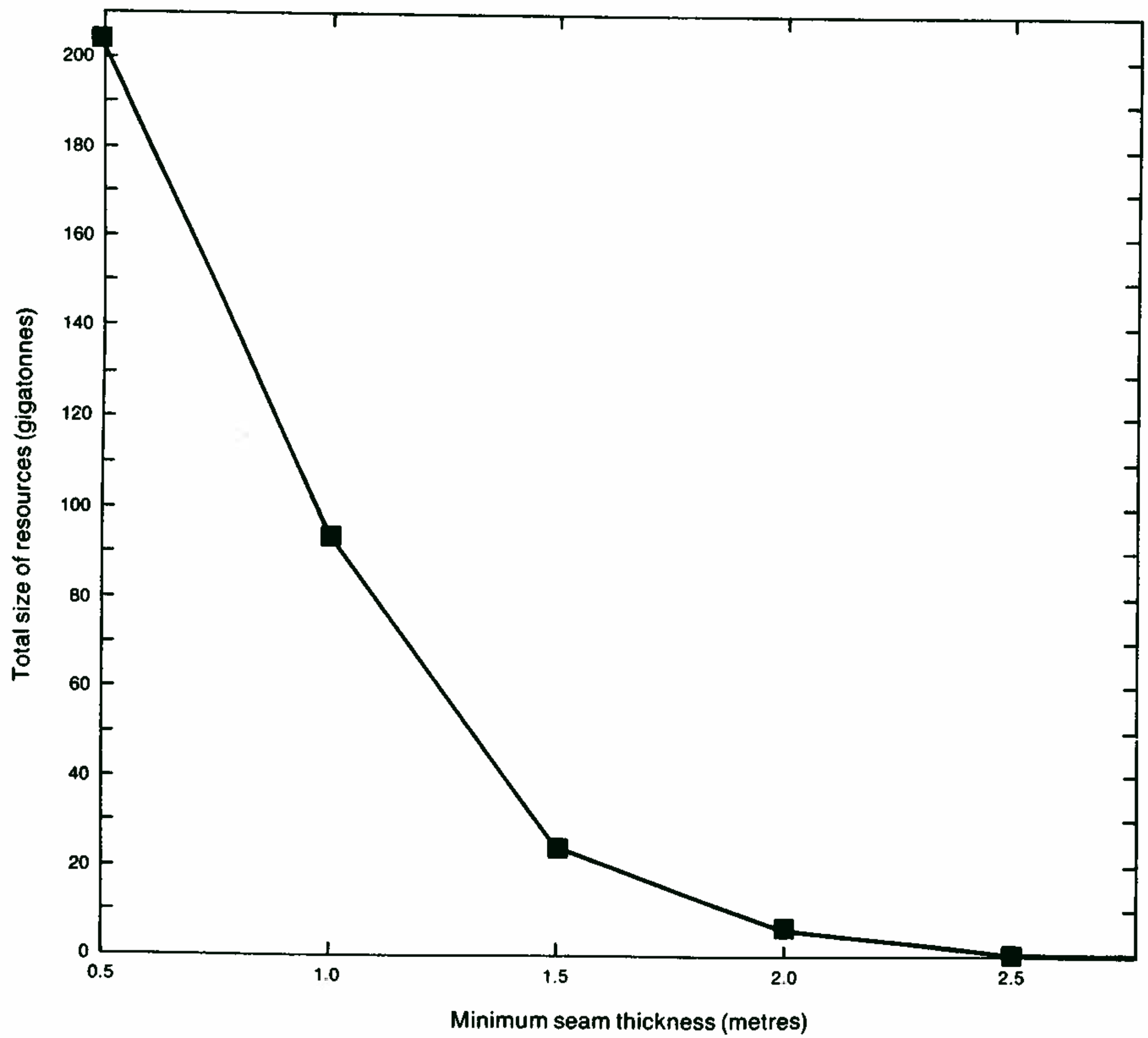


Figure 10. Inferred resources of the Belly River Group to 400 m depth.

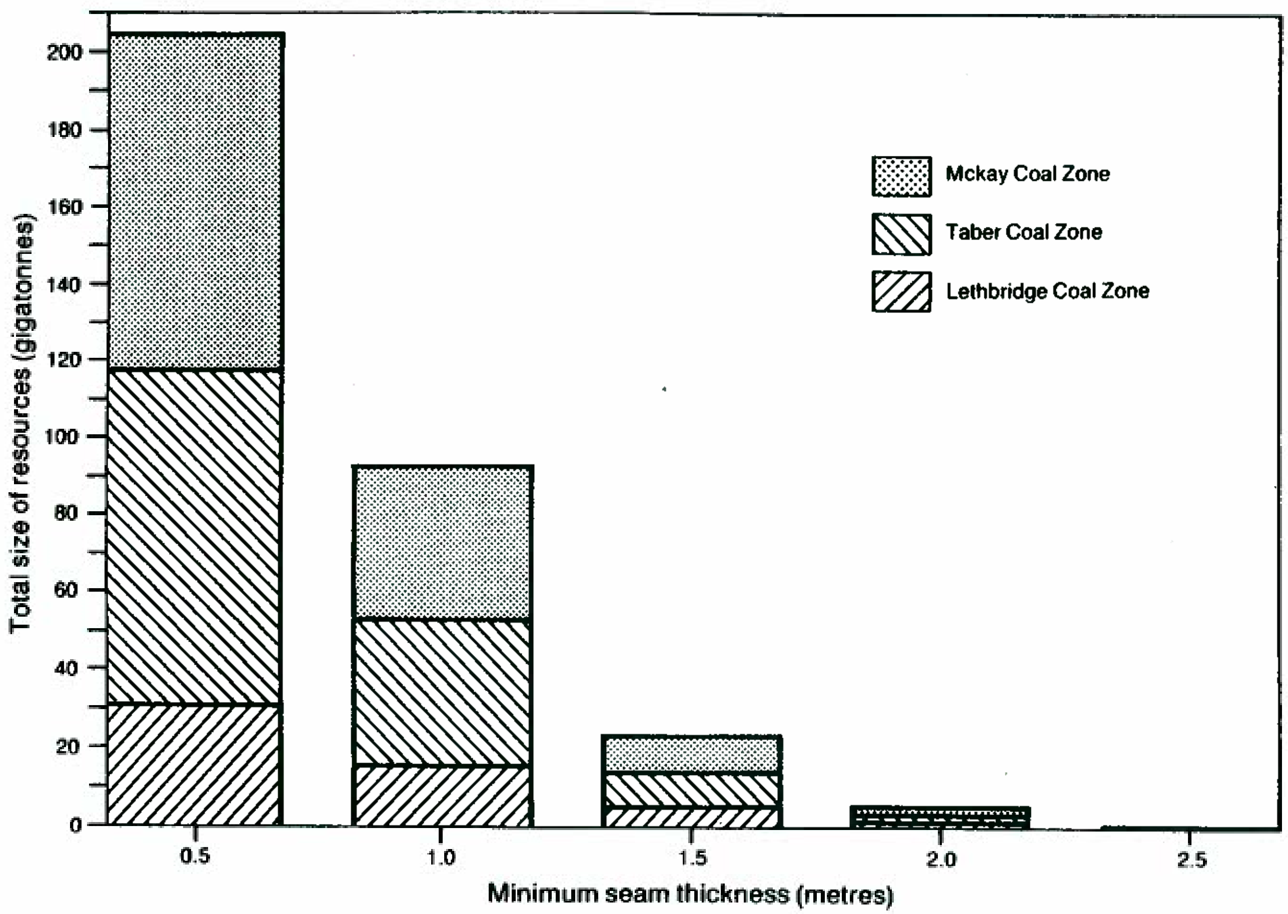


Figure 11. Comparison of the size of the resources of the three major coal zones of the Belly River Group.

zone (figure 6). The shape of each curve is largely a function of the modal seam thickness. The curve for the Ardley coal zone is more linear than the others. In the Ardley, a considerable portion of the total resources is made up of seams greater than 1 m thick and seams commonly exceed 3 m in thickness. In the Belly River Group and the lower Horseshoe Canyon Formation, however, the curves are exponential in nature, resulting from the large increase in total resources for seams 0.5 to 1.0 m thick.

The geologic model developed for the Ardley coal zone involves a continental setting in an alluvial plain environment characterized by widespread peat swamps that were far removed from marine conditions. Due to extremely low relief, relatively rapid subsidence and sediment starvation, thick and extensive peats developed. This geologic setting was particularly favourable for the development of thick (i.e. greater than 1.0 m) and extensive coal beds.

In contrast, the geologic model developed for the lower Horseshoe Canyon and Belly River coals involves a coastal plain setting characterized by shore-parallel peat swamps, 30 to 50 km inland from actual shorelines. Frequent transgressions and regressions of the ancient seas resulted in deposition of many thinner coal beds. The peats could only accumulate for a relatively short time before the swamps were drowned during periods of marine transgression. Nearly half the resources available for the Horseshoe Canyon Formation and the Belly River Group are in seams 0.5 to 1.0 m in thickness.

8. ECONOMICS

The present calculations as to the size of inferred resources of the three major coal-bearing units are shown in Table 2. Estimates of coal resources by the Energy Resources Conservation Board (ERCB) are also shown. The Research Council's figures are substantially larger. The present study is clearly important in

	Ardley	Lower Horseshoe Canyon	Belly River
ARC[1] Inferred (resource)	104.4	125.3	93.0
ERCB[2] Initial-in-place (resource)	20.7	20.2	1.7
ERCB[2] (reserves)	9.1	6.1	0.7

[1] Alberta Research Council, unpublished data.

[2] ERCB, 1984, Reserves of Coal - Province of Alberta, ERCB ST85-31 Energy Resources Conservation Board

Table 2. Coal Resource/Reserve Estimates in Billions of Tonnes

that it has delineated huge coal resources, previously poorly understood. The Research Council and ERCB figures are, however, complimentary and are in no way contradictory.

The ERCB issues two sets of figures, both resources ("initial-in-place") and reserves. "Initial-in-place" resources are estimates of the quantity of the resource prior to production and "reserves" are estimates of established resources considered recoverable by current technology under present or anticipated economic and social conditions (ERCB, 1984). The ERCB calculates the size of reserve primarily from data obtained in designated coal fields. In these areas extensive data, primarily from shallow coal company wells, are available and the extent of the coal deposits is known in considerable detail. In parts of the Dodds-Roundhill coalfield, for example, there are over 200 wells per township, giving a higher degree of geologic assurance. Designated coal fields are of economic interest because of the feasibility for surface mining.

In contrast, the Research Council's studies have not been restricted to designated coal fields. Inferred coal resources have been delineated from the near surface to depths of 400 m. In a large part, therefore, the higher resource figures of the Research Council reflect a wider geographic area studied. The purpose of the recent studies has been to delineate deposits of coal that could be early targets for future underground mining in the province. Results of these studies prove the existence of huge coal resources in the province and point out favourable areas for future exploration. Much more drilling will have to be done to delineate the coal reserves of the future.

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