

GEOLOGY AND MINERAL RESOURCES,
NORTHWEST-CENTRAL ALBERTA
(Hinton to Grande Prairie)

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Alberta
RESEARCH COUNCIL



INTRODUCTION

This report describes the geology and mineral resources of an area in west-central Alberta, extending from Highway 16 in the south to the Grande Prairie district in the north, and from Jasper National Park-British Columbia boundaries in the west to the Swan Hills region in the east. Special emphasis is given to the western part of this area, which is traversed by the route of the Alberta Resources Railway.

SOURCES OF DATA

Information on the bedrock geology of the Foothills region is mainly from reports published by the Geological Survey of Canada (Greiner, 1955; Irish, 1965) and from unpublished maps supplied by oil companies. Most of the bedrock geology and coal resources data for the Plains area were obtained from helicopter surveys conducted by the Research Council's Geology Division in 1969 and 1970. This material is supplemented by information in reports by Allan and Carr (1946) and Govett (1961), and by unpublished data on gypsum and coal resources in Research Council files.

Information on oil and gas fields is compiled from maps and other material published by the Energy Resources Conservation Board in Calgary.

PHYSIOGRAPHY

The area is divisible into two broad physiographic units which correspond to the major geologic features of northwest-central Alberta:

- (1) Rocky Mountains and Foothills, which extend across the southwest portion of the map-area into northeastern British Columbia. They consist of a series of subparallel, northwest-trending ridges composed of complexly folded and faulted sedimentary strata¹ of Late Precambrian to Cretaceous

¹ Sedimentary strata are rocks composed of organic and mineral detritus deposited in ancient seas, lakes, and rivers -- for example: sandstone, mudstone (shale), limestone, dolomite, evaporite deposits such as salt and gypsum, and coal (an organic "sediment"). They should be distinguished from igneous rocks such as granite, basalt, and volcanic rocks which are formed by crystallization of molten rock materials beneath or at the earth's surface.

ages. Maximum elevations range from 10,000 feet in the southwest to 6000 feet along the northeast margin where the strata merge with the flat-lying beds of the Plains.

(2) Plains, which is that area outside of the Foothills proper. The "Plains" consist of a nearly flat to gently rolling terrain which extends across the northern part of the area from Grande Prairie to Valleyview, and south to Fox Creek. The lowlands merge to the south with a dissected tableland consisting of a series of narrow flat-topped ridges and hills separated by the deep valleys of Cutbank, Kakwa, Smoky, and Simonette Rivers and major tributary streams.

The Alberta Resources Railway runs from Brule on the main CNR line in the south northward along the eastern margin of the Foothills to Grande Cache. From Grande Cache the railway follows the deeply incised valley of the Smoky River for some distance, then swings north across relatively flat glaciated terrain to Grande Prairie.

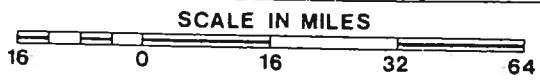
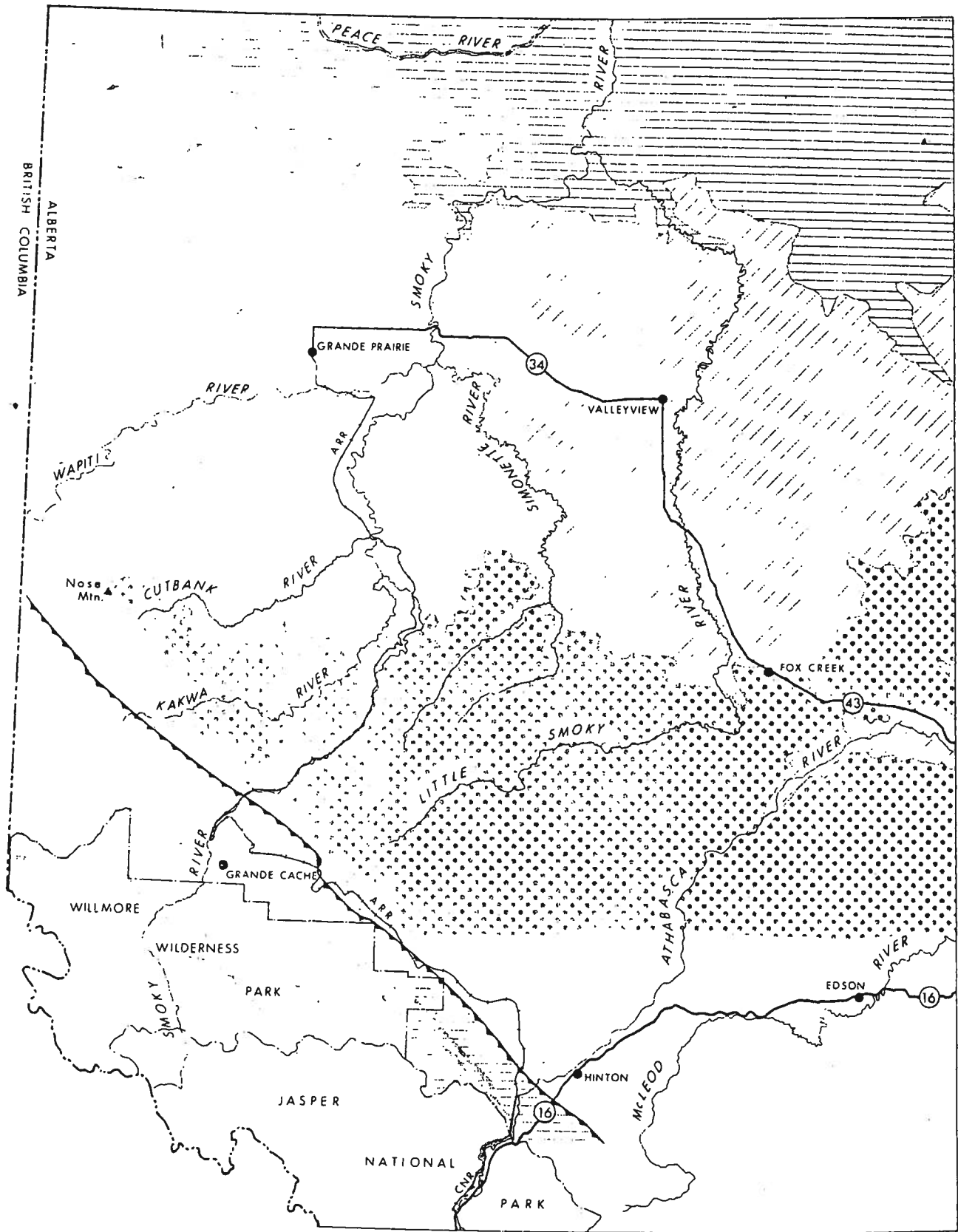
GEOLOGY AND MINERAL RESOURCES

The bedrock of the region is formed by sedimentary rocks which can be divided into several groups or "formations" outlined in a general way in figure 1 (Bedrock Geology).

The strata of the Plains are composed of sandstone, shale, and coal; they dip very gently to the southwest where they merge with the complexly folded and faulted strata of the Foothills. Exposures (outcrops) of these rocks are scarce, except along the valleys of major rivers and streams, and most of the region is covered by thick unconsolidated deposits of glacial origin -- gravel, sand, and clay.¹

The Rocky Mountains and Foothills also are composed of sedimentary strata but, unlike the Plains beds, are complexly folded and faulted to form a series of northwest-trending ridges that increase in maximum

¹ Deposited during the Pleistocene ice age, about 10,000 to 12,000 years ago.



BEDROCK GEOLOGY

- | | | | |
|--------|---|-----------|--|
| PLAINS | TERTIARY:
SANDSTONE AND SHALE | FOOTHILLS | UNDIVIDED MESOZOIC:
INCLUDES L. CRET. COAL MEASURES |
| | UPPER CRETACEOUS:
SANDSTONE, SHALE, COAL | | UPPER PALEOZOIC
CARBONATE ROCKS |
| | UPPER CRETACEOUS:
MARINE SHALE | | PRECAMBRIAN & |

elevation towards the west. The composition of the rocks is variable: the younger Cretaceous strata consist largely of sandstone, shale and coal, whereas the older Triassic and Paleozoic formations are composed of limestone, dolomite, gypsum, and quartzite.

The mineral resources of the region can be grouped into three categories, which are discussed below with reference to the accompanying maps:

- (1) metallic and industrial minerals;
- (2) coal;
- (3) oil and natural gas.

Exploration for and development of these resources are still at an early stage, and the evaluation given below therefore should be treated as a preliminary review, based on best available data.

Metallic and Industrial Minerals

Metallic mineral showings have not been recorded from the area (either Foothills or Plains), and the geology of the region indicates that it is unlikely metallic ore deposits (iron, lead, zinc, gold, etc.) will be found. A possible exception is uranium, for which some prospecting has been carried out recently in the area south of Grande Prairie, extending west to the British Columbia border.¹ The basis for suggesting that uranium could be present in this area is that the coal-bearing sedimentary strata of the Plains region are grossly similar in composition and structure to the uranium-bearing sedimentary rocks of the Colorado Plateau in the United States. However, to date no *bona fide* uranium showings in the bedrock strata of northwest-central Alberta have been confirmed, and it seems unlikely, although not highly improbable, that economic deposits of this mineral will be found in the region.

Industrial minerals are those rock or mineral commodities other than metallic and hydrocarbon resources. They can be grouped into two broad

¹ An unpublished report submitted to the Department of Mines and Minerals describing the results of this work is in the Research Council's Geology Division files.

categories according to their origin:

- (1) surficial (glacial) deposits: unconsolidated gravel, sand, and clay overlying bedrock;
- (2) bedrock deposits: limestone, gypsum, kaolin, shale, bentonite, and a number of similar materials found in or associated with sedimentary bedrock formations.

Surficial deposits of different types and variable thickness overly bedrock in most parts of northwest-central Alberta, including portions of the Foothills in the southwest.¹ These materials can be summarized for economic purposes as follows:

silica sand: large quantities of dune sand extend from south of Grande Prairie north of the Wapiti River eastward to Simonette River. They appear to have compositional and textural properties similar to low grade silica sand (dune) deposits in the Edmonton and Red Deer areas of central Alberta, which (in the Edmonton area) are being used for manufacture of fibreglass.

clay: large quantities of clay suitable for cement- or brick-making purposes are undoubtedly present in the flat agricultural terrain surrounding Grande Prairie. However, like the silica sand deposits noted above, these clays have only a limited local potential as an industrial mineral commodity.

concrete sand: a serious shortage of coarse sand for construction purposes exists in the Grande Prairie district. One local supplier (Foothills Sand and Gravel Limited) presently is producing concrete sand by crushing quartzite gravel from terraces on the Wapiti River -- an expensive proposition. Also, some sand is being hauled from the Hines Creek district, about 90 miles north of Grande Prairie. Thus, a good deposit of high-grade concrete sand within 50 miles of Grande

¹ The surficial deposits of this region have not been mapped in any detail, except to the east about the flanks of the Swan Hills. The Research Council's Geology Division plans to map the surficial deposits in the western part of the area in 1972, with emphasis on finding sand and gravel deposits for road-building and other construction purposes.

Prairie undoubtedly would merit investigation, even although the material would have to be hauled by truck or rail to Grande Prairie.

The bedrock formations of northwest-central Alberta contain a number of potential industrial mineral deposits, although the quality and (primarily) the distance from existing markets of these deposits suggest that their development is still some years away. These include:

limestone (used mainly in cement manufacture and for quicklime products): limestone formations are present in the Rocky Mountains in the southwest part of the area, extending northward along the eastern margin of Jasper National Park into the area designated as Willmore Provincial Park. They are shown on figure 1 as "Upper Paleozoic" formations, forming a series of subparallel ranges that trend in a northwesterly direction. The quality of the limestone is not known in any detail, but these formations provide the closest source of raw cement-making materials for the Peace River district (the other necessary raw material for cement is clay, found in abundance about Grande Prairie). Thus, should economic conditions warrant establishing a cement industry in northwestern Alberta, the limestone ranges of this region should be investigated more thoroughly.

gypsum (used in wallboard and ceiling tile manufacture and as a minor constituent of cement): a gypsum deposit is present on Featherstonehaugh Creek, on the Alberta-British Columbia border west of Grande Cache (approximately Sec. 20, Tp. 55, R. 13, W. 6th Mer.). It was drilled several years ago by Domtar Chemicals Ltd., but the quality apparently proved to be marginal and the company subsequently dropped its lease. It should be noted that the deposit lies within the confines of Willmore Wilderness Park.

phosphate rock (used in fertilizer manufacture): some deposits of low grade phosphate rock have been examined in various parts of the Alberta Foothills; these showings extend northward into the general Grande Cache-Smoky River area. However, the deposits are either too

thin or too low grade to constitute an economic mineral resource within the foreseeable future.

bentonite (a clay used in drilling mud, as a bonding agent in iron ore processing and in a variety of manufacturing processes): a number of minor bentonite deposits have been found in Upper Cretaceous strata of the Plains (see Fig. 1) which extend south of Grande Prairie towards the high ridges margining the Foothills. Similar bentonites presently are being exploited in central Alberta (near Onoway and at Rosalind, south of Camrose), but the market for these products is limited. Thus, unless the bentonites in northwest-central Alberta prove to have unusual physical and chemical properties that would enable them to compete with the central Alberta bentonites, or with imported drilling muds,¹ they stand little chance of being developed for industrial use.

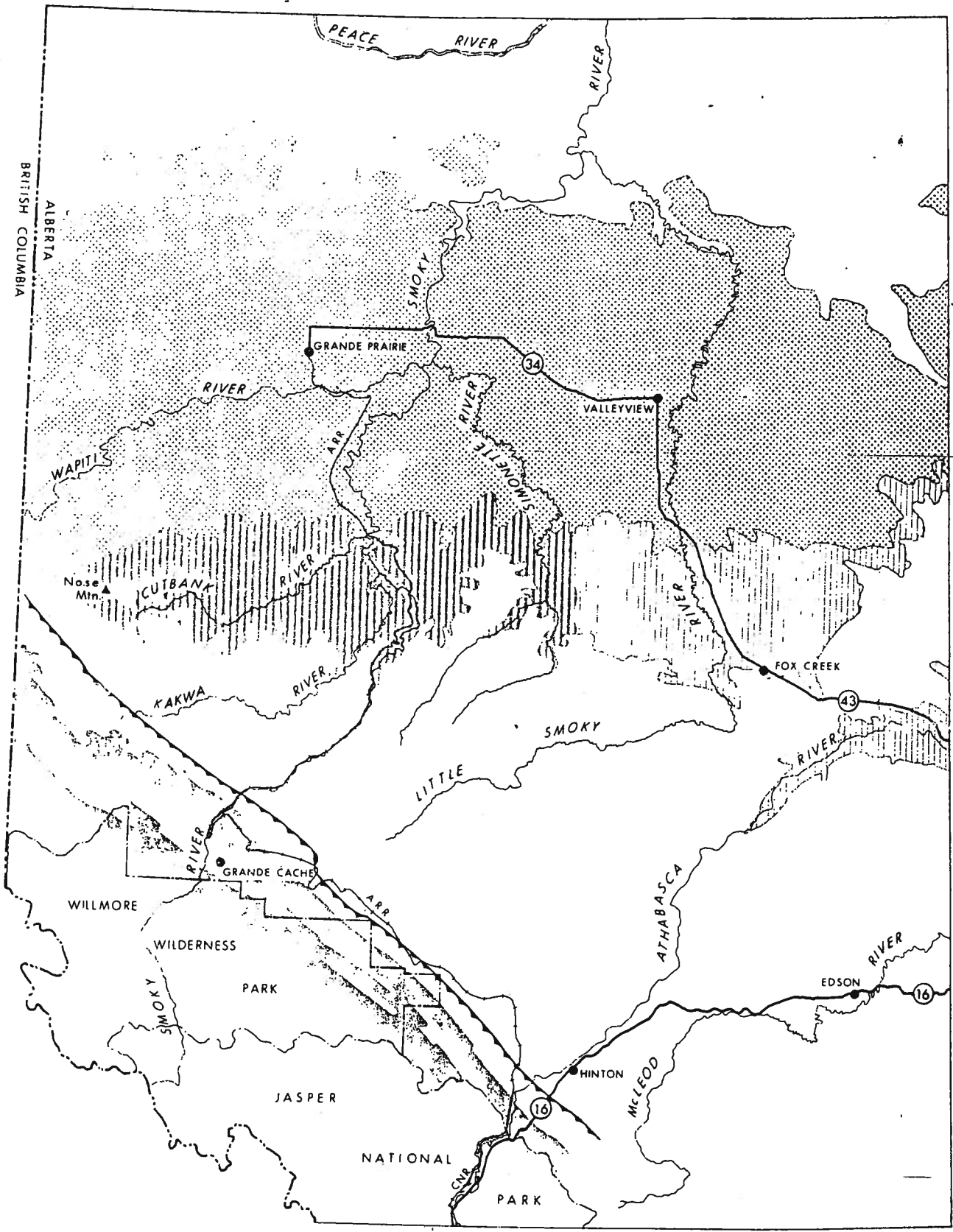
kaolin (a clay used for stoneware and refractory materials, in high quality paper manufacture, and in many other industrial processes): kaolinitic sandstones have been found outcropping on the Wapiti River southwest of Grande Prairie during the course of a survey carried out by Research Council geologists in 1969. However, the extent and grade of these sandstones have not been investigated in any detail, although they may merit further attention. There is also a possibility that stoneware-quality clays or shales may be found in association with the coal-bearing Cretaceous strata that extend south of Grande Prairie, or in younger Tertiary strata that merge with the folded Foothills strata to the southwest.

Coal

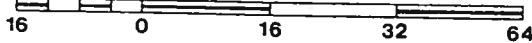
Coal deposits are widespread throughout northwest-central Alberta, falling into two main categories:

- (1) medium to low volatile bituminous coking (or metallurgical) coal;

¹ Most high-grade drilling muds used in Western Canada are made from Wyoming bentonites. Similarly, the bulk of the bentonite used in Eastern Canada for pelletizing iron ores is imported.







SCALE IN MILES





COAL-BEARING STRATA

UPPER CRETACEOUS

-  BELLY RIVER - EDMONTON
-  ARDLEY
-  HIGH VOL. BITUM.
-  SUB. BITUMINOUS

LOWER CRETACEOUS

-  LOW VOL. BITUMINOUS (COKING)
-  FOOTHILLS BOUNDARY

(2) high volatile bituminous to subbituminous "thermal" coal.

Coking coal is confined to folded and faulted Lower Cretaceous strata of the Foothills in the southwest part of the area (Fig. 2).¹ Large reserves apparently are present in a zone that extends (with some interruptions due to structural complexities) northward from Brule on the eastern boundary of Jasper National Park, to the present site of the McIntyre operation at Grande Cache, across the Kakwa River into British Columbia. Existing coal lease maps of the Foothills (available from the Department of Mines and Minerals) provide a reliable indication of the precise locations of Lower Cretaceous coal-bearing strata.

Thermal (i.e. non-coking) coal is found at many localities within the broad band of Upper Cretaceous strata that extends across the northern part of the area from the British Columbia border to the Simonette River and eastwards (Fig. 2). These deposits were mined on a local scale in the general vicinity of Grande Prairie (Halcourt area) in the 1940's, but it is only recently that interest in them as a potential energy source has revived.

The strata are grouped into two units in figure 2, of which the upper Ardley coal zone² appears to contain the best-developed seams. The thickest deposits apparently extend about the flanks of Nose Mountain (near the headwaters of Cutbank River), on the Kakwa and Smoky Rivers near their junction, and on Simonette River to the east. The grade or "rank" (i.e., calorific value) of these coal deposits decreases gradually in an eastward direction. Thus, the coal seams west of the Simonette River generally rank as high volatile bituminous, and those to the east about the flanks of the Swan Hills as subbituminous, with a lower average calorific value. Several

¹ The map in figure 2 showing the distribution of potential coal-bearing strata in the Foothills indicates the maximum areal extent of these strata. In fact, the actual extent of Lower Cretaceous coal-bearing beds is considerably less than indicated, but existing maps are not sufficiently accurate to delineate the exact boundaries.

² The term "Ardley" is taken from correlative coal-bearing strata which extend southward through central Alberta. The coal beds mined at Wabamun are from the Ardley zone.

companies currently are exploring or intend to explore these deposits in some detail.¹

Other Upper Cretaceous beds, shown as Edmonton-Belly River equivalents in figure 2, also contain coal deposits of variable thickness and extent, but these apparently are not as widespread as the younger Ardley beds. Nevertheless, the older strata provide some basis for additional exploration, although glacial deposits form a relatively thick cover in most parts of the region.

Oil and Gas

One gas field and one small oil field have been developed within the area between Hinton and Grande Prairie, west of the 6th meridian (Fig. 3). The gas field (Gold Creek) consists of seven pools producing from Devonian and Lower Cretaceous strata. As of December 31, 1970 the marketable gas reserves totalled 332 billion cubic feet. The gas recovered from Devonian strata contains approximately 7.6 per cent H_2S -- this yields reserves of 1,075,000 long tons of sulphur. In addition to the Gold Creek gas field, several shut-in gas wells are present in the area (Fig. 3) with estimated reserves of approximately 71 billion cubic feet. The wells, southwest of Grande Prairie towards the Foothills, are considered too remote at present for economic development.

The oil field (Lator) consists of two oil wells, one suspended well, and one well being drilled as of December 31, 1971. Production is from Cretaceous sandstones, but reserve figures are not available. The nearest oil field to Lator is the Simonette field to the east (Fig. 3), which produces from Devonian strata with estimated reserves of approximately 37 million barrels (December 31, 1970).

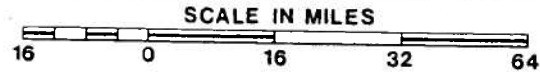
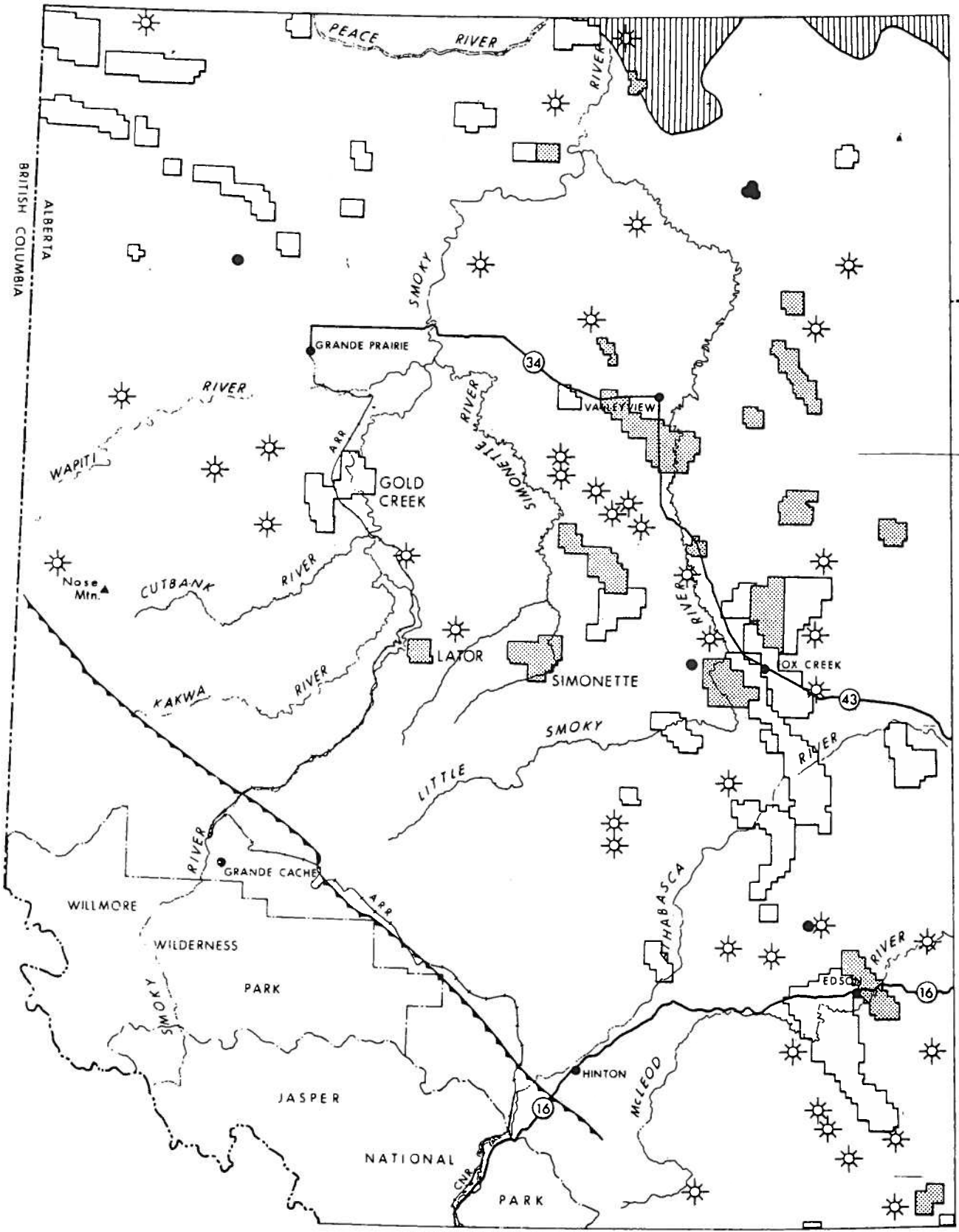
The future potential for oil and gas deposits in the area described above is conjectural. Drilling activity has been relatively slow, and the well density is low compared to the more shallow parts of the sedimentary

¹ A paper describing the Upper Cretaceous coal deposits of this area was presented by Research Council geologists at the Coal Geology Conference held in Edmonton, November, 1971.







basin to the north and east (note the distribution of oil and gas fields in figure 3). The reasons for this are generally difficult access and (more important) the relatively great depths to potential producing formations -- in the order of 10,000 feet or more. As a result, drilling is expensive although the number and thickness of potential oil- and gas-bearing formations is greater than in the more shallow parts of the basin to the east (about Swan Hills, for example). Thus, it seems reasonable to conclude on the basis of existing knowledge that the oil and gas potential of the area is good -- particularly the potential for "sour" gas -- and that economic amounts of these resources will be found as exploration activity increases.

REFERENCES CITED

- Allan, J. A. and J. L. Carr (1946): Geology and coal resources of Wapiti-Cutbank area, Alberta; Res. Council Alberta Report No. 48.
- Govett, G. J. S. (1961): Stratigraphy of some gypsum and anhydrite deposits in Alberta; Res. Council Alberta Bulletin 7.
- Greiner, H. R. (1955): Two Lakes, Alberta; Geol. Survey Canada Paper 55-14.
- Irish, E. J. W. (1965): Geology of the Rocky Mountain Foothills, Alberta (between latitudes 53° 15' and 54° 15'); Geol. Survey Canada Memoir 334.
- Kramers, J. W. and G. B. Mellon (in press): Geology of Upper Cretaceous coal-bearing strata, northwest-central Alberta; Res. Council Alberta contribution paper.



OIL AND GAS FIELDS

-  OIL FIELD
-  GAS FIELD
-  OIL WELL
-  GAS WELL
-  OIL SANDS
-  FOOTHILLS BOUNDARY