# *LIMESTONE RESOURCES OF ALBERTA*

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**cover photographs**

*(Locations given clockwise beginning at top)*

1. *Canada Cement Lafarge Limited plant and quarries at Exshaw (photograph courtesy of Alberta Business Development and Tourism)*

2. *Outcrop of the Upper Devonian Waterways Formation (Moberly Member) along the east side of the Athabasca River, near Fort McMurray.*

3. *Drilling blast holes in the quarries of the Inland Cement Company Limited near Cadomin.*

4. *Cadomin and the valley of the McLeod River. Quarries of Inland Cement Company Limited are on the mountaintop on the left side of the valley (Photograph courtesy of Alberta Business Development and Tourism)*

5. *Steel Brothers (Canada) Limited lime kiln at Kananaskis.*

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# LIMESTONE RESOURCES OF ALBERTA


## ABSTRACT

Seven areas in Alberta, close to transportation facilities, were studied to determine quality and reserves of high-calcium limestone.

Three formational units in the foothills and mountain regions are of importance. The lower Cambrian Eldon Formation has a limited potential in the Exshaw area where it was previously exploited for limemaking. The Upper Devonian Palliser Formation contains large reserves of high-grade rock in the Crowsnest, Exshaw, Cadomin, and Brûlé areas. At one time a lime plant operated successfully at Cadomin, utilizing rock from this formation. Present production of Palliser limestone at Exshaw and Cadomin is used for cement-making. The Mississippian Livingstone Formation is of proven high quality in the Crowsnest, Blairmore, Exshaw, and Nordegg areas. Formerly a cement plant operated at Blairmore, utilizing limestone from this formation; new quarries have been opened in the Crowsnest and Exshaw areas to supply lime plants.

Quality of foothills and mountain limestone deposits is often lowered by the presence of siliceous and dolomitic beds. Compositional variation is a particular problem in the Livingstone Formation.

Near Fort McMurray, in northeastern Alberta, the large resources of limestone in the Moberly Member of the Upper Devonian Waterways Formation appear to be of moderate quality. The calcium carbonate grades are affected in places by an abundance of silica and alumina.

## INTRODUCTION

Limestone, a sedimentary rock composed primarily of calcium carbonate ($CaCO_3$), has a wide variety of industrial uses, both as a raw or semi-processed commodity and as source of calcium compounds. The major uses of raw limestone are as a source of crushed stone (aggregate) in areas where other forms of sand and gravel are scarce; as a metallurgical flux in the iron and steel industry; and as a neutralizing agent for treatment of acid soils. Processed limestone yields a variety of compounds, the most important being hydraulic cement which reacts with water to form a hard crystalline mass. Mixed with water, sand, and gravel (or other types of aggregate), cement hardens to form concrete, a product of fundamental importance to the construction industry. Smaller amounts of limestone are quarried to produce quicklime (CaO) and hydrated lime [$Ca(OH)_2$], which find diverse uses in the construction, chemical, papermaking, and agriculture industries. Metallic calcium and calcium chloride ($CaCl_2$), which have a variety of specialized industrial uses, are other common compounds produced from limestone.

Alberta is well endowed with limestone resources, most of which are contained within Paleozoic strata exposed in the Rocky Mountains along the southwest margin of the province. Limestone formations also are exposed at or near the surface in northeastern Alberta, along the lower Peace and Athabasca Rivers and their tributaries. In addition to these major resources, smaller deposits of marl (freshwater deposits of calcium carbonate and clay) and coquina (fossil shell beds) are found at several localities in the province.

The objective of this report is to describe the existing and potential limestone resources of Alberta with special reference to those areas which are accessible or may become accessible for development in the near future. Major limestone formations of the Rocky Mountains and northeastern Alberta have been examined, sampled, and analysed, and the results are summarized for each of seven areas investigated during the course of the study.

### PREVIOUS WORK

The most extensive survey of Alberta's limestone deposits was carried out by M. F. Goudge (1945), who sampled and described limestone-bearing formations at a number of localities in the Rocky Mountains between the Crowsnest Pass and the Athabasca River. However, owing to the lack of large-scale maps in some areas and to the reconnaissance nature of the survey, Goudge's report lacks much of the geological detail necessary for assessing the economic potential of the limestone-bearing strata in particular areas. This report attempts to build upon Goudge's basic investigation of Alberta's limestone resources by providing the necessary stratigraphic and structural details for areas of potential economic interest, and by providing a more detailed suite of analyses from selected stratigraphic intervals.

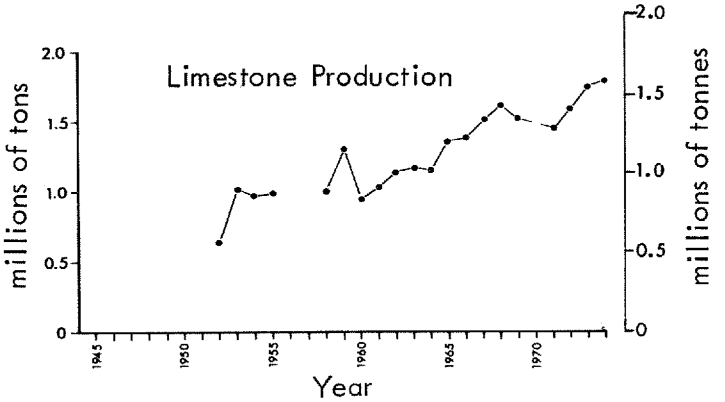
In addition to Goudge's work, several unpublished reports on Alberta's limestone resources have been prepared at various times by investigators concerned with specific deposits or areas. These are listed in the reference section at the end of the report.

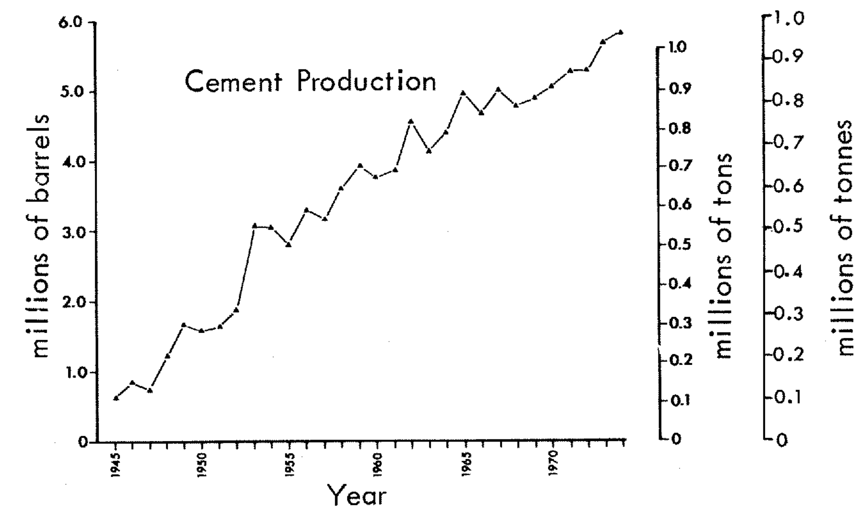
### ACKNOWLEDGMENTS

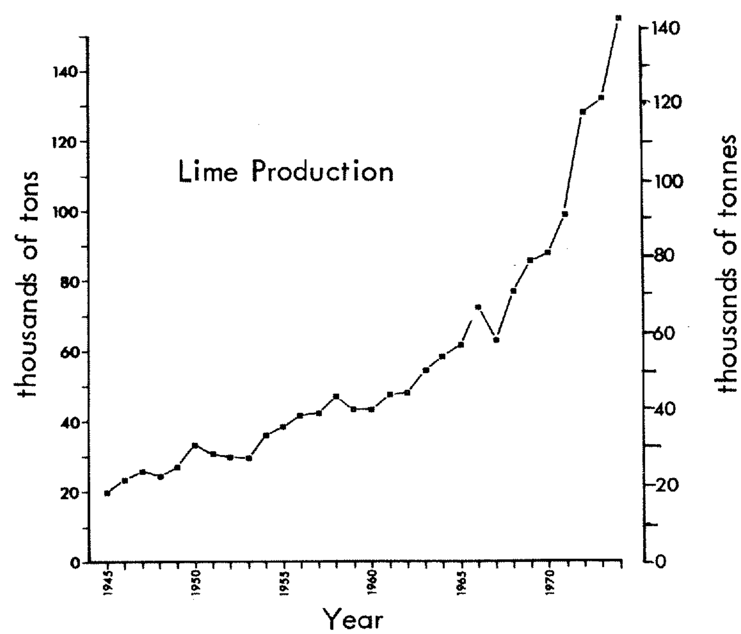
The author acknowledges the services of R. M. Baaske in preparing the samples for examination and analysis, and those of I. E. Davidson and J. R. Nelson for performing the chemical analyses. Thanks are extended to various quarry operators for granting access to their properties, and to colleagues at the Alberta Research Council and in industry for their helpful comments and information. W. H. Shaw provided capable assistance in the field during the sampling aspects of the investigation. X-ray fluorescence analyses were run by D. H. Harvey of the Department of Geology, University of Calgary, under the supervision of Dr. A. A. Levinson.

## PRODUCTION

The bulk of the high quality limestone produced in Alberta is used in the lime and cement industries. At present there are two main lime plants: Summit Lime Works Limited in the Crowsnest Pass area and Steel Brothers (Canada) Limited at Exshaw. These two operations also produce the limestone used in making lime at the Northwest Pulp and Power Limited mill at Hinton, at the Canadian Sugar Factories Limited refinery at Taber, and at a sugar refinery at Moses Lake, Washington. The pulp mill is supplied with limestone by Steel Brothers and the sugar refineries receive shipments from Summit Lime Works. The daily production of rock at the Steel Brothers quarry is approximately 1,000 tons (900 t) and that of Summit Lime Works about 500 tons (450 t). In addition to producing quicklime and hydrated lime, one or both of the plants process limestone for use as aggregate, or poultry grit, and for metallurgical purposes, water treatment, glass processing, and mine dusting. Dolomite is also processed at the Summit Lime Works plant for use as a flux.




Data from reports by:
Statistics Canada
Alberta Energy and Natural Resources

***Figure 1.*** ***Charts showing Alberta's production of limestone, cement, and lime between the years 1945 and 1975***

Quarries at Exshaw and Cadomin respectively produce limestone for cement plants operated by Canada Cement Lafarge Limited at Exshaw and the Inland Cement Company Limited at Edmonton. These plants each have capacities of more than 3 million barrels ($3.9 \times 10^5$ t) of cement clinker a year. Canada Cement Lafarge operates an additional milling plant at Edmonton for crushing clinker from Exshaw.

Total annual production of limestone in Alberta has increased from less than 500,000 tons ($4.5 \times 10^5$ t) prior to 1950 to approximately 1.8 million tons ($1.6 \times 10^6$ t) in 1974 (Fig. la). Most of this increment is attributable to production gains in the cement industry, which climbed from less than 1 million barrels ($< 1.5 \times 10^5$ t) during 1945 to nearly 6 million barrels ($9 \times 10^5$ t) in 1974 (Fig. 1b). During the same period, annual lime output increased from 20,000 tons ($1.8 \times 10^4$ t) to over 150,000 tons ($1.4 \times 10^5$ t) (Fig. lc).

It should be noted that annual cement production has shown a nearly constant rate of increase since 1965. In light of increasing demand for cement and concrete products, it appears certain that markets shortly will demand sizable expansions in output. It is, however, beyond the scope of this report to attempt a prediction of future production of limestone and limestone products (including cement) in Alberta; it is sufficient to state that these materials will continue to play an important role in the industrial development of the province.

## GEOLOGY AND DISTRIBUTION OF FORMATIONS

Most of Alberta's potential limestone resources are restricted to strata of Paleozoic age, and are exposed along the strike of the Rocky Mountains and Foothills in southwestern Alberta, or at the margin of the Canadian Shield in the northeast (Fig. 2).

### ROCKY MOUNTAINS AND FOOTHILLS

The Rocky Mountains and Foothills form a northwest-trending belt of complexly folded and faulted strata extending along the southeastern margin of Alberta from the International Boundary in the south to the British Columbia-Alberta border in the northwest, a distance of approximately 450 miles (720 km). Width of the folded belt varies from 25 to 75 miles (40 to 120 km). Within the Foothills and Front Ranges, a series of west-dipping, low angle thrust faults has brought to the surface a thick succession of sedimentary strata ranging in age from Precambrian to Paleocene. The region contains three national parks (Waterton Lakes, Banff, and Jasper), and three major provincial wilderness parks (Willmore, White Goat, and Siffleur), with the result that a significant portion of the Alberta Rocky Mountains presently is interdicted from mineral resource exploration and development.

Although limestone-bearing strata of various types and diverse origins are exposed in the Rocky Mountains and Foothills, those with reasonable economic potential are restricted to formations of Cambrian, Devonian, and Mississippian ages (Table 1). Cambrian strata with some potential limestone resources are confined to the Front Ranges of the Rocky Mountains near Exshaw, west of Calgary (Fig. 2).

Lower Cambrian strata in the Exshaw area exceed 800 feet (240 m) in thickness and are composed of limestone and variable amounts of dolomite. The Cambrian Eldon Formation was quarried east of Exshaw until exhaustion of the high-calcium limestone in the quarries.

Limestone-bearing formations of Devonian age are widely distributed in the Rocky Mountains, extending from the Crowsnest Pass region in the south to the Athabasca River valley in the north. The rocks have been divided into a diverse array of stratigraphic units; the most important are listed in table 1.

The upper Devonian Fairholme Group comprises up to 1,200 feet (370 m) of carbonate section in the Foothills and Rocky Mountains. The entire succession is dolomitic and the only commercial development to date is in the Crowsnest Lake area where one quarry has been opened as a source of dolomite.

The Alexo Formation varies from 100 to 200 feet (30 to 60 m) thick and is entirely dolomitic. No development of the Alexo has been attempted.

Throughout most of southwestern Alberta the Palliser Formation contains high-calcium limestone within the 600- and 900-foot (180- to 270-m) thick succession. Commercial exploitation of Palliser limestones is presently underway at Exshaw and Cadomin.

The transitional Mississippian-Devonian Exshaw Formation overlies the Palliser Formation. The Exshaw is up to 160 feet (49 m) thick and consists of black shale and argillaceous, silty limestones which are not of value to the limestone industry.

Mississippian carbonate strata have as wide a distribution as those of Devonian age. The major stratigraphic units into which the Mississippian succession has been divided are listed in table 1.

The Mississippian Banff Formation occurs stratigraphically above the Exshaw Formation and contains 500 to 850 feet (150 to 260 m) of shales and argillaceous and siliceous limestones. Development of the formation as a source of limestone is deemed unlikely.

**Table 1. Stratigraphic relationships of geological formations**

| System | CROWSNEST PASS | BLAIRMORE | EXSHAW | NORDEGG | CADOMIN | BRÛLÉ | FORT McMURRAY |
|---|---|---|---|---|---|---|---|
| MISSISSIPPIAN | Rundle Group: Etherington | Rundle Group: Etherington | Rundle Group: Etherington | Rundle Group | Rundle Group | Rundle Group | |
| | Mount Head | Mount Head | Mount Head | | Mount Head | | |
| | | | | | Turner Valley | | |
| | Livingstone | Livingstone | Livingstone | Shunda | Shunda | | |
| | | | | Pekisko | Pekisko | | |
| | Banff | Banff | Banff | Banff | Banff | Banff | |
| | Exshaw | | Exshaw | Exshaw | Exshaw | Exshaw | |
| UPPER DEVONIAN | Palliser | | Palliser | Palliser | Palliser | Palliser | |
| | Alexo | | Alexo | Alexo | | Alexo | |
| | Fairholme Group | | Fairholme Group: Southesk | Fairholme Group: Mount Hawk | | Fairholme Group: Mount Hawk | |
| | | | Cairn | | | | Waterways * |
| CAMBRIAN | | | Pika | | | | |
| | | | Eldon | | | | |

* The Waterways Formation is divided into five members: (from oldest to youngest): Firebag, Calumet, Christina, Moberly and Mildred.

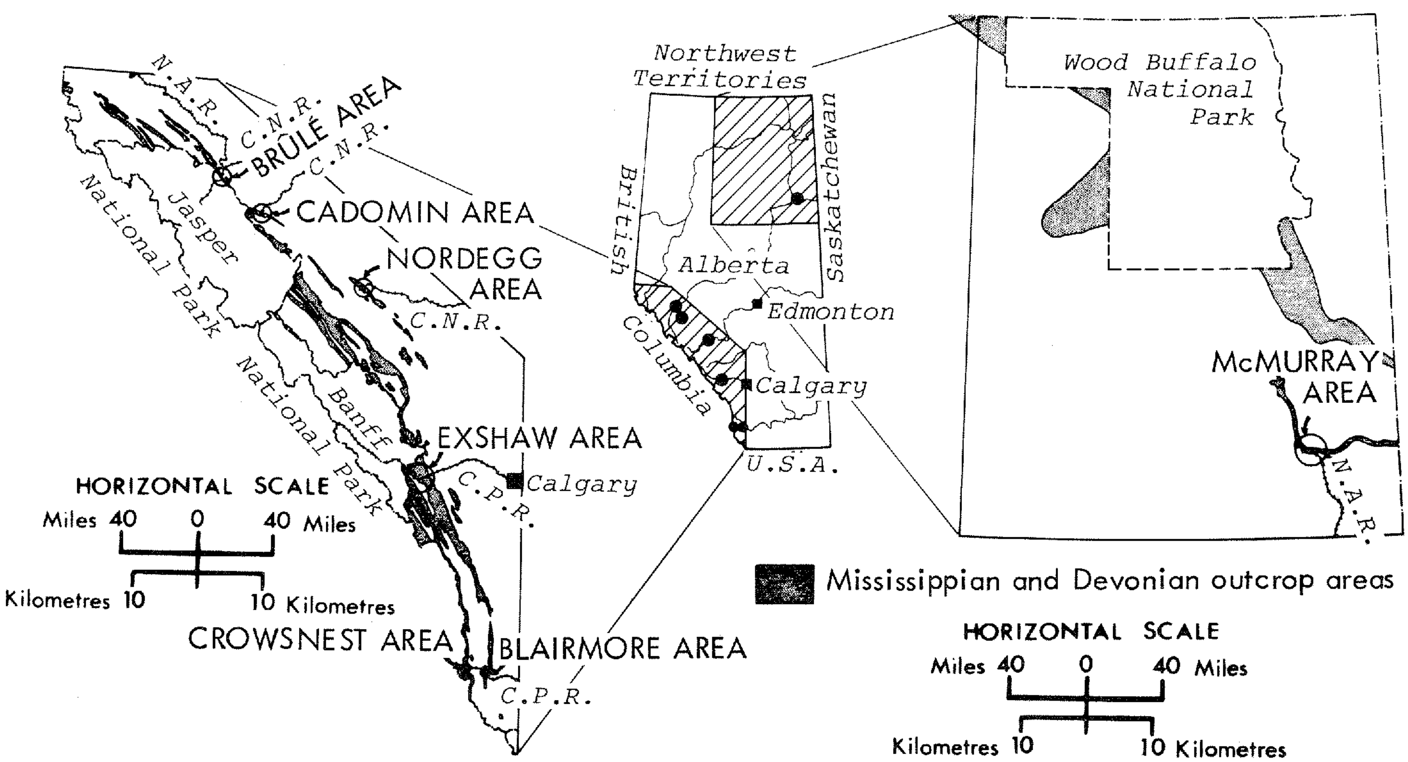



*Figure 2. Index map showing locations of Alberta's limestone resources*

The Livingstone Formation, overlying the Banff Formation, includes a succession of limestone and minor dolomite beds up to 1,500 feet (460 m) thick. This unit yields high-grade limestone in the southern part of the province. Past and present commercial development of these beds has been undertaken in the Crowsnest Lake, Blairmore, Exshaw, and Nordegg areas. Quarries opened at Nordegg were developed only as sources for railway ballast; however, calcium grades in this location may be favorable for lime or cement industries. North of Nordegg, at Cadomin, the equivalent sequence is more dolomitic and of limited value for development. At Brûlé, no Mississippian strata have been satisfactorily tested.

The Mount Head Formation, situated stratigraphically above the Livingstone, is composed of limestones and dolomites with variable amounts of chert and argillaceous material and is between 500 and 1,000 feet (150 to 300 m) thick. The basal part of the formation is quarried in the Crowsnest Lake area. Farther north it appears to be of lower calcium grade.

The uppermost Mississippian strata belong to the Etherington Formation. The unit includes up to 200 feet (60 m) of cherty limestones and dolomites which are not of importance for development.

## NORTHEASTERN ALBERTA

Carbonate and evaporite strata of Middle and Late Devonian ages underlie a large area in northeastern Alberta adjacent to the lower reaches of the Peace and Athabasca Rivers and their tributaries (Fig. 2). Much of this region is contained within the boundaries of Wood Buffalo National Park and is thus closed to mineral exploration. Farther south, Devonian limestones outcrop along the Athabasca and Clearwater Rivers in the vicinity of Fort McMurray, where they underlie the Cretaceous Athabasca Oil Sands.

The Devonian strata in this area are divided into the units listed in table 1. However, good exposures of these beds are scarce, and knowledge of the stratigraphic succession is based mainly on well log data. To the north, towards Lake Claire, the bedrock is covered by Pleistocene glacial and Recent alluvial and deltaic deposits. Consequently, little is known of the lithology and thicknesses of Devonian beds in this region.

Limestone beds in the Fort McMurray area belong to the Upper Devonian Waterways Formation which is approximately equivalent to the Beaverhill Lake Formation in subsurface and the Flume Formation (underlying the Fairholme Group) in the Foothills and Rocky Mountains. The Waterways includes about 700 feet (200 m) of shale and argillaceous limestone interbedded with limestone. The deposits have not been developed to date.

## SAMPLING AND ANALYTICAL PROCEDURES

All samples obtained by the author were collected during the 1970 summer field season. Standard procedures of section measurement and description were utilized and samples were taken at regular vertical intervals, the spacing depending on the amount of section available in outcrop and the apparent degree of variability of the rock. As a result, outcrop sample control varies widely from as little as 5 feet (1.5 m) to over 100 feet (30 m) of vertical section being tested in an individual sample. Because the number of individual samples collected was large, wet chemical analyses were performed only on composite samples representing tens of feet of a section's thickness. This was thought to be a valid approach, as most quarries mine a considerable thickness of rock. Preparation of material for analysis involved cutting a slab from each individual sample for use in petrographic work and pulverizing the remainder. Composite samples for standard wet chemical analyses were then prepared by thoroughly mixing equal proportions of pulverized limestone from each of several individual samples. A portion of each individual sample was analyzed using the X-ray fluorescence technique.

The locations of lines of sampling are given on each of the geological maps provided (Figs. 3, 8, 11, 14, 16, 18, and 20). In addition, the stratigraphic positions from which samples were obtained are shown on the stratigraphic sections (Figs. 4, 5, 6, 7, 9, 10, 12, 13, 15, 17, 19, and 21). Results of composite analyses are presented in Appendix A adjacent to the corresponding samples combined. X-ray fluorescence analyses of individual samples are provided in Appendix B.

# CROWSNEST PASS AREA

## LOCATION AND ACCESSIBILITY

The Crowsnest Pass area, located in southwestern Alberta (Fig. 3), is traversed by both the main line of the Canadian Pacific Railway and Alberta Highway No. 3. A limited number of roads and trails provide access to the surrounding terrain which has up to 3,000 feet (1000 m) of relief.

## GEOLOGY

The area was most recently mapped by Price (1961). Paleozoic and younger strata are thrust to the east over Upper Cretaceous Belly River sandstones along the Lewis Thrust. The beds strike north-south and dip to the west at angles of between 30 and 70 degrees. A few minor thrust faults were also mapped by Price.

The upper part of the Fairholme Group and the entire Alexo Formation consist of buff and grey, sandy dolomites with minor amounts of limestone. Detailed measurements by DeWit and McLaren (1950) placed the thickness of the Alexo at 268 feet (81 m) and the underlying Fairholme beds at 375 feet (115 m).

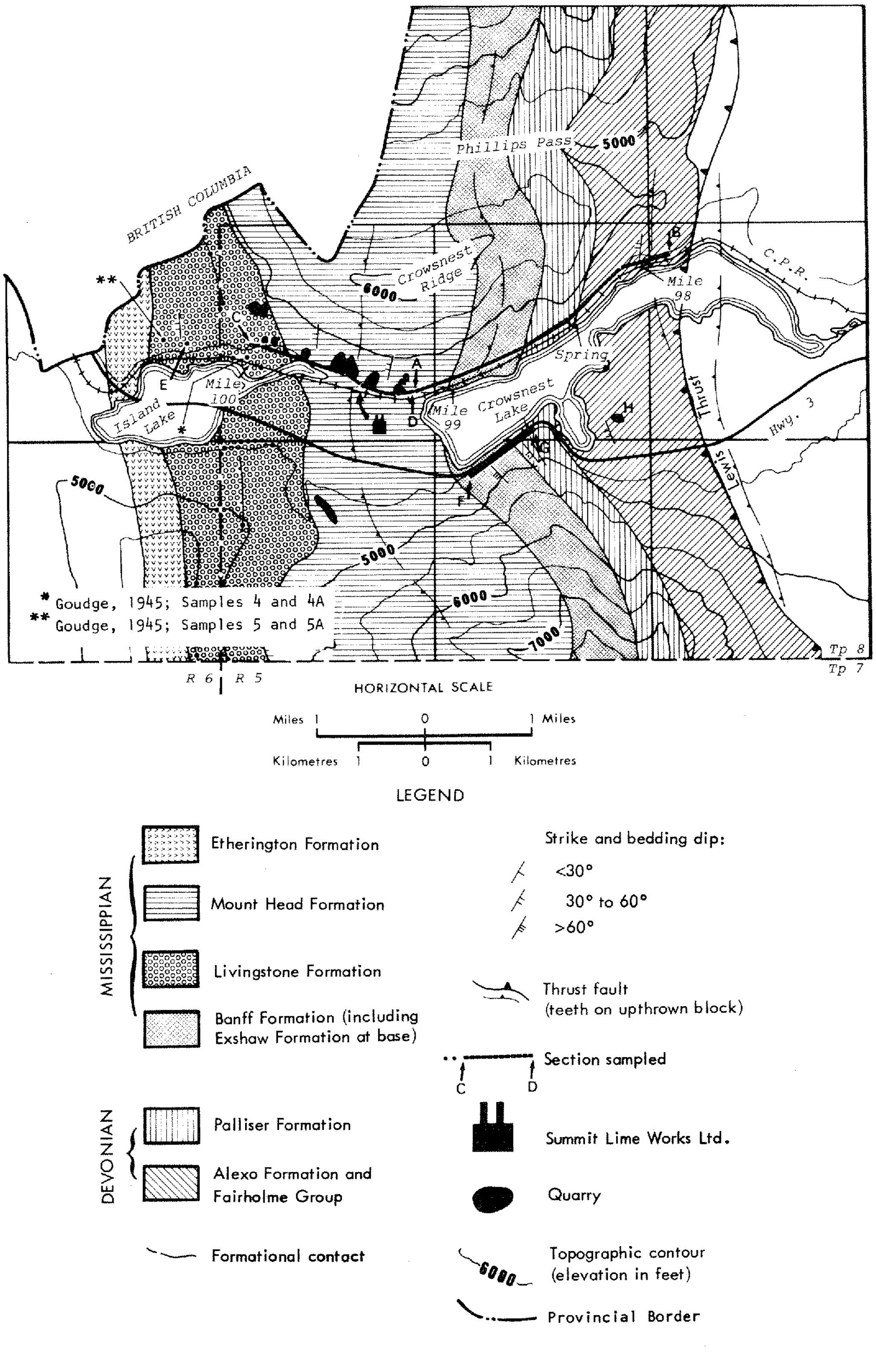



***Figure 3. Geology of the Crowsnest Pass area (after Price, 1961)***

The Palliser Formation is a dark grey, finely crystalline limestone mottled with grey-brown dolomite. Price (1961) estimated for the formation a thickness of 650 feet (200 m) to 720 feet (220 m) whereas deWit and McLaren obtained a thickness of 900 feet (270 m) from composite measurements in the Pass area. The Palliser's lower member is the massively bedded cliff-forming Morro Member which was measured as 600 feet (180 m) thick by Price and 833 feet (254 m) thick by deWit and McLaren. The overlying Costigan Member is thinly bedded, argillaceous and less resistant. Price placed its thickness at 100 to 150 feet (30 to 45 m), deWit and McLaren at 67 feet (20 m).

The Exshaw Formation, which is very well exposed along Highway No. 3, consists of over 40 feet (12 m) of black fissile shale with minor beds of argillaceous limestone. The relationship of the Exshaw to the overlying Banff has been studied in considerable detail by Macqueen and Sandberg (1970).

The Banff Formation varies from black shale and dark grey, argillaceous and cherty limestone in the lower part to dark grey, cherty limestone above. The total thickness is about 850 feet (260 m).

The Livingstone Formation is typically composed of light grey, finely to medium crystalline biofragmental limestone (Plate 1). Matrix support of coarsely crystalline particles and skeletal grains by finely crystalline limestone is common. Grey and buff finely crystalline dolomite beds are found throughout the succession and result in some complications in the planning of quarry locations. The formation is approximately 1,000 feet (300 m) thick in the Crowsnest area.

The overlying Mount Head Formation is not well exposed in the Pass. It is approximately 1,000 feet (300 m) thick and the beds examined consist of light grey and brown biofragmental limestones exhibiting much less compositional and granular consistency than those of the Livingstone Formation.

Figure 4 is a composite section showing all these formations.

## SAMPLING

Sections were sampled by the author along the north side of Crowsnest Lake adjacent to the railway from near Mile 98 west to the quarries of Summit Lime Works (Fig. 3, Plates 1 and 2). Included in the section are: the upper part of the Fairholme Group, the Alexo Formation, the Palliser Formation, the Banff Formation, and the lower beds of the Livingstone Formation (Section A-B, Fig. 5). A more detailed sampling of the Livingstone Formation and basal Mount Head Formation was carried out in the quarries themselves (Section C-D, Fig. 6). West of Summit Lime Works, a few scattered outcrops of the Mount Head Formation were visited (Location E). Section F-G (Fig. 7), along Highway No. 3, on the south side of Crowsnest Lake, was traversed to complement Section A-B. The sequence immediately above and below the Exshaw shale has excellent exposures at this location. The Summit Lime Works dolomite quarry at the east end of Crowsnest Lake has been opened in Fairholme beds and was visited and sampled.

Earlier work of Goudge (1945) is of considerable importance and an abbreviated account of his investigations is given in Appendix C. The approximate locations of Goudge's samples are indicated on the location map and sections, and his chemical analyses are listed in Appendix A.

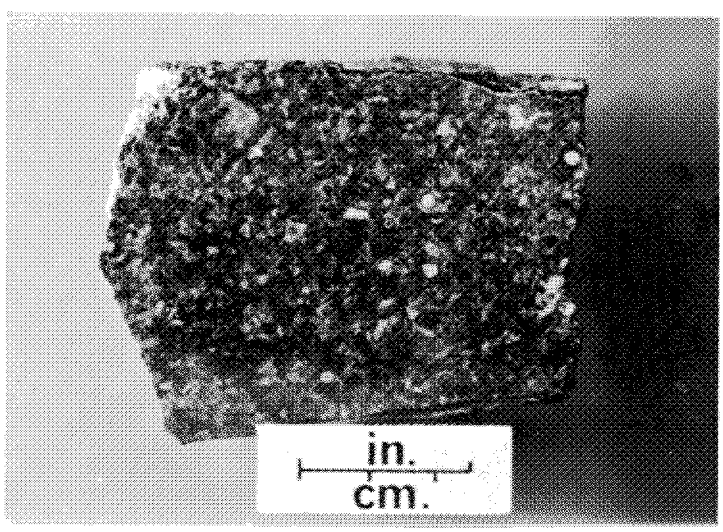



***PLATE 1. Coarsely crystalline biofragmental (crinoidal) limestone of the Livingstone Formation from quarries of the Summit Lime Works, Crowsnest Pass (sample 1).***

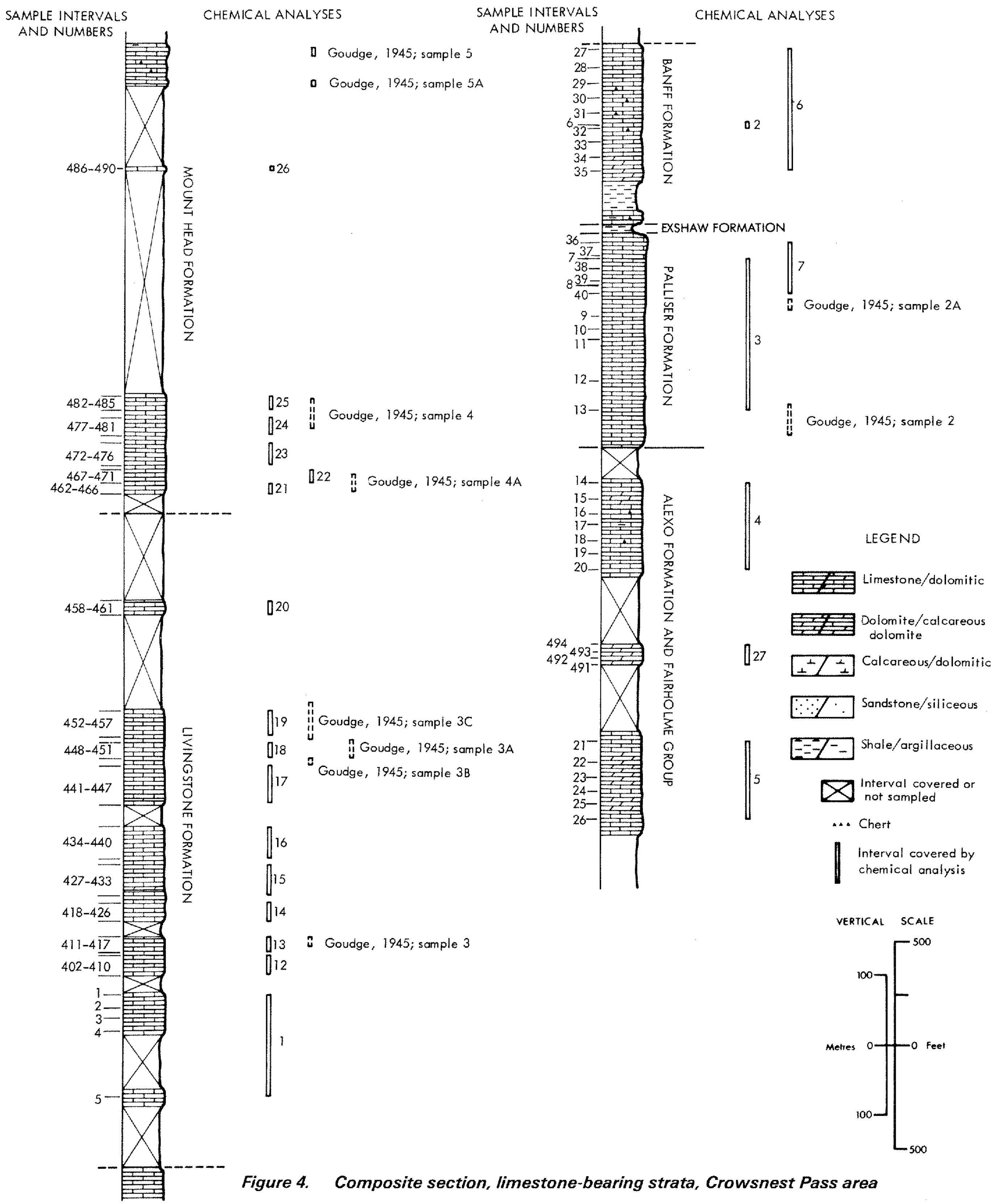



***Figure 4. Composite section, limestone-bearing strata, Crowsnest Pass area***

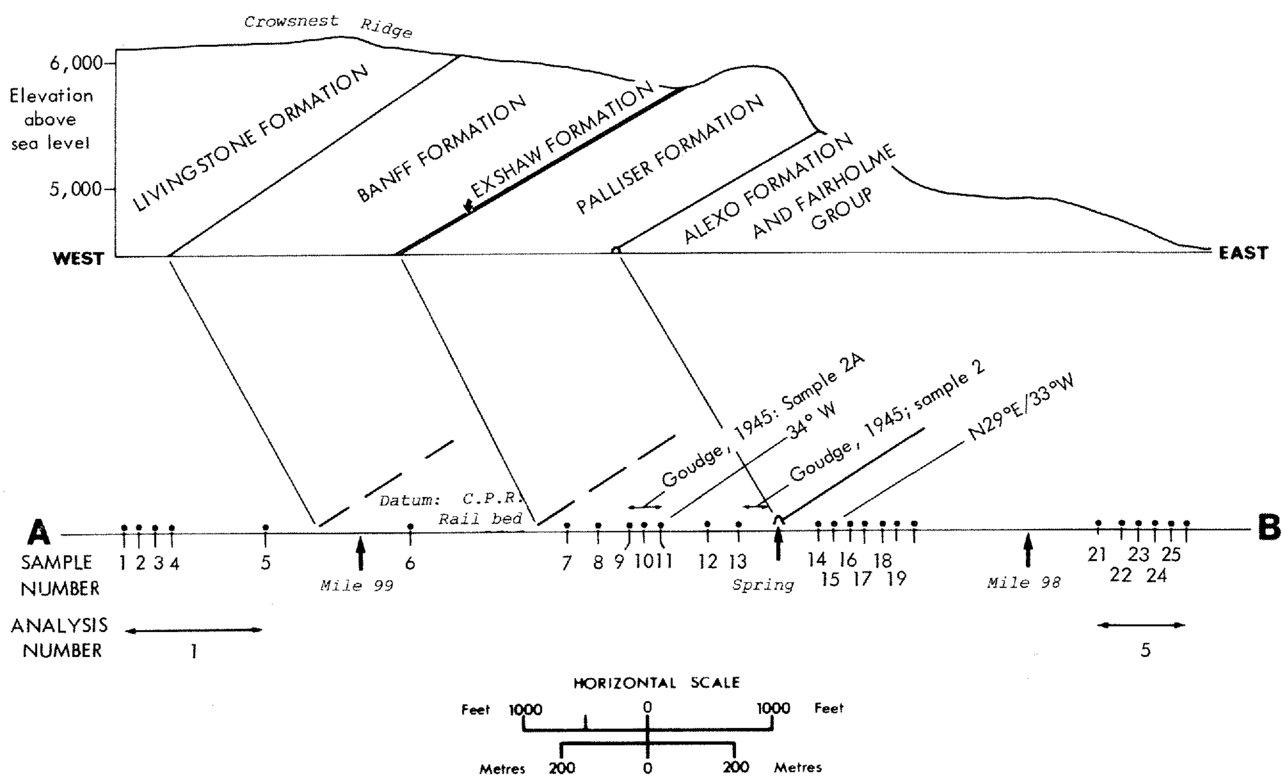



*Figure 5. Section A-B, Crowsnest Pass area*

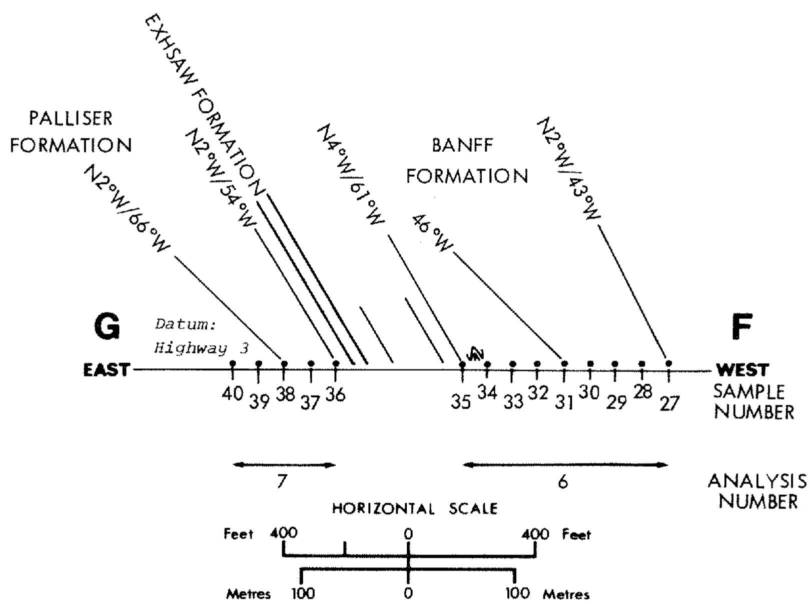



*Figure 7. Section F-G, Crowsnest Pass area*

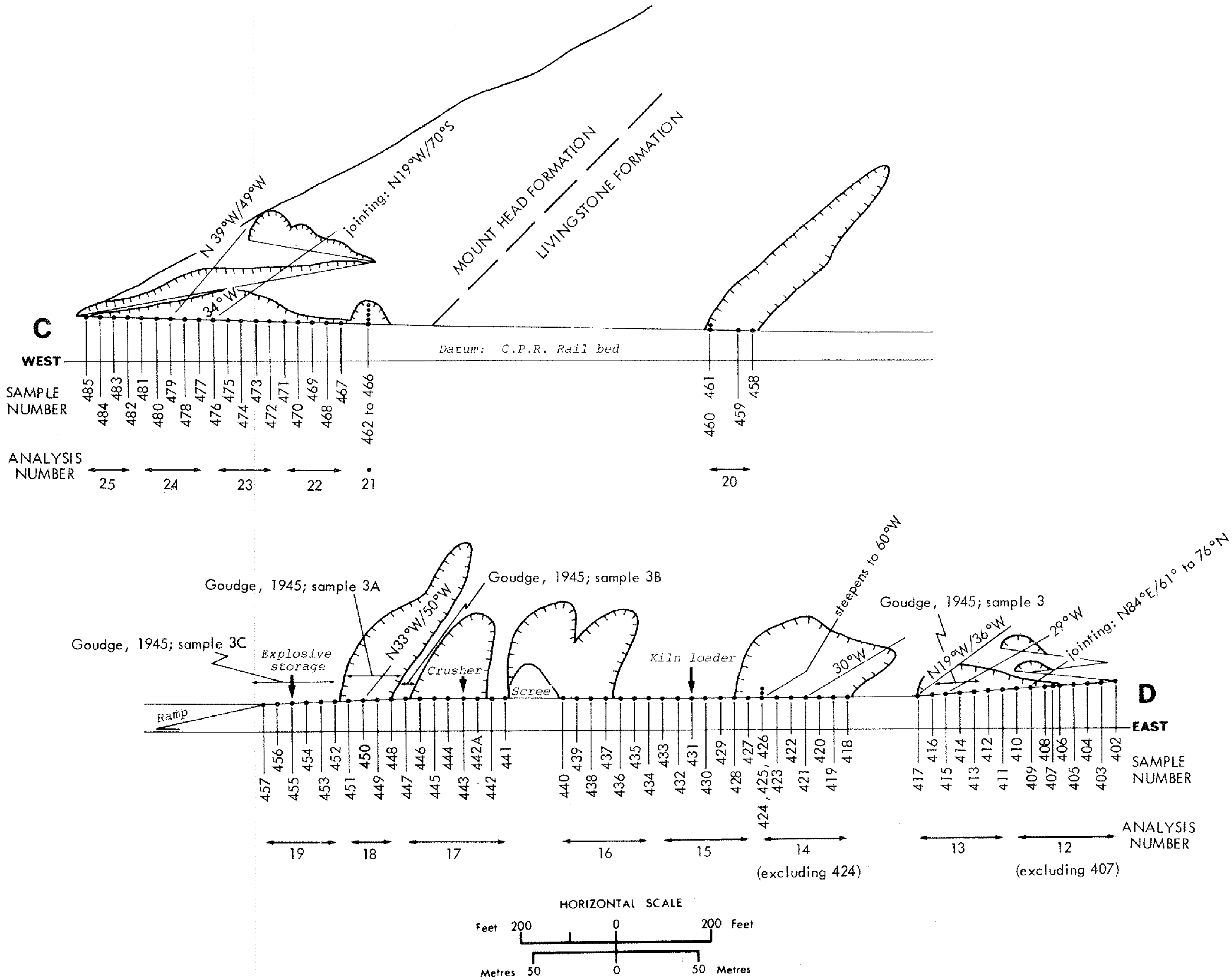



**Figure 6. Section C-D, Crowsnest Pass area**

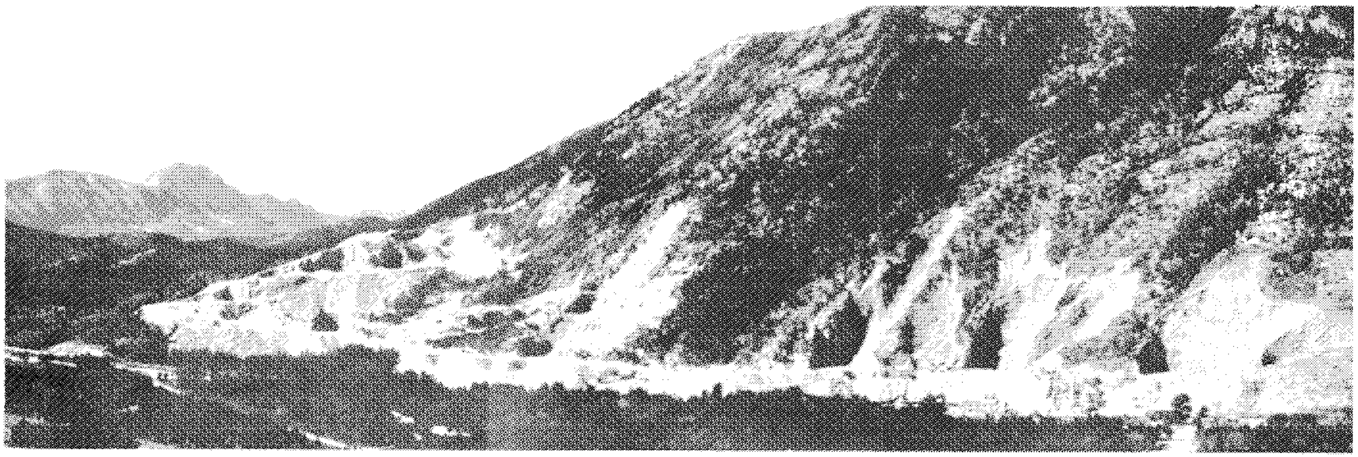


***PLATE 2. Summit Lime Works quarries and lime plant north side of Crowsnest Pass. Quarries to the left (west) are in beds of the Mount Head Formation; quarries in the center and right (east) portions of the photo are in beds of the Livingstone Formation.***

## ANALYSES

Three chemical analyses were run on rock from the Alexo Formation and Fairholme Group. Chemical analysis no. 4 (samples 14 to 20) includes, in the main, Alexo beds and indicates a $CaCO_3$ content of about 72 percent. Analysis no. 5 (samples 21 to 26), taken lower in the succession of the section, shows a $CaCO_3$ value of 61 percent. The third analysis comes from samples taken from the Summit Lime Works quarry on the south side of Crowsnest Lake (chemical analysis no. 27, samples 491 to 494, Location H. Fig. 3) and produced a $CaCO_3$ value of 56 percent. Figures 3, 4 and 5 as well as Appendix A provide the details of location, sampling intervals, and analyses.

Seven combined samples taken throughout the Palliser succession north of Crowsnest Lake yielded $CaCO_3$ values of 96 percent (analysis no. 3, samples 7 to 12). Values obtained by Goudge from the same section (samples 2 and 2A) range from 77 percent to 96 percent $CaCO_3$. Silica values are less than 1 percent. Across the lake, adjacent to Highway No. 3, samples were obtained immediately below the Exshaw Formation from beds which, for the most part, probably belong to the Costigan Member. An analysis of 91 percent $CaCO_3$ was obtained (analysis no. 7, samples 36 to 40). Silica contents appear to be somewhat higher in these beds (over 2 percent).

Tests on rock from the Banff Formation showed very low amounts of $CaCO_3$ (less than 54 percent). Analysis no. 2 (sample 6) represents beds in the middle of the formation, adjacent to the railway. Analysis no. 6 (samples 27 to 35) defines material throughout most of the formation as exposed along Highway No. 3.

The Livingstone Formation was sampled in considerable detail (Figs. 3, 4, 5, and 6); analyses varied widely, but high-calcium limestones appear to be general throughout this unit, with values of $CaCO_3$ commonly exceeding 90 percent. However, in places dolomite beds decrease the $CaCO_3$ percentages to as low as 60 percent. The $SiO_2$ values also vary, and range from less than 1 percent to as much as 9 percent.

Exposures of the Mount Head Formation have been made available through quarrying and ramp construction at the west end of the Summit Lime Works operations. Analyses range from 81 percent to over 95 percent $CaCO_3$ with an average of about 1 percent $SiO_2$. Goudge tested equivalent beds near the level of the railway (samples 4 and 4A); these tested 97 and 98 percent $CaCO_3$ respectively.

Limestones from the same formation, exposed along the old No. 3 Highway (Location E, Fig. 3, analysis no. 26, samples 486 to 490) proved to be very cherty (10 percent $SiO_2$) and thus correspondingly low in $CaCO_3$ (84 percent).

Goudge sampled beds that are stratigraphically near the top of the Mount Head Formation and are exposed farther west along old Highway No. 3 (samples 5 and 5A). Both samples contain high amounts of $CaCO_3$ (95 percent or greater) but are associated with cherty beds which were not tested.

Results of X-ray fluorescence analyses of individual samples are presented in Appendix B.

## PRODUCTION AND RESERVES

The quarries of Summit Lime Works have been worked for a number of years. They were opened on the northern side of the Pass, first at the base of the Livingstone Formation, and later at successively higher stratigraphic levels as development proceeded west. Current production is from beds at the base of the Mount Head Formation. One quarry has recently been worked on the southern side of the Pass within the Livingstone Formation. The only other exploitation that has taken place is the opening by the same operators of a dolomite quarry at the east end of Crowsnest Lake. Goudge (1945) explains in some detail the equipment and procedures used by the company. Vertical kilns are still in use although considerable modification of the operations has taken place since 1945.

Sufficient reserves of limestone are available in the Crowsnest Pass for some time to come. Exploitation of the Mississippian strata can continue on both sides of the Pass, the only complication being the definition of dolomitic bands. The variability of bedding in the Livingstone and Mount Head Formations calls for a detailed exploration procedure prior to quarrying.

The Palliser Formation presents some difficulties for development within the Pass itself. A dip face is not easily accessible and the sheer scarp of the eastern face would be difficult to work. The proximity of the outcrop to the rail line and highway would complicate equipment operation and the setting aside of an area for fixed installations. For these reasons, the Phillip's Pass area, 1 mile (2 km) north of the Crowsnest Pass, may be of prime importance for future development of the Palliser Formation, even though this area is farther from transportation facilities.

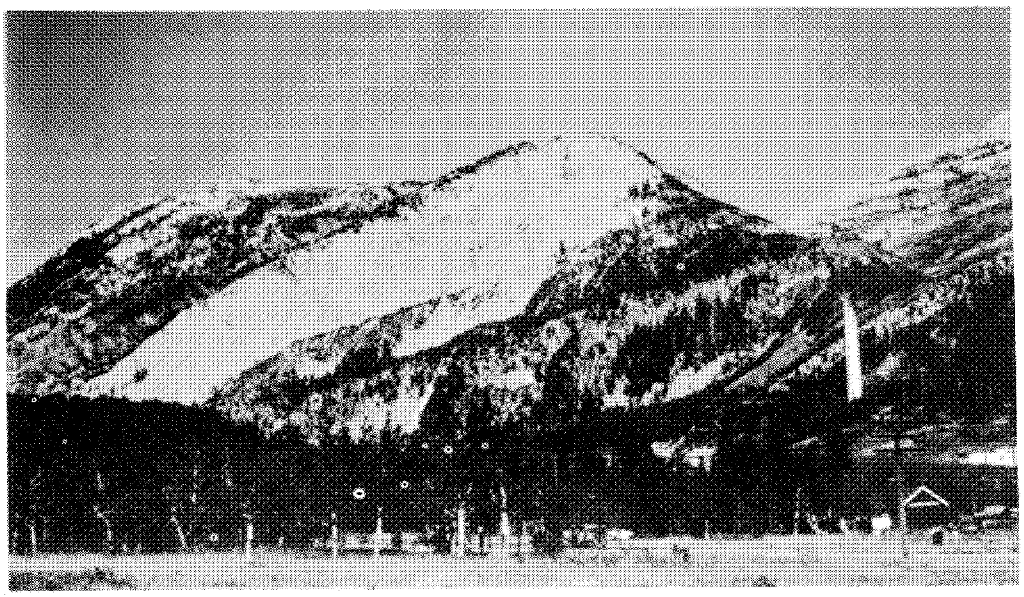


*PLATE 3. Crowsnest Ridge, Crowsnest Pass. Photo was taken facing northwest. The prominent cliff face is formed by the Palliser Formation. Beds below include the Alexo Formation and the upper part of the Fairholme Group. The Banff and Exshaw Formations above the Palliser are recessive. The tower on top of the ridge to the left is on resistant Livingstone strata.*

## BLAIRMORE AREA

### LOCATION AND ACCESSIBILITY

The Blairmore area is located in southwestern Alberta approximately 10 miles (16 km) east of the Crowsnest Pass (Fig. 2). Blairmore and Frank, about 1 mile (2 km) apart, service the region. The main line of the Canadian Pacific Railway and Highway No. 3 both cross the area (Fig. 8). There is a local relief of nearly 3,000 feet (1000 m), but, because of the long history of settlement and coal mining, numerous roads and trails provide good access throughout the area.

### GEOLOGY

Norris (1955) mapped the Blairmore area in detail. The Blairmore Range, a Paleozoic outlier of the Main Ranges, forms the most distinctive physiographic feature and is breached at Blairmore by the Crowsnest River where good limestone exposures are found. Banff, Rundle, and younger strata form the core of the Range and are folded into a doubly plunging anticline underlain by the Turtle Mountain Fault. At Blairmore, the Paleozoic beds dip west at about 60 degrees and have a north-south strike.

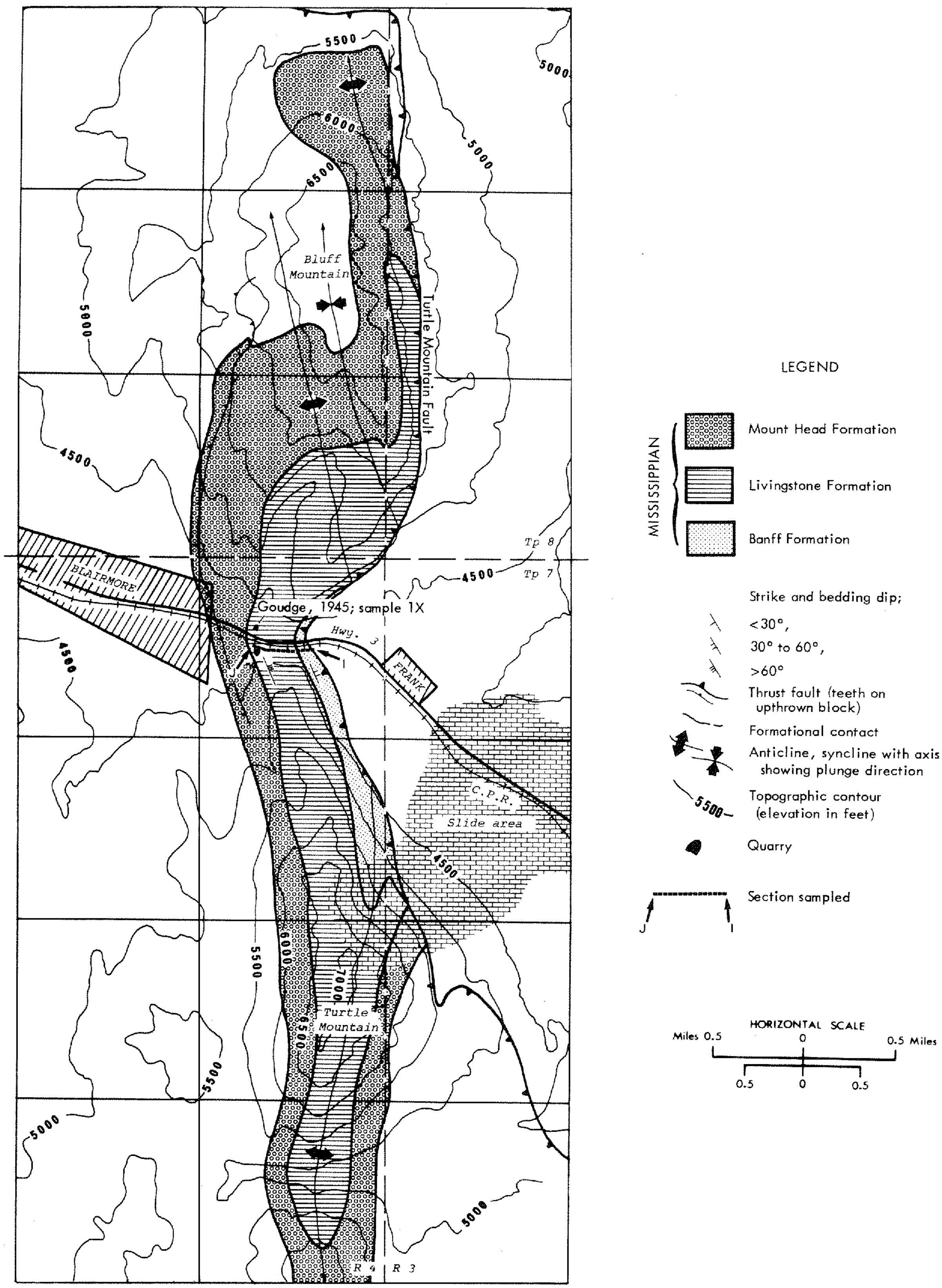



***Figure 8. Geology of the Blairmore area (after Norris, 1955)***

The upper 400 feet (120 m) of the Banff Formation are exposed and include dark grey, medium-crystalline dolomitic limestones with shale interbeds and abundant chert lenses.

The total thickness of the Livingstone Formation at Blairmore exceeds 1,000 feet (300 m) (Norris, 1955). The basal and upper beds are well exposed on the south side of the Crowsnest River along the railway. The lower beds are composed of grey, medium-bedded, medium to coarsely crystalline biofragmental (crinoidal) limestones interbedded with grey, thin- to medium-bedded, finely crystalline cherty and dolomitic limestones. One small quarry, not now in operation, was opened in high-calcium limestones of these basal beds. Upper beds of the Livingstone outcrop farther west and are described in some detail by Goudge in his study of the Rocky Mountain Cement Company quarry (see Appendix C).

## SAMPLING

A traverse was made along the railway and samples were obtained from as much of the Banff and Livingstone Formations as is exposed (Fig. 8); samples were taken at intervals indicated in figures 9 and 10. Recent trenching for a gas transmission line has exposed rock higher on the side of Turtle Mountain which could yield considerably more data.

Goudge's description of the area is in Appendix C.

## ANALYSES

A composite sample of the Banff Formation confirmed the low quality of the rock as an industrial source of high-calcium limestone (analysis no. 8, samples 41 to 48, Appendix A).

The small quarry in beds at the base of the Livingstone Formation indicated excellent quality rock with a $CaCO_3$ content of

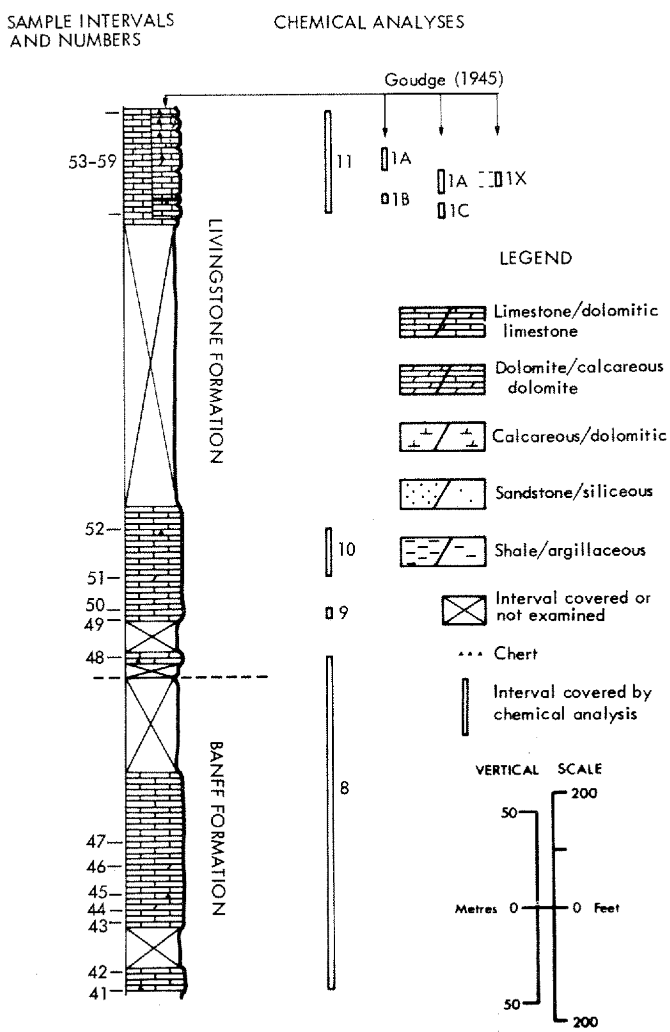



*Figure 9.* ***Composite section, limestone-bearing strata, Blairmore area***

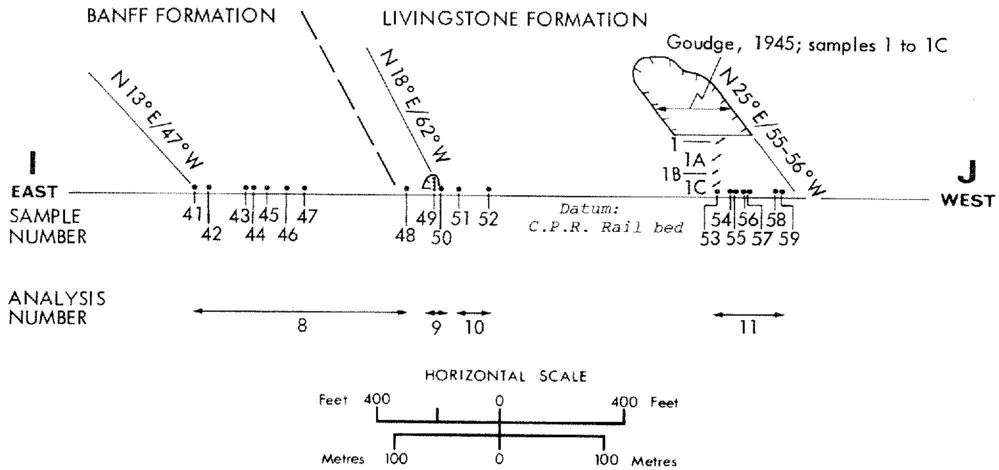



*Figure 10. Section I-J, Blairmore area*

99 percent (analysis no. 9, samples 49 and 50). Beds immediately above these were of lower grade (86 percent $CaCO_3$) because of the abundance of chert (10 percent $SiO_2$), as shown in analysis no. 10 (samples 51 and 52). The upper Livingstone strata were tested by Goudge (samples 1, 1A, 1B, and 1C). Amounts of $CaCO_3$ ranged from 65 percent to 99 percent. The lowest value was due in part to the presence of chert with over 8 percent $SiO_2$ in the sample. An aggregate sample taken by the author over approximately the same interval at the same level as the railway, analysed 76 percent $CaCO_3$ and 9 percent $SiO_2$ (analysis no. 11, samples 53 to 59).

Across the valley, in another small quarry examined by Goudge, a limestone of very good quality was tested and analysed (sample 1X) (Fig. 8). X-ray fluorescence analysis results for individual samples are given in Appendix B.

## PRODUCTION AND RESERVES

As previously noted, at least three quarries have been operated in the Blairmore area and all are now inactive. Excellent quality rock is available but the greatest problem is the variability of grades from bed to bed. Cherty and dolomitic beds of the Livingstone Formation appear to be as prevalent as the high-calcium sequences. Additional mapping, sampling, and drilling is necessary to delineate the extent of the deposits.

# EXSHAW AREA

## LOCATION AND ACCESSIBILITY

The Bow River Valley, 40 miles (64 km) west of Calgary, was studied from the Foothills Front to the east entrance of Banff National Park, a distance of approximately 15 miles (24 km) (Fig. 11). The Canadian Pacific Railway and Highway Nos. 1 and 1A pass through the valley. Highway No. 1 skirts the south side from the east end of the valley to Canmore; Highway No. 1A was constructed on the north side in the eastern half of the area. Both roads are positioned centrally in the valley from Canmore west, Highway No. 1 having replaced 1A over much of this section. The only other major access routes are the road from Dead Man Flat to ski slopes on Pigeon Mountain (not indicated in figure 11), and a road south from Canmore to the Spray Lakes Reservoir of Calgary Power Ltd.

Canmore is the largest community in the area. The smaller centers of Gap, Exshaw, and Kananaskis have only very limited services available.

The valley floor lies at an elevation of approximately 4,300 feet (1300 m) and the surrounding mountains rise to a maximum of 9,000 feet (2750 m).

## GEOLOGY

Paleozoic and Mesozoic strata, striking north-northwest, are thrust east over Upper Cretaceous formations along the McConnell Fault, which surfaces at the eastern front of the mountains. Other major thrust faults repeat the succession of west-dipping strata, the main ones being (from east to west): the Exshaw Thrust, which passes through Exshaw; the Lac des Arcs Thrust, near the west end of Lac des Arcs; and the Rundle Thrust, paralleling the base of Mount Rundle and the Three Sisters. Numerous splay faults, minor thrusts, and tear faults occur in the area. The most recent geological map compilation is by Price (1970).

Lower Cambrian strata are well represented in the Exshaw area although only the Eldon and Pika Formations are easily accessible for possible industrial development. The Eldon has a thickness of greater than 800 feet (240 m) and comprises dark grey, finely crystalline, variegated and mottled limestones (Plate 4) and interbedded dolomites. Some of the purer limestone beds were quarried in the past at Kananaskis by Loder's Lime Company Ltd. There are at least three bands of dense, pale grey, high-calcium limestone on the property and these vary in width from 40 to 80 feet (12 to 24 m) each being separated from the other by 75 to 150 feet (23 to 46 m) of dolomitic limestone (Matthews, 1956). The Pika strata are similar to those of the Eldon but weather somewhat browner in color. This formation has a thickness of more than 50 feet (15 m).

The Devonian Fairholme Group is well exposed but is largely dolomitic and therefore of only passing interest. The lower unit, the Cairn Formation, exceeds 400 feet (120 m) in thickness and is made up of brown, argillaceous dolomites. Its lower sequence is biostromal (the Flume equivalent). The upper part, the Southesk Formation, also has a thickness of over 400 feet (120 m) and includes light grey, argillaceous and silty dolomites.

Overlying the Fairholme Group are the argillaceous and silty dolomites of the Alexo Formation which average about 200 feet (60 m) thick. These beds are not potential sources of high-calcium limestone.

Upper Devonian Palliser strata constitute some of the major reserves of high-grade limestone in the area. Limestone from this formation is used by the Canada Cement Lafarge plant at Exshaw. The rock is typically dark grey, medium-bedded, finely crystalline limestone mottled in part by dolomite and interbedded with grey and brownish-grey, finely crystalline dolomite. Over 800 feet (240 m) of the formation is present in the area.

Stratigraphically overlying the Palliser are the Exshaw and the Mississippian Banff Formations. The Banff has been mapped by Price (1970) as a tripartite unit with a total average thickness of about 700 feet (210 m). The lower beds are dark grey shales and thin-bedded, argillaceous and cherty limestones. Middle Banff strata include grey, medium-bedded, medium-crystalline limestones and argillaceous, dolomitic limestones. The upper unit includes beds similar to the middle unit but which are cherty in part.

The Livingstone Formation, about 1,500 feet (460 m) thick is quarried by Steel Brothers west of Gap Lake (Plate 5). The rock is typically light grey, medium-bedded, medium-crystalline limestone, much of which is biofragmental (Plate 6). Some beds are high in chert and sand.

Strata of the Mount Head Formation range from light grey, finely crystalline, cherty limestones (finely laminated in

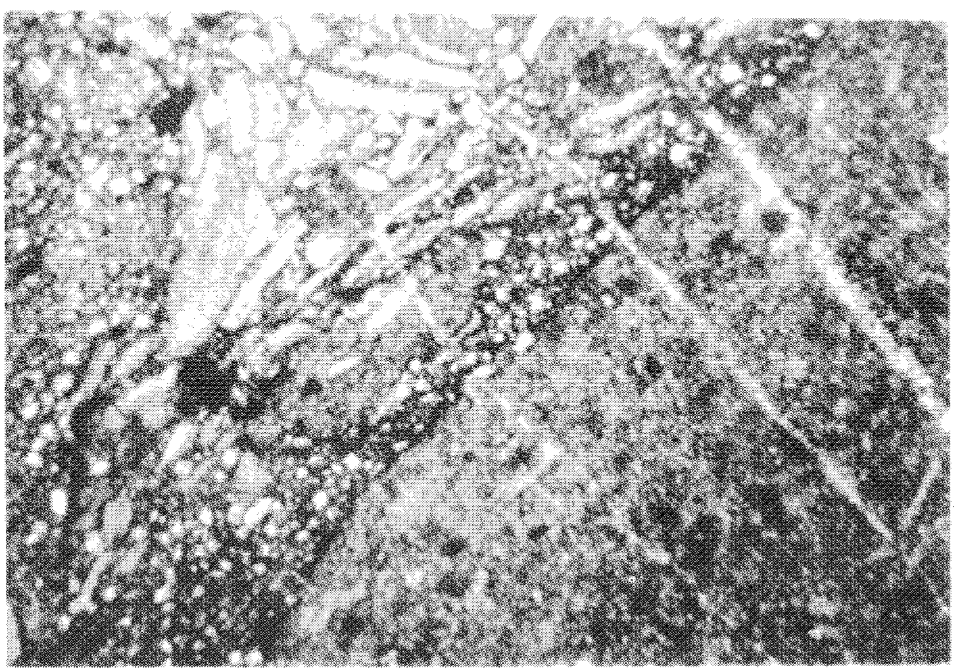


***PLATE 4. Photomicrograph representing material from the Eldon Formation showing dolomite rhombs and platy limestone fragments comprising the variegations, adjacent to finely crystalline limestone which constitutes the main mass of the rock (sample 77-2, 400X).***

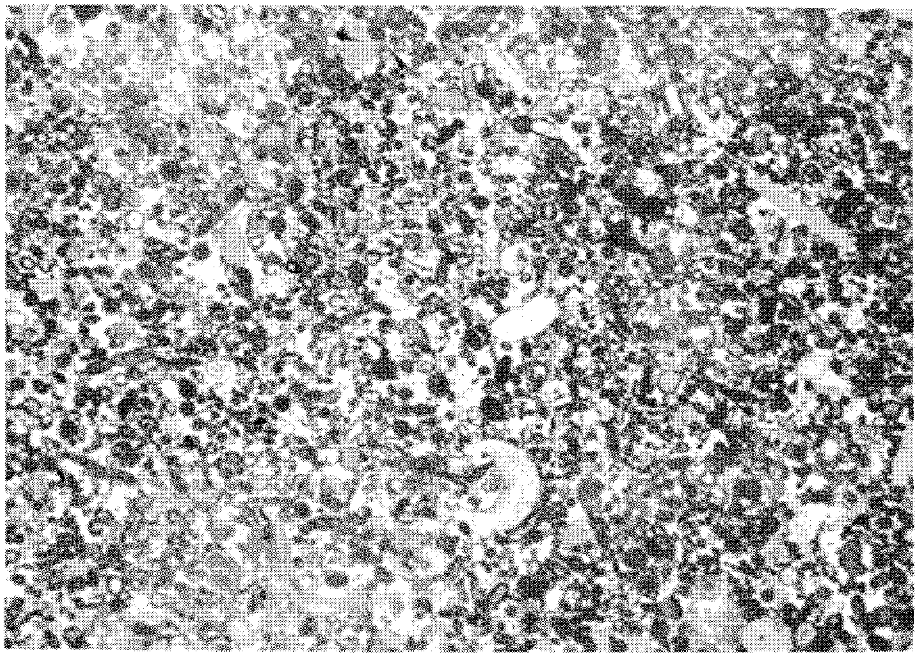


*PLATE 6. Unstained acetate peel of biofragmental limestone from the Steel Brothers quarry, Exshaw area (sample 87, 2X).*

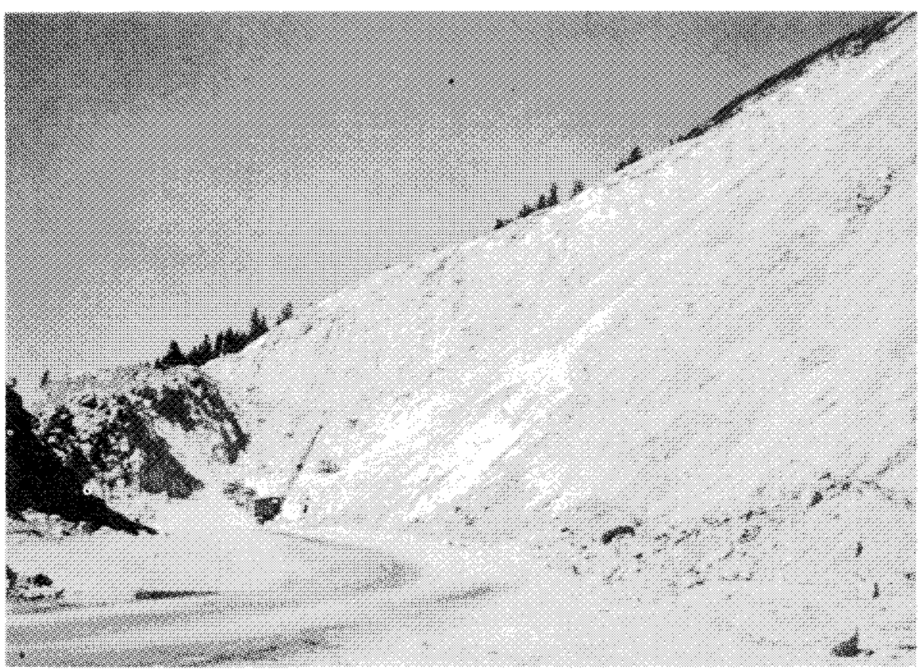


*PLATE 5. Steel Brothers (Canada) Ltd. limestone quarry in strata of the Livingstone Formation on Grotto Mountain in the Exshaw area.*

some beds) to dark grey, argillaceous, finely crystalline limestones and dolomites. The total succession has a thickness of approximately 500 feet (150 m).

The uppermost Paleozoic unit examined was the 200 foot (60 m) thick Etherington Formation which is composed of light grey, cherty limestones and dolomites.

## SAMPLING

Sampling by the author was largely confined to exposures along Highway Nos. 1 and 1A where a large percentage of the succession is exposed in road cuts (Fig. 11). One section was sampled across the Eldon Formation 2 miles (3 km) north of Kananaskis (Plate 7). The upper part of the Livingstone Formation and both the Mount Head and Etherington Formations were examined at Cougar Canyon 2 miles (3 km) west-northwest of Canmore. The quarries in the area were visited but not extensively sampled because they were sampled by Goudge in 1945 (see Appendix A).

The Canadian Pacific Railway (1949) prepared an open-file report on Livingstone beds immediately east of Exshaw.

An open-file report by Matthews (1961) gives an account of sampling and testing of limestones of the Livingstone Formation on Heart Mountain south of Exshaw (locations of sections sampled are given in figure 11).

Goudge sampled material throughout the Bow River Valley including deposits within Banff National Park. Information which refers to localities outside the Park is included in Appendix C.

## ANALYSES

Goudge's sampling of the Eldon Formation in the Loder's Lime westernmost quarry (samples 8 to 8G, Appendix A) documented somewhat variable grades. Rock from the west side of the quarry analysed 98 to 99 percent $CaCO_3$ demonstrating the very high quality of some of the Eldon beds. Samples 7 to 7C and the resultant analyses are difficult to relate to the area due to the brevity of Goudge's descriptions of their locations. Analyses of rock collected by the author across the valley from approximately the same stratigraphic position as Loder's Lime quarry showed $CaCO_3$ values of 95 percent (analysis no. 47, composite sample 78) and very low $SiO_2$ values. The samples from the section 2 miles (3 km) north of Kananaskis examined by the author (samples 495 to 570) were analysed in intervals representing approximately 100 feet (30 m) of section each and nearly the entire Eldon Formation was thus tested. The analyses (nos. 48 to 55 inclusive) varied from 71 percent to 98 percent $CaCO_3$. Silica values remained constant at less than 1 percent with the exception of analysis no. 55 (5 percent) which was rock from the upper part of the Eldon. The main variant encountered was the $MgCO_3$ content which varied between 5 and 32 percent. Tests on rock from road cuts through the

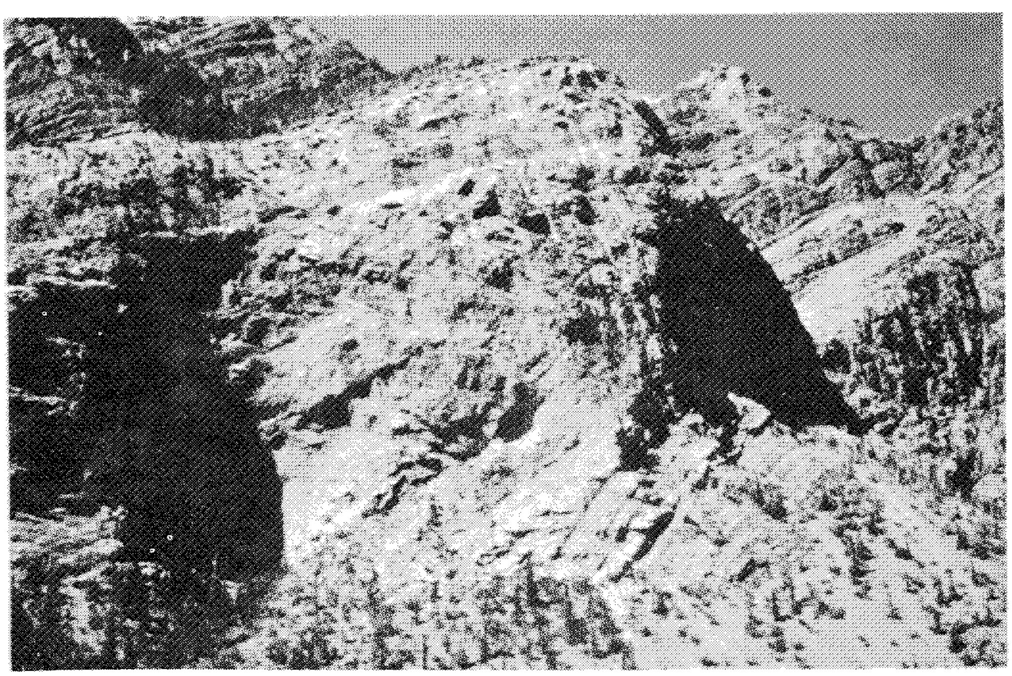


***PLATE 7. Outcrop of the Eldon Formation exposed 2 miles (3 km) north of Kananaskis in the Exshaw area. Variegated beds are well represented at the base of the section.***

upper part of the Eldon Formation on Highway No. 1 (analysis no. 46, composite sample 77) showed $CaCO_3$ values of 94 percent $CaCO_3$ and over 5 percent $MgCO_3$.

The results of analyses of the Cairn and Southesk Formations verified field indications of low-calcium rock. Analyses 31, 39, 40, 41, 42, 45 and 56 give values of 50 to 58 percent $CaCO_3$ and 42 to 44 percent $MgCO_3$. The apparent purity of rock as a dolomite source is worthy of note.

Sample 10B of Goudge may have come from the Alexo Formation 1 mile (2 km) northeast of Gap Lake judging from his description of the rock, its location, and its associated strata. A $CaCO_3$ content of 90 percent was determined.

Goudge's sample 10A, from the same area as 10B, was apparently derived from Palliser limestone, possibly from near the base, and tested 97 percent $CaCO_3$. This author's analysis no. 38 (sample 70) represents strata from the middle of the Palliser; the sample was collected from an outcrop at the west end of Lac des Arcs. The values reveal a low-grade limestone (88 percent $CaCO_3$, 12 percent $MgCO_3$). A single sample of the Palliser approximately on strike with beds in the Canada Cement Lafarge quarry, and across the valley, proved to be highly dolomitic (analysis no. 44, sample 75; 83 percent $CaCO_3$, 20 percent $MgCO_3$). The uppermost beds of the Palliser were studied in some detail by Goudge and reference is made to his samples (9 to 9F). Most of his results are from the sequence quarried by Canada Cement Lafarge at the time of sampling.

The only indication of high-grade limestone within the Banff Formation of the area is from a sample taken from the middle unit west of Exshaw (analysis no. 29, sample 63). An almost pure $CaCO_3$ was determined upon lab testing. Of the eight other analyses run on rock from the Banff, including Goudge's sample 10, none is of sufficient $CaCO_3$ content to be of potential value.

Excellent detail concerning the basal part of the Livingstone Formation has been produced by Matthews (1961) and the two sections investigated on Heart Mountain (sections A-A′ and B-B′ of figure 11) are illustrated in figure 12. As much as 98 percent $CaCO_3$ was analysed over 40 feet (12 m) of section. Slightly lesser amounts (97 percent) occur over a 74 foot (23 m) interval. Values of $CaCO_3$ within thin intervals fall as low as 85 percent and reduction of grade is due to anomalous amounts of dolomite and chert. An aggregate sample collected during the course of the author's work, over an approximately equivalent stratigraphic interval outcropping on Highway No. 1 across the valley from Gap Lake, yielded only 69 percent $CaCO_3$ (analysis no. 35, composite sample 69).

The Canadian Pacific Railway (1949) sampled a section near the middle of the Livingstone Formation (Fig. 11, Appendix A) east of Exshaw. The most favorable interval sampled was 92 feet (28 m) thick and contains 96 percent $CaCO_3$ (analysis no. 14). The lowest amount of $CaCO_3$ recorded was 73 percent. Silica contents are not given but the insoluble residue was less than 1 percent in four samples, and 4 percent and 2 percent on samples 12 and 13 respectively. Livingstone beds at Highway No. 1A west of Gap Lake (which may in part be equivalent to the rock sampled by Canadian Pacific) are of low grade (51 percent $CaCO_3$, analysis no. 34, composite sample 68).

Uppermost Livingstone strata were examined by Goudge in and near quarries predating the Steel Brothers operations west of Gap Lake. The rock selected for the original quarrying operations was 96 to 98 percent $CaCO_3$ (samples 11A, 11B and 12). One sample (12A) from adjacent beds tested only 97 percent $CaCO_3$ in spite of the fact that chert nodules were removed before analysis. A representative analysis of rock presently being quarried by Steel Brothers was provided to the author and yielded 99 percent $CaCO_3$ and less than 1 percent $SiO_2$ (Appendix A). The hanging wall rock in the quarry has a much higher $SiO_2$ content (88 percent) than the footwall rock which contains 12 to 30 percent $SiO_2$ (J. Jordon, personal communication).

Analyses of individual samples by the X-ray fluorescence method are available in Appendix B.

## PRODUCTION AND RESERVES

Two formations are now being exploited in the Exshaw area: the Devonian Palliser Formation by Canada Cement Lafarge for cement-making, and the Mississippian Livingstone Formation by Steel Brothers for crushed limestone and lime production.

The Palliser Formation has been repeated four times across the area by faulting. Sampling by the author at two locations proved disappointing $CaCO_3$ grades. However, the upper part of the formation remains a target for future exploration as shown by the success of the Canada Cement Lafarge operations.

Steel Brothers have confirmed reserves some distance west of their quarry at the base of Grotto Mountain. The Canadian Pacific Railway (1949) and Matthews (1961) have proven up other high-grade material within the Livingstone Formation as shown (Fig. 11, Appendix A). Deposits on Pigeon Mountain and Mount McGillivray are worthy of future attention.

Although the Eldon Formation is not being quarried presently it produced an excellent grade of limestone in the past. A relatively small surface area of outcrop presents itself, however, and much of this is along the sheer face of the mountain front.

# NORDEGG AREA

## LOCATION AND ACCESSIBILITY

The Nordegg area is situated about 50 miles (80 km) west of Rocky Mountain House. A branch line of Canadian National Railways was originally constructed to the town of Nordegg to service Brazeau Collieries but the line has not been regularly used since closing of the mines in the mid-1950's. An all-weather road, Highway No. 11 (the David Thompson Highway), crosses the area. The Forestry Trunk Road intersects the David Thompson Highway immediately west of Nordegg providing additional access north and south (Fig. 13).

The northwest-southeast trending Brazeau Range is the dominant topographic feature of the area and achieves a maximum height of 2500 feet (760 m) above the surrounding foothills terrain.

## GEOLOGY

The Brazeau anticline (Fig. 13) is the principal structure of the area. The axis of the fold strikes northwest-southeast and plunges in both directions (Erdman, 1950; Douglas, 1956, 1958). The structure is the result of westward thrusting and, consequently, the western flank of the assymetrical anticline dips gently west whereas the eastern limb dips at high angles to the east or is overturned. A number of thrust faults have been mapped along the eastern margin of the anticline. Two major thrusts, the Coliseum and the Brazeau Range faults, have acted as the main surfaces of movement. Mississippian and Devonian carbonates form the core of the Brazeau anticline and are exposed along both the railway and Highway No. 11.

The stratigraphically lowest exposures in the area are the uppermost beds of the Fairholme Group. Strata belonging to the Mount Hawk Formation consist of medium-bedded, black, argillaceous, finely crystalline dolomite.

According to Douglas (1956) the overlying Alexo Formation is about 250 feet (80 m) thick and consists of silty and argillaceous limestones and brecciated and vuggy dolomite interbedded with laminated, greenish grey siltstone, sandstone and shale.

Douglas recognized two major units within the Palliser. The lower is about 500 feet (150 m) thick and consists of massively bedded, brown, porous and vuggy, finely crystalline dolomite which becomes calcareous, silty and less porous towards the base. The upper unit is composed of interbedded, finely laminated, silty and argillaceous dolomite, finely porous dolomite, dolomite breccias, and argillaceous, finely crystalline, dark grey, fossiliferous limestone. The formation is about 850 feet (260 m) thick with the upper unit comprising 350 feet (110 m) of this.

Seven feet (2 m) of black fissile shale constituting the Exshaw Formation overlie the Palliser and underlie the Banff Formation.

Douglas reported the Banff Formation to be distinguishable as two units. Overlying a 12½-foot (4-m) basal bed of argillaceous and silty dolomite are fissile black shales that grade upward into thinly bedded, calcareous shales and alternating shales and argillaceous, cherty limestones in 1- to 6-inch (3- to 15-cm) beds. This lower unit is 270 feet (80 m) thick. The upper unit consists of 300 feet (90 m) of medium-bedded, argillaceous, finely crystalline limestone and dolomite which is, in part, scattered with crinoid remains. The upper unit is the more resistant of the two, commonly forming cliffs.

The Livingstone Formation is 107 feet (33 m) thick and has been described as being massively bedded, cliff-forming, grey-weathering, medium to coarsely crystalline, crinoidal limestone.

Douglas (1958) recognizd both the Pekisko and Shunda Formations on Shunda Mountain north of Nordegg. Here, the Pekisko consists of 107 feet (33 m) of massively bedded, cliff-forming mainly medium to coarsely crystalline limestone, which becomes dolomitic towards the top. The Shunda includes 205 feet (62 m) of argillaceous, finely crystalline limestone. Beds are up to 3 feet (1 m) thick and range from finely laminated to completely brecciated. Some dark grey calcareous shale and dolomitic limestone are present.

The following description of the upper part of the Rundle Group is taken from Douglas (1958):

> "On Shunda Mountain, Brazeau Range, the upper part of the Rundle Group is 359 feet thick and consists of several distinctive units. The basal 107 feet are massive bedded, medium crystalline, porous and vuggy dolomite with cryptocrystalline and finely crystalline, light brown, cherty dolomite in the middle.
>
> The succeeding 50 feet are covered, except for the basal 2 feet which are a breccia of finely crystalline buff dolomite with calcite cement. This interval is overlain by 25 feet of massive bedded, fine- to medium-crystalline dolomite with disseminated fine, pyrobitumen-filled vugs, interbedded with fine-grained, laminated dolomite. The uppermost 77 feet are cryptocrystalline, thinly bedded, buff dolomite, weathering creamy buff."

## SAMPLING

Figure 14 illustrates the details of sampling carried out by the author, by Goudge (1945), and by Matthews (1960). Good exposures on both sides of the Brazeau anticline were studied along the railway and Highway No. 11. A quarry located approximately 1 mile (2 km) east of Nordegg was studied in some detail by Matthews (1960). Goudge (1945) described the lithology and sample intervals employed in some detail (Appendix C).

## ANALYSES

Rock from the Fairholme Group, sampled adjacent to the Highway, analysed 53 percent $CaCO_3$ (analysis no. 74, samples 158 to 160), and thus is of very low quality (see figure 15 and Appendix A for stratigraphy and details of analyses).

The Alexo Formation tested an equally low grade as shown by analyses 75 and 76. Basal beds were sampled near the same location as the Fairholme and are very siliceous (analysis no. 75, samples 161 to 165, 40 percent $SiO_2$). Strata slightly higher in the succession and also exposed at the Highway are composed of nearly pure dolomite (analysis no. 76, sample 166).

Basal Palliser beds are represented by sample 21 of Goudge and a $CaCO_3$ content of 57 percent is recorded. Analysis no. 60 (samples 110 to 112A) of this author also includes lower beds of the formation and confirms siliceous, dolomitic rock (29 percent $SiO_2$, 28 percent $MgCO_3$). A small quarry at Mile 147 on the railway, at a slightly higher stratigraphic position, contains dolomitic material (analysis no. 61, samples 112 to 117, 44 percent $MgCO_3$). Analysis no. 62 is of strata from the top of the Palliser farther west along the railway. The beds are somewhat more calcareous but of low industrial grade (73 percent $CaCO_3$). Sampling from immediately below the Exshaw Formation is documented as analyses 63, 59 and Goudge's sample 20. The first is from along the railway at a position between Mile 147 and Mile 148; the latter two are from exposures along the railway at the point where it intersects the David Thompson Highway. All the values are low in $CaCO_3$, ranging from 53 percent to 86 percent.

Samples of the lower part of the Banff Formation, taken east of the highway crossing of the railway, graded 70 percent $CaCO_3$ (analysis no. 58, samples 100 to 102). Other tests made on the formation, as exposed east and west of Mile 148, all show low $CaCO_3$ (analyses nos. 64 to 69 inclusive, samples 126 to 136, 46 to 82 percent $CaCO_3$).

The Pekisko Formation contains high-calcium rock throughout as shown by analyses 70, 71, 77 (samples 137 to 142 and 168, 169) and Goudge's samples 22 and 22A. The grades of these samples varied from 92 percent to over 98 percent $CaCO_3$. Lower beds are available for study along the railway; uppermost beds are exposed at the main turnoff to Nordegg from the David Thompson Highway.

The quarry described by Goudge at Mile 148.5 on the railway is in Pekisko strata and was studied in greater detail by Matthews (1960). He recognized three major units in the immediate vicinity:

> "An uppermost bed (Bed A) consists largely of grey-weathering, dark grey to black, massive, coarse-grained, high-calcium limestone (Analyses S3, S5, S7 and S9). This bed has an estimated maximum thickness of 65 feet but, due to topographic irregularities, would probably average about half this amount. Underlying Bed A are a series of beds of magnesian limestone with a thickness of 50 to 60 feet (Analysis S1). These beds, in turn, lie above another high-calcium limestone zone (Bed B). This zone is very similar in lithology to Bed A."

These analyses are presented in Appendix A.

Samples of Bed A were collected by the author from the 18 feet (5.5 m) exposed in the quarry (Plate 8). Four feet (1.3 m) of the magnesian limestone is also present, below Bed A, at the quarry site. Analyses of Bed B were not presented by Matthews but this bed is represented in part by analysis no. 70 (samples 143 to 147) of this paper.

One analysis, believed to be of Shunda strata, was prepared from a sample taken slightly east of Mile 149 (analysis no. 72, sample 143). The $CaCO_3$ content is a favorable 98 percent.

Beds of the Rundle Group, stratigraphically above the Shunda, are poorly exposed along the railway. Analysis no. 73 (samples 149 and 150) is of basal beds which are dolomitic (54 percent $CaCO_3$). Strata near the middle of the sequence were sampled by Goudge (sample 23) and are similar in composition (55 percent $CaCO_3$).

For the sake of completeness, Park's (1916) information on the Nordegg Member of the Jurassic Fernie Group is given in Appendix A. These beds unconformably overlie the Rundle and outcrop on Martin Creek immediately east of Nordegg (Fig. 14). They consist of black, phosphatic, very siliceous, dolomitic limestones.

Appendix B presents X-ray fluorescence analyses of individual carbonate copies.

## PRODUCTION AND RESERVES

The only production realized from the Nordegg area was from two small quarries and was used as railway ballast. The Mississippian Pekisko Formation, in which the larger quarry was developed, is the only formation in which high-grade limestones have been confirmed to date. The Shunda Formation warrants further evaluation, preferably through drilling as exposures are scarce. The Palliser Formation, which is worthy of considerable attention elsewhere in the foothills, appears to be of little economic significance in the Nordegg area.

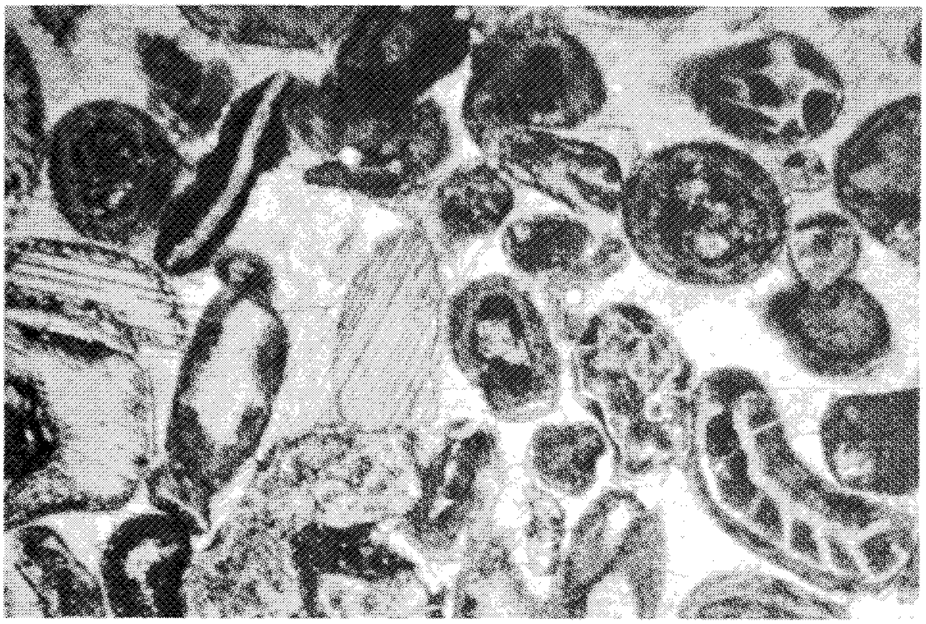


***PLATE 8. Photomicrograph of limestone, Pekisko Formation, Nordegg area (sample 146, 400X).***

## CADOMIN AREA

### LOCATION AND ACCESSIBILITY

The Cadomin area, 60 miles (97 km) southwest of Edson, is reached by Highway No. 47 and a branch of Canadian National Railways. Cadomin is the only community in the area with the exception of the nearby station of Leyland, the local railway servicing point. Inland Cement Company operates a large quarry south of Cadomin which supplies limestone to the company's cement plant in Edmonton, 190 miles (306 km) to the east (Plate 9).

Relief in the area ranges from rolling foothills with elevations near 5,000 feet (1500 m) to the rugged topography of the Nikanassin Range where elevations may exceed 8,000 feet (2400 m) (Fig. 16). The Mcleod River flows through a ½ mile (0.8 km) wide gap in the range at Cadomin.

### GEOLOGY

The geology of the area is presented on two maps by MacKay (1929): the Cadomin and Mountain Park sheets (compilation given in figure 16). Paleozoic and early Mesozoic strata are thrust north over Jurassic and Cretaceous strata. The regional strike is west-northwest. Formations north of the main thrust are folded with the amplitudes of the structures decreasing northeastward away from the Nikanassin Range. Devonian and Mississippian strata southwest of the front of the range dip south at angles averaging approximately 25 degrees. They have been repeated at least twice by secondary thrusts or splays. A few folds and minor thrusts have been mapped in these beds.

The Palliser Formation is composed of thick-bedded, grey, fine-grained limestone and interbedded dolomitic limestones (Plate 10) with minor chert in part. Gotts (1966) reported that at least three magnesian limestone beds are continuous through the main Inland Cement deposit: one near the top, about 100 feet (30 m) below the Exshaw shale contact, one in the center, and one near the base. He further states that these high-magnesian beds vary in thickness from 10 to 40 feet (3 to 12 m) and, on fresh surfaces, are not distinguishable by eye from the high-calcium beds. On weathered surfaces, however, the dolomite has an irregular brownish grey mottling. The upper dolomitic band is thicker in the abandoned Inland Cement quarry (Fig. 16, Plate 11), otherwise the formation exhibits similar bedding characteristics within the southern thrust slice.

Seven feet (2 m) of dark brown shale comprising the Exshaw Formation overlie the Palliser. The Banff Formation, above the Exshaw, has been subdivided into three units by Macqueen (1966). The lowest is a recessive unit, 352 feet (107 m) thick, consisting of dark brown, calcareous shales and minor interbedded shaly, very fine-grained limestones at the base. The middle is a resistant 63-foot (19-m) thick unit, composed of medium-to thin-bedded, grey, very fine-grained limestones,

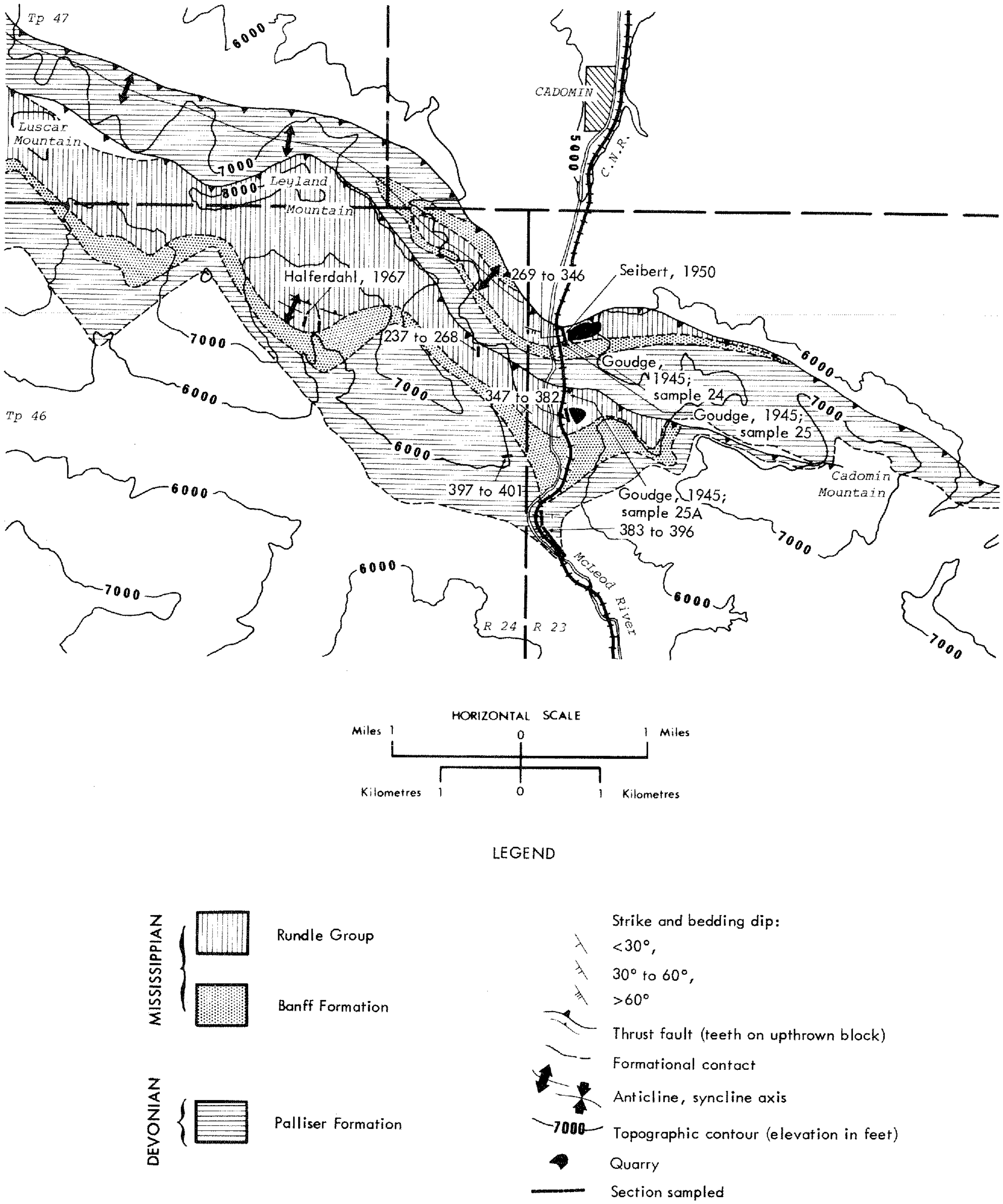



*Figure 16. Geology of the Cadomin area (after MacKay, 1929)*

dolomitized in part, with calcareous shale interbeds. At the top is 100 feet (30 m) of microcrystalline to very finely crystalline, yellowish brown silty dolomites with minor interbeds of very fine-grained limestones.

The Rundle Group is well exposed along the railway opposite the mouth of Whitehorse Creek. Stratigraphy of the beds has been described in detail by Macqueen (1966).

The Pekisko is mainly massively bedded, very fine- to very coarse-grained, light grey limestone. The limestone is dolomitized in places and grey chert bands occur near the top.

Macqueen (1966) recognized four units within the Shunda Formation. The lowest is 66 feet (20 m) of recessive, thickly bedded, finely crystalline dolomite. Overlying this is 134 feet (40 m) of cyclically bedded carbonates with individual cycles varying between 3 and 5 feet (1 to 1.5 m) in thickness. A single cycle consists of very fine-grained limestones passing upwards into tan, microcrystalline to very finely crystalline dolomite. This cycle may be immediately repeated or may be overlain by shaly dolomite beds or finely crystalline dolomite. The third unit includes 38 feet (11 m) of microcrystalline dolomite and shaly dolomite. The upper part of the Shunda is composed of 94 feet (28 m) of breccias, brown microcrystalline dolomites, shaly dolomites, and grey, very fine-grained limestones.

The Turner Valley Formation contains finely to medium-crystalline, brown, porous, and resistant dolomite. The upper part is finely crystalline and less porous than the lower part.

Microcrystalline to finely crystalline dolomite interbedded with green dolomitic shale or shaly dolomite makes up the Mount Head Formation. The formation is 200 feet (60 m) thick in the Cadomin area.

## SAMPLING

The entire Palliser Formation was sampled by the author at the presently active Inland Cement quarry (see figure 17 for sampling intervals and stratigraphy). Exposures sampled in the company's abandoned quarry 1 mile (2 km) to the south represent beds near the middle of the formation. One section measured and sampled across the valley and above the Cadomin caves (samples 237 to 268) is also of strata from the middle of the formation.

A brief account of sampling carried out on the site of the main Inland Cement quarry before operations began is given by Seibert (1950).

Halferdahl (1967) tested two sections on Leyland Mountain 3 miles (5 km) west of the main Inland Cement quarry. The beds outcrop along a small tributary of Whitehorse Creek and are from the top of the Palliser Formation.

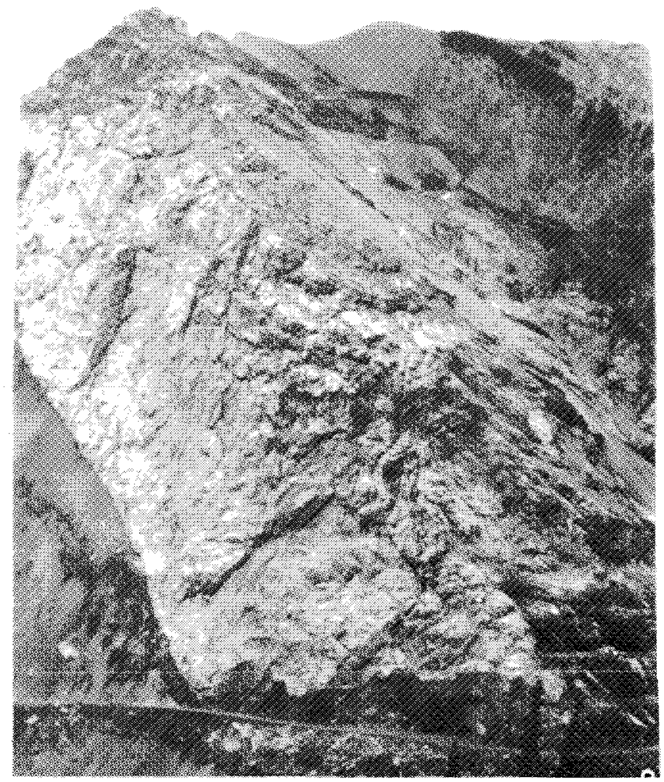


***PLATE 9. Palliser limestone exposed at the main Inland Cement Quarry at Cadomin. Quarrying is underway at a level near the upper left hand corner of the photo. The Nikanassin Thrust, thrusting the Palliser over the Fernie is exposed at the lower left.***

The author did not sample the Banff Formation. However, overlying Mississippian beds of the Rundle Group were sampled along the railway south of Cadomin opposite the mouth of Whitehorse Creek. Samples were also obtained from the basal part of the Pekisko Formation at a low cliff above the campgrounds on Whitehorse Creek. Goudge's account of investigations in the Cadomin area is included in Appendix C.

## ANALYSES

Samples taken in the Palliser Formation, along the railway below the main Inland Cement quarry, were divided into successive 100-foot (30-m) intervals and analysed (Fig. 17). The results are documented in analyses 81 to 87 inclusive (samples 270 to 346) and indicate $CaCO_3$ grades of between 86 and 96 percent. A similar range of values was determined for the abandoned quarry using similar procedures (analyses 88 to 91, samples 347 to 382). Goudge's sample 24 was probably from mottled beds in the middle or lower part of the formation whereas sample 25 was from strata near the top. Analyses of the former reflect the presence of dolomite mottling (6 percent $MgCO_3$); the latter proved the deposit's economic potential (96 percent $CaCO_3$). Seibert (1950) provided one analysis of the upper part of the Palliser, on beds outcropping on the face above the railway (98 percent $CaCO_3$). The top of the mountain above the quarry yielded samples with not less than 96 percent $CaCO_3$. Samples from the middle of the Palliser taken by the author across the valley from the plant showed relatively low $CaCO_3$ (87 to 92 percent) and high $MgCO_3$ (6 percent to 11 percent). The results are given in analyses 78 to 80 (samples 237 to 268A).

Quality of upper strata of the Palliser Formation was determined by Halferdahl (1967) farther west on Leyland Mountain. Calcium carbonate contents vary from 87 to 97 percent and only one sample exceeds 5 percent $MgCO_3$ (analysis 12-20). Silica values tend to be relatively high and are commonly greater than 2 percent.

The basal beds of the Mississippian Pekisko Formation sampled above the campgrounds on Whitehorse Creek, are of very low industrial quality (analysis no. 96, samples 397 to 401, 79 percent $CaCO_3$). The formation was also tested along the railway south of Whitehorse Creek and low grades were verified (analysis no. 92, samples 383 to 384, 54 percent $CaCO_3$). The remainder of the Mississippian succession above the Pekisko, also examined along the railroad, consists of highly dolomitic material (analyses 92 to 95, samples 385 to 395).

Results of X-ray fluorescence analyses of individual samples are given in Appendix B.

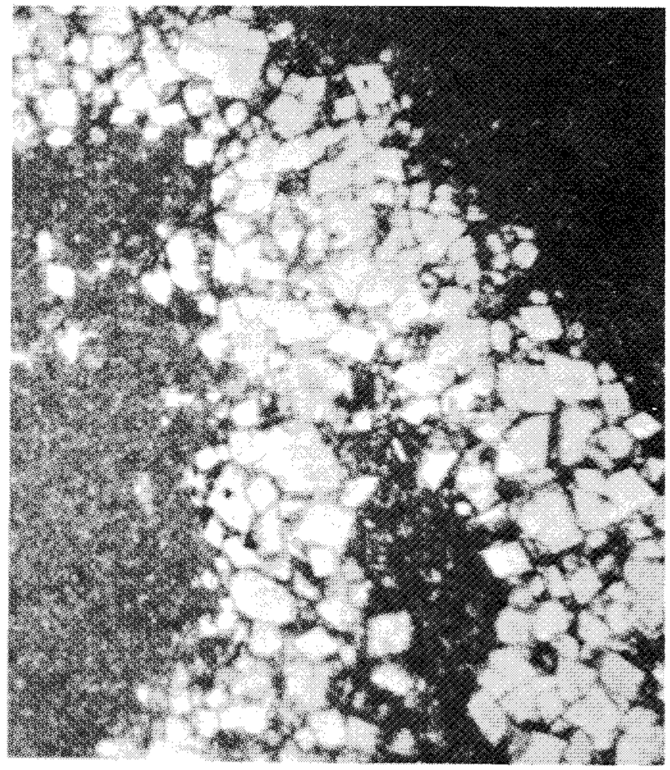


***PLATE 10. Photomicrograph of mottled limestone showing dolomite rhombs comprising the mottled zones and very finely crystalline limestone of the main rock mass (sample 339, 400X).***

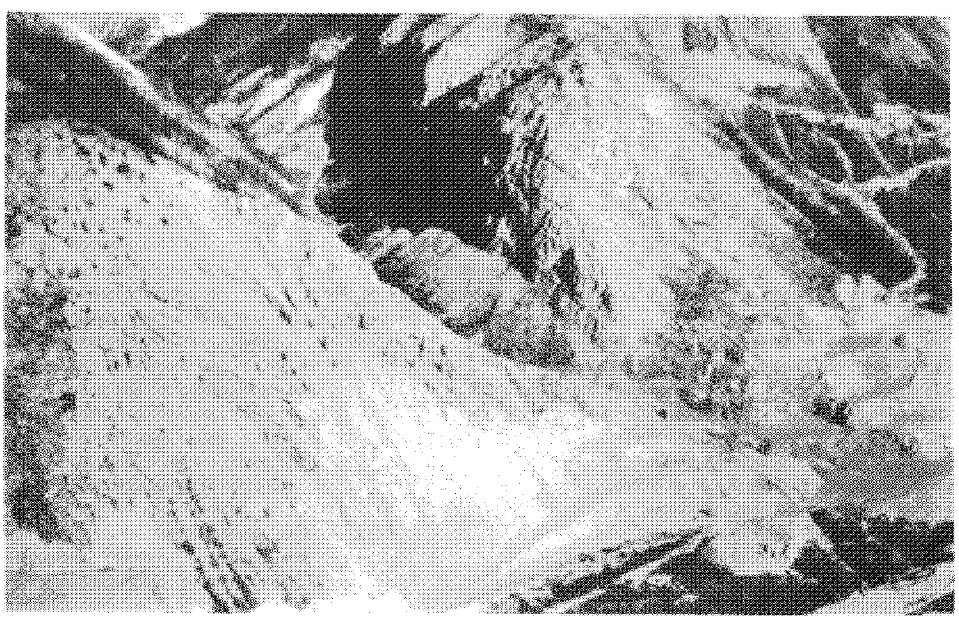


***PLATE 11. Abandoned Inland Cement quarry in Palliser strata at Cadomin, situated approximately one mile south of the main quarry. The Palliser overlies the Rundle Group (to the left) along a thrust demarked by Cadomin Creek (center of photo).***

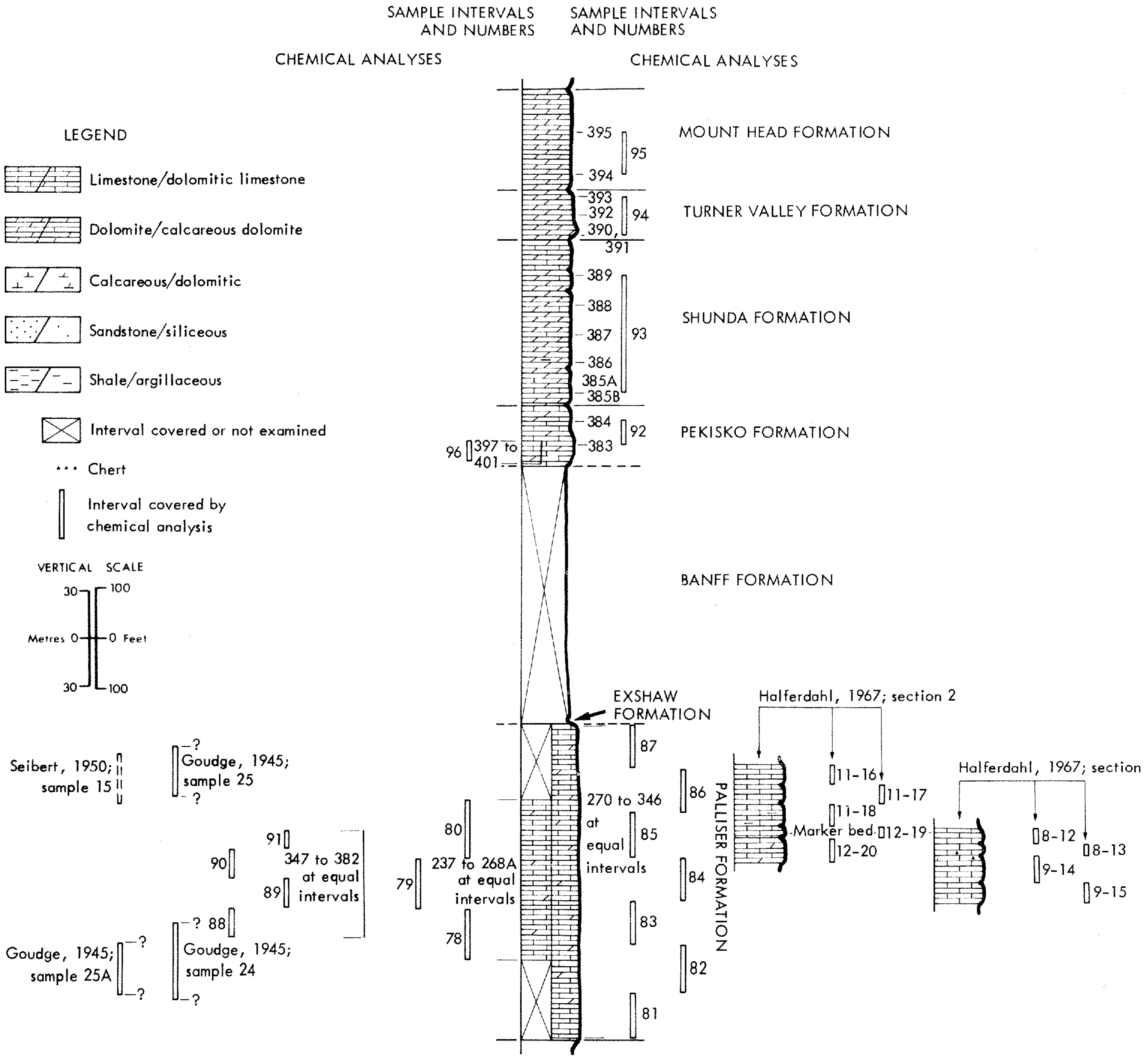



*Figure 17. Composite section, limestone-bearing strata, Cadomin area*

## PRODUCTION AND RESERVES

Palliser limestones were first quarried for lime production close to the present site of the main Inland Cement quarry. For a brief time, after quarrying operations began to supply the cement plant in Edmonton, Inland Cement also produced limestone from the south quarry. This quarry was later abandoned in favor of production from the top of the north deposit. Details of history and development and reserves of the area are provided by Gotts (1966).

The Alberta Lime Company has recently done evaluation work on Leyland Mountain on their property west of that of Inland Cement. The Palliser sections described by Halferdahl occur on the company's property.

The Palliser appears to be the only formation in the area containing high-calcium limestones. Reserves and development potential hinge on the distribution and accessibility of this one unit.

# BRÛLÉ AREA

## LOCATION AND ACCESSIBILITY

The Brûlé area is located 15 miles (24 km) west of Hinton and 200 miles (320 km) west of Edmonton. Highway No. 16 passes through the area as does the main line of Canadian National Railways. Brûlé, on the west side of Brûlé Lake, is the only community in the area and provides minimal commercial services (Fig. 18).

The Athabasca River flows from a wide mountain valley in the west into the adjacent foothills where it immediately broadens out to form Brûlé Lake. The nearby northwest-southeast trending mountain ranges are up to 7,000 feet (2100 m) in elevation in contrast to the valley floor which lies at about 3,300 feet (1000 m). The eastern boundary of Jasper National Park at Brûlé is shown in figure 18. Investigations for limestones were confined to occurrences outside the Park.

## GEOLOGY

The Brûlé area was mapped by Lang (1947) and Mountjoy (1959); the results are compiled in figure 18. Typical Rocky Mountain structural features are observed in the area. Paleozoic strata are thrust east over Mesozoic beds along the main fault, the Boule Thrust. A second major thrust, the Perdrix Fault, has repeated the Paleozoic rocks within a distance of less than 1 mile (2 km) across the strike. Folding Mountain, on the east side of the area, is an anticlinal outlier of Paleozoic rocks 1 mile (2 km) beyond the mountain front. The east limb of anticlinal structures, dip southwest at angles of between 30 and 60 degrees. Due to thrusting, beds in the Brûlé area are more contorted than in the other areas of the Foothills and Front Ranges which were examined in this study.

The lowest stratigraphic unit present, the Mount Hawk Formation, is dark grey, argillaceous, thin-bedded, finely crystalline limestone with some calcareous shale. It may be up to 600 feet (180 m) thick.

Above the Mount Hawk is the Alexo Formation which includes less than 100 feet (30 m) of yellowish grey, calcareous

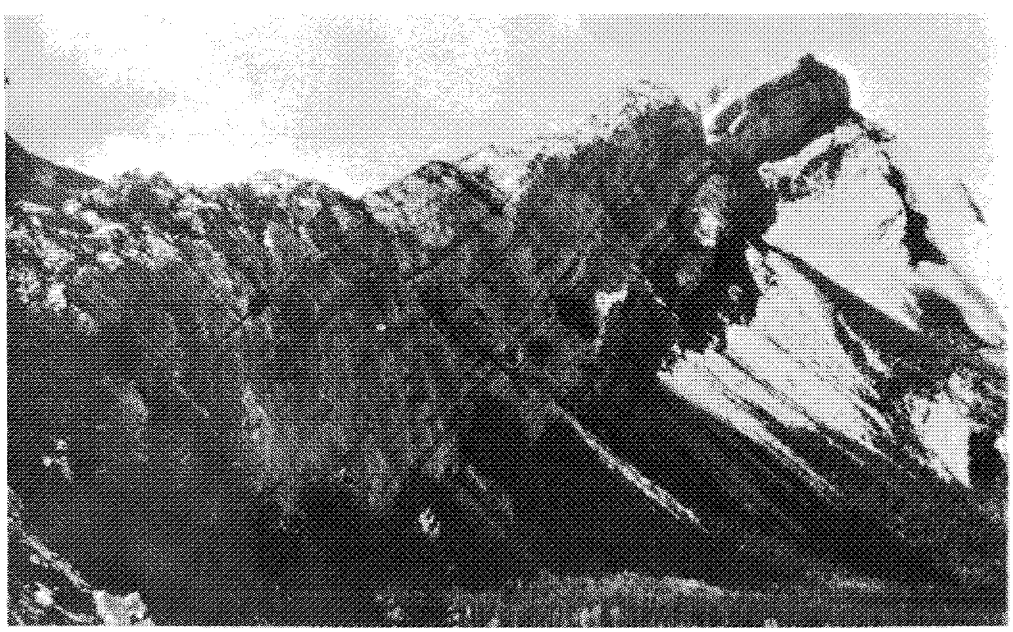


***PLATE 12. Cliff-forming Palliser Formation exposed on Boule Range, Brule area. Photo taken from top of ridge ½ mile (0.8 km) south of Ogre Canyon, looking north.***

siltstone, cryptocrystalline limestone, with breccia and dolomite beds. No outcrops of the Alexo were visited.

Palliser strata are typically dark grey, massively bedded, finely crystalline limestones, mottled and dolomitic in part (Plate 12). The formation varies between 600 and 800 feet (180 to 240 m) in thickness.

The Exshaw Formation, overlying the Palliser, is composed of 7 feet (2 m) of black fissile shale. The Banff Formation, above the Exshaw, is about 550 feet (170 m) thick and Mountjoy (1959) described four units:

> ". . . a lower 400 feet of recessive-weathering shales and argillaceous limestones, up to 50 feet of interbedded crinoidal and argillaceous limestones, 150 feet of argillaceous limestone with thin interbeds of crinoidal limestone, and a 5- to 30-foot siltstone and silty limestone at the top."

Mountjoy divided the Rundle into two main units for mapping purposes. Each of these was further divided into two other "formations." Thus, basal formation A and the overlying formation B were placed in the lower main unit of the Rundle; formation C and formation D are found in the upper. The following descriptions were given:

> "Formation A: light grey, micro- to coarse-grained massive organic calcarenite and partly organic calcarenite.
>
> Formation B: dark grey, argillaceous, fine-grained limestone and dolomite; thin interbeds of shale, collapse breccias and dolomitic limestone.
>
> Formation C: greyish brown, fine- to coarse-crystalline, thick-bedded, porous dolomite with relicts of fine- to medium-grained organic calcarenite.
>
> Formation D: buff, dense, cherty dolomite and argillaceous dolomite."

Mountjoy further noted that:

> ". . . formation A and B of the Rundle group vary in thickness from 40 to 180 feet and from 200 to 500 feet respectively; formations C and D of the Rundle group vary from 75 to 200 feet and from 150 to 350 feet respectively,"

within the Miette map area. Formations A, B, C and D are considered, in part or wholly, equivalent to the Pekisko, Shunda, Turner Valley and Mount Head Formations of the Rundle Group of southern Alberta.

## SAMPLING

The Mount Hawk Formation outcrops along the railway at the south end of Brûlé Lake and this occurrence was sampled during the 1970 field season (Fig. 18, samples 185 to 195).

Palliser strata are exposed at four easily accessible points: near Highway No. 16 within the core of the Folding Mountain anticline (samples 700 to 702) at a quarry near the highway at the entrance to Jasper National Park (samples 610 to 613), at Ogre Canyon west of the railway at the south end of Brûlé Lake (samples 173 to 184), and farther southeast along the same ridge through which the canyon is cut (samples 196 to 236). The latter three of these locations were sample.

The Banff Formation and Rundle Group were not sampled as only limited exposures are available at locations near access routes.

A description of the area by Goudge is included in Appendix C.

## ANALYSES

Samples of the Mount Hawk Formation analysed 90 percent $CaCO_3$ and less than 5 percent $MgCO_3$. Silica accounts for about 3 percent of the constituents (see analysis no. 99 and figure 19).

Analyses of samples from the Palliser section south of Ogre Canyon describe all the formation except the top. Between 60 and 120 feet (18 to 37 m) is represented by each analysis and the results show between 93 and 97 percent $CaCO_3$ with the $MgCO_3$ varying between 2 and 4 percent (analyses 100 to 103, samples 196 to 236). A quarry in steeply dipping beds of the Palliser Formation east of Highway No. 16 and immediately north of the Jasper Park entrance contains high-calcium rock (97 percent $CaCO_3$, 3 percent $MgCO_3$; analysis no. 97, samples 610 to 613). Goudge's sample 26, from Ogre Canyon, indicates relatively high $CaCO_3$ (92 percent) but grades are lowered by the presence of dolomite (6 percent).

Analyses of individual samples obtained by the X-ray fluorescence method are given in Appendix B.

## PRODUCTION AND RESERVES

One quarry has been opened near the east entrance of Jasper National Park, presumably as a source of riprap. It is now apparently inactive. This is the only limestone production known from the area, in spite of the fact that excellent grades of limestone are available. Further investigation of the Palliser Formation is warranted at the above-mentioned quarry, on the west side of Brûlé Lake, and adjacent to Highway No. 16.

Each of these deposits does present some problems for development. The inactive quarry is across the Athabasca River from rail facilities. The Palliser beds in the core of Folding Mountain anticline on old Highway No. 16 present the same problem. Deposits near the railway on the west side of the valley are limited by their proximity to the Park boundary. In addition, the steep eastern face of Roche Boule would be difficult to quarry. Consideration should be given to evaluating the Palliser Formation farther north near creek re-entrants where it may be suitable for quarrying operations.

## FORT McMURRAY AREA

### LOCATION AND ACCESSIBILITY

The Fort McMurray study area includes that region in northeastern Alberta in which outcrops of the Upper Devonian Waterways Formation are located close to Fort McMurray and the rail line. Fort McMurray is situated at the confluence of the Athabasca and Clearwater Rivers 275 miles (440 km) northeast of Edmonton and is serviced by Highway No. 63, the Northern Alberta Railway line, and air facilities. The highway continues north to Fort MacKay; the rail line terminates at the neighboring community of Waterways, a major terminus for north-bound barge traffic.

Valleys formed by the Athabasca and Clearwater Rivers constitute the only major topographic relief within the area. The valley floors are at elevations of approximately 800 feet (240 m) which is 400 feet (120 m) below the elevation of the regional plain across which the rivers flow.

### GEOLOGY

Norris (1963) included the Fort McMurray area in his study of the Devonian stratigraphy of northeastern Alberta and northwestern Saskatchewan. The area is structurally simple with Devonian strata dipping gently southwest except at localities where small flexures are found. Devonian rocks are mantled by Cretaceous and Pleistocene cover except along major river valleys where erosion has exposed numerous low outcrops of the Waterways Formation (Fig. 20). Approximately 40 miles (64 km) upstream from Fort McMurray on the Clearwater River the Waterways Formation outcrops end and are replaced by the underlying Middle Devonian Methy Formation dolomites.

Crickmay (1957), on the basis of fossil content, divided the Waterways Formation into five members named (in ascending order): the Firebag, Calumet, Christina, Moberly, and Mildred. Outcrops of the Calumet, Christina, and Moberly Members are readily accessible from Fort McMurray and were the only units studied (Fig. 21).

The Calumet Member was described by Norris as:

> ". . . very light greyish brown, hard, cryptograined, thin-bedded slightly argillaceous limestone towards the base; light grey to medium brown, irregularly thin-bedded, strongly argillaceous, richly fossiliferous limestone with calcareous shale partings; pale brown, thin-bedded, hard cryptograined limestone; light greenish grey, irregularly thin-bedded, richly fossiliferous argillaceous limestone with thin interbeds of nodular calcareous shale; and olive-green, rubbly bedded, strongly argillaceous limestone."

The member has an average thickness of about 95 feet (29 m).

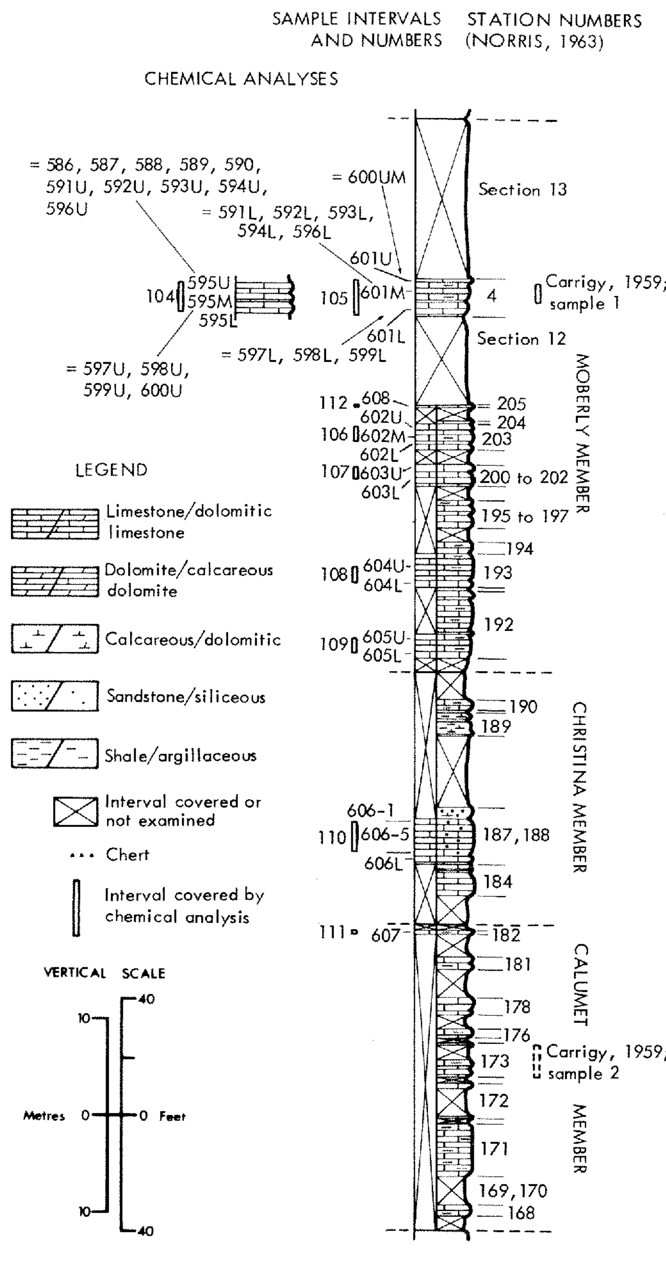



*Figure 21. Composite section, limestone-bearing strata, Fort McMurray area*

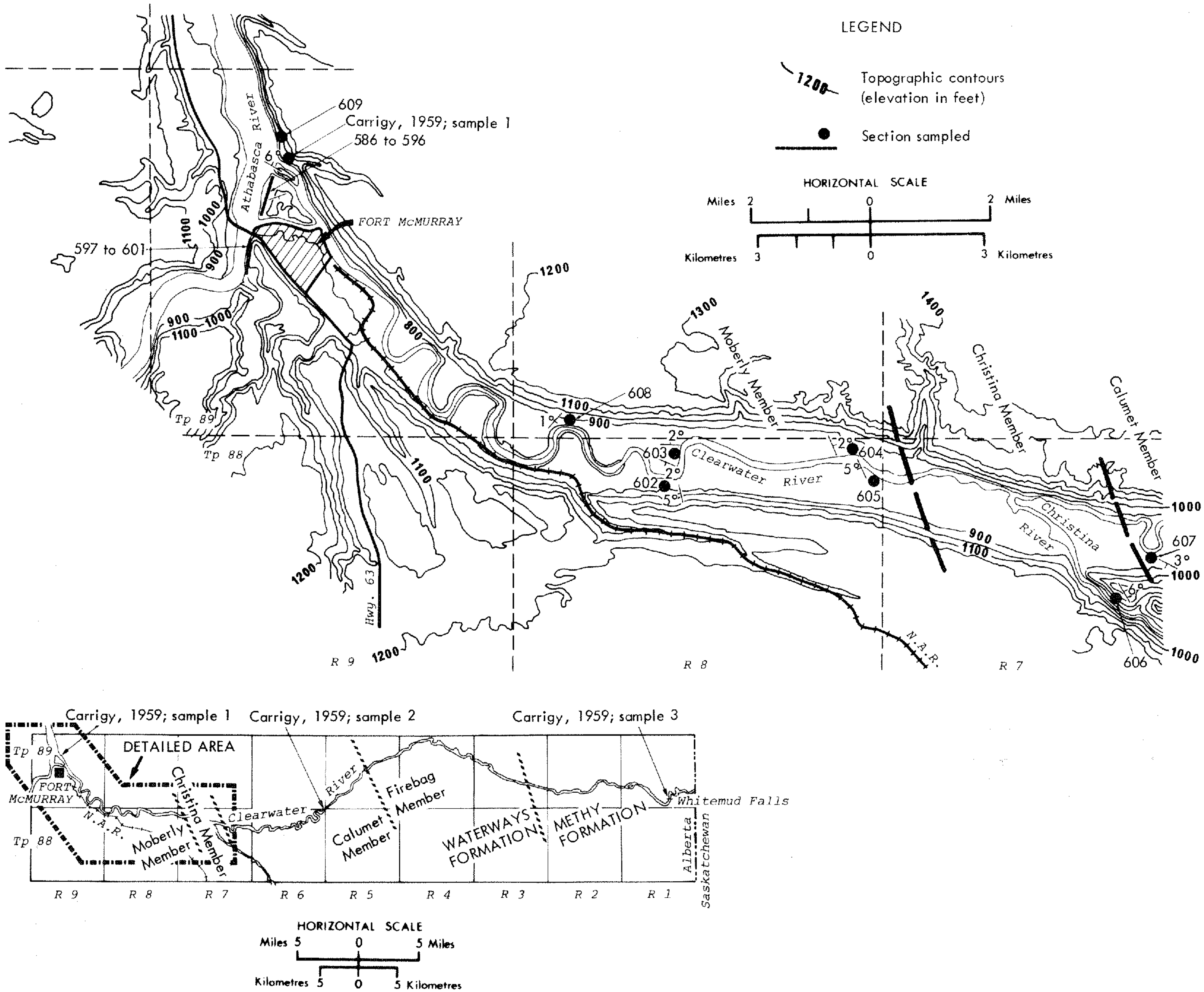



*Figure 20. Geology of the Fort McMurray area (after Norris, 1963)*

Christina outcrops examined by Norris were variously noted as light grey to light brown, argillaceous to sandy thin-bedded and rubbly to massive, cryptograined to fine-grained limestones; as thin-bedded and fissile calcareous shale; and as fine-bedded, brown, fine-grained, calcareous, quartzitic sandstone. A thickness of 90 feet (27 m) or more has been measured by Crickmay.

Norris summarized the Moberly Member as comprising:

> ". . . very thin-bedded, medium grey, soft argillaceous limestones, weathering light orange-brown; resistant, light brown fine-grained, fossiliferous limestones; thick-bedded, resistant, light grey, cryptograined limestones with fragmentary organic remains; and thin-bedded, medium brown, fine-grained . . . limestones with calcareous shale partings."

The member is approximately 200 feet (60 m) thick (Plates 13 and 14).

## SAMPLING

Sampling of the Waterways Formation was carried out approximately 1 mile (2 km) north and south of the highway bridge across the Athabasca River, on the east side of the river. All outcrops in this area are of the Moberly Member. The remainder of the samples was obtained from outcrops between the mouth of the Clearwater River and upstream to a point east of the confluence of the Clearwater with the Christina River. The most easterly sampling locations were in upper Calumet beds on the Clearwater River 2 miles (3 km) east of the mouth of the Christina River; and 2 miles (3 km) upstream on the Christina River, where the Christina Member was sampled. A number of samples of Moberly strata were collected from exposures along the Clearwater River west of the mouth of the Christina River.

## ANALYSES

One analysis of Methy dolomite from the Whitemud Falls on the Clearwater River is given by Carrigy (1959). This rock contains 59 percent $CaCO_3$ and 34 percent $MgCO_3$ (see inset diagram in figure 20 for location and Appendix A for analysis details).

Carrigy also lists an analysis of rock from Calumet beds 10 miles (16 km) upstream on the Clearwater River from its junction with the Christina River (sample 2). Calcium carbonate content is 93 percent, $MgCO_3$ is less than 2 percent and $SiO_2$ values exceed 3 percent. One analysis of the Calumet Member was obtained by the author (analysis no. III, sample 607). The beds are siliceous (10 percent $SiO_2$) and dolomitic (5 percent $MgCO_3$).

Samples from the Christina Member were combined for one analysis which showed 66 percent $CaCO_3$, 3 percent $MgCO_3$, 5 percent $SiO_2$ and 15 percent $Fe_2O_3$ (analysis no. 110, sample 606).

Seven analyses of the Moberly Member range from 86 percent to 91 percent $CaCO_3$ with less than 5 percent $MgCO_3$ (analyses nos. 104 to 109 and 112; samples 595, 601 to 605, and 608). Silica contents average about 4 percent. One analysis of the Moberly limestone reported by Carrigy from an exposure on the north bank of the Clearwater River at its junction with the Athabasca, tested 95 percent $CaCO_3$ and 1 percent $MgCO_3$ (sample 1).

X-ray fluorescence analyses of individual samples are given in Appendix B.

## PRODUCTION AND RESERVES

There has been no production of limestone in the McMurray area to date. Although $CaCO_3$ contents are lower than those usually accepted for limestone industries, the factors lowering the grades are unusual in comparison to low-grade limestones elsewhere in the province. Values of $MgCO_3$ are slightly high for industrial grade limestones but are commonly less than 5 percent. However, $SiO_2$ values are relatively high, exceeding 5 percent in places. In one case (analysis no. 110, sample 606 of Christina beds) the $Fe_2O_3$ content exceeds 15 percent. Percentages of $Al_2O_3$ appear to be considerably higher than rock sampled in the Foothills and Front Ranges of western Alberta. Development of Waterways carbonates (particularly Moberly limestones) is feasible only if quality standards to be met are not excessively high, particularly with respect to high $SiO_2$ content. Large reserves with thin overburden are in the area; however, most of these reserves may lie below the local water table.

# CONCLUSIONS

Alberta has abundant resources of high-calcium limestone and future development is feasible in seven areas of the province. In the Crowsnest and Exshaw areas substantial reserves are exploitable in the Mississippian Livingstone and Upper Devonian Palliser Formations. At Blairmore and Nordegg high-grade beds are confined to the Livingstone Formation. In the Cadomin and Brule areas, large reserves are found in the Palliser Formation. In the Fort McMurray area, within the Moberly Member of the Upper Devonian Waterways Formation, are limestones of moderate quality which may be suitable for development. The variability of the rock in each area considered necessitates detailed evaluation to define accurately dolomitic and siliceous bands.

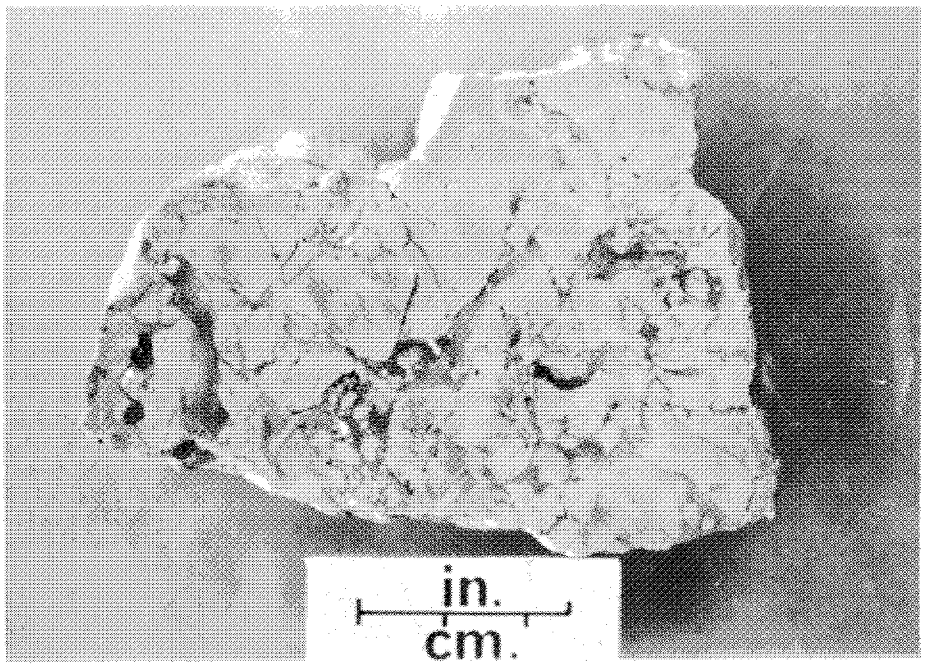



*PLATE 13. Breccia-like limestone from the Moberly Member of the Waterways Formation. Sample from outcrop north of the bridge, along the east side of the Athabasca River, near Fort McMurray (sample 595).*

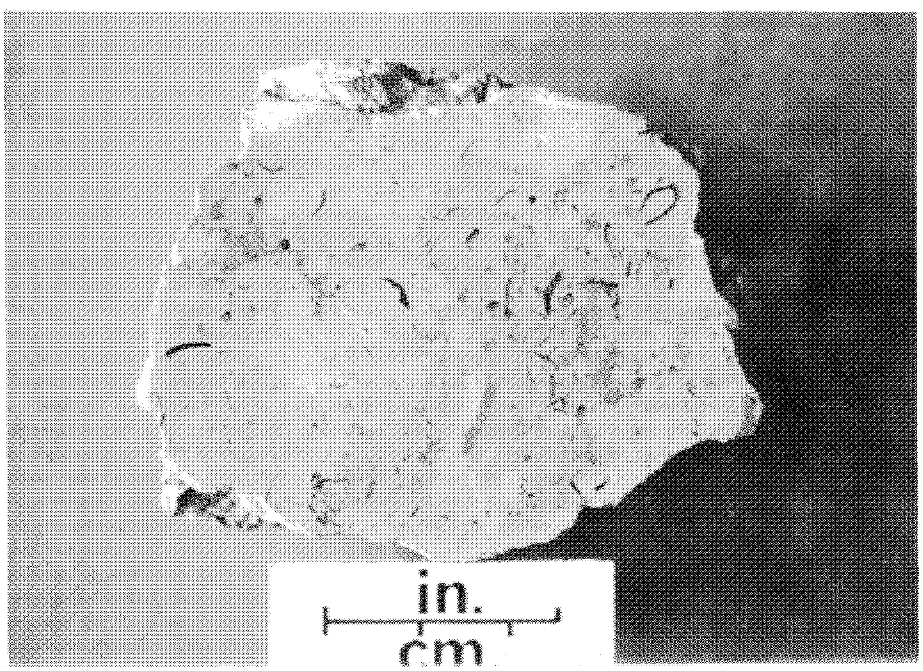



*PLATE 14. Very fine crystalline, fossiliferous limestone from the Moberly Member of the Waterways Formation. Sample from outcrop south of the bridge, along the east side of the Athabasca River, near Fort McMurray (sample 600U).*

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# APPENDIX A

## CHEMICAL ANALYSES OF COMPOSITE SAMPLES

## Table A-1. Chemical analyses, Crowsnest Pass area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 12 | 13 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 1 to 5 | 6 | 7 to 13 | 14 to 20 (excl. 14B) | 21 to 26 | 27 to 35 | 36 to 40 | 402 to 410 (excl. 407) | 411 to 417 |
| Insolubles | 0.49 | 1.08 | 0.24 | 1.75 | 0.62 | 2.07 | 0.28 | 0.18 | 0.35 |
| $SiO_2$ | 2.02 | 37.44 | 0.98 | 8.95 | 6.94 | 39.26 | 2.36 | 0.21 | 0.42 |
| $Fe_2O_3$ | 0.11 | 0.81 | 0.14 | 0.69 | 0.19 | 0.94 | 0.26 | 0.05 | 0.05 |
| $Al_2O_3$ | 0.46 | 0.35 | 0.29 | 1.59 | 0.55 | 0.79 | 0.70 | 0.09 | 0.32 |
| CaO | 46.54 | 29.99 | 53.66 | 40.10 | 34.37 | 26.78 | 50.65 | 55.03 | 52.82 |
| MgO | 6.42 | 3.55 | 2.39 | 6.92 | 14.34 | 4.85 | 2.69 | 1.37 | 2.72 |
| L.O.I. | 43.14 | 27.11 | 43.31 | 39.05 | 42.14 | 26.06 | 42.33 | 43.06 | 43.50 |
| $H_2O$ | 0.09 | 0.08 | 0.04 | 0.06 | 0.04 | 0.07 | 0.07 | 0.09 | 0.06 |
| TOTAL | 99.27 | 100.41 | 101.05 | 99.11 | 99.19 | 100.82 | 99.64 | 100.08 | 100.24 |
| $CaCO_3$ | 83.11 | 53.55 | 95.82 | 71.61 | 61.37 | 47.82 | 90.45 | 98.27 | 94.32 |
| $MgCO_3$ | 13.43 | 7.42 | 5.00 | 14.47 | 29.99 | 10.14 | 5.63 | 2.87 | 5.69 |

## Table A-1. (continued)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | Sample Number(s) | | | | | | | | |
| | 418 to 426 (excl. 424) | 427 to 433 | 434 to 440 | 441 to 447 | 448 to 451 | 452 to 457 | 458 to 461 | 462 to 466 | 467 to 471 |
| Constituent | | | | | | | | | |
| Insolubles | 0.28 | 1.56 | 0.25 | 0.07 | 0.04 | 0.61 | 0.15 | 0.02 | 0.10 |
| $SiO_2$ | 0.42 | 6.57 | 0.33 | 0.67 | 0.57 | 9.00 | 1.98 | 0.83 | 1.14 |
| $Fe_2O_3$ | 0.07 | 0.16 | 0.04 | 0.10 | 0.11 | 0.20 | 0.12 | 0.10 | 0.08 |
| $Al_2O_3$ | 0.12 | 1.07 | 0.14 | 0.09 | 0.04 | 0.44 | 0.26 | 0.19 | 0.31 |
| CaO | 47.57 | 36.18 | 53.57 | 44.46 | 54.89 | 47.42 | 50.62 | 56.41 | 45.32 |
| MgO | 7.69 | 13.36 | 1.49 | 9.51 | 0.78 | 2.36 | 3.10 | 0.65 | 10.16 |
| L.O.I. | 44.12 | 41.96 | 43.92 | 44.67 | 43.47 | 39.57 | 43.02 | 41.98 | 42.86 |
| $H_2O$ | 0.02 | 0.05 | 0.03 | 0.02 | 0.06 | 0.08 | 0.12 | 0.10 | 0.02 |
| TOTAL | 100.29 | 100.91 | 99.87 | 99.59 | 99.96 | 99.68 | 99.37 | 100.28 | 99.99 |
| $CaCO_3$ | 84.95 | 64.61 | 94.84 | 79.39 | 98.02 | 84.68 | 90.39 | 100.73 | 80.93 |
| $MgCO_3$ | 16.08 | 27.94 | 3.12 | 19.89 | 1.63 | 4.94 | 6.48 | 1.36 | 21.25 |

## Table A-1. (continued)

| | Chemical Analysis Number | | | | |
|---|---|---|---|---|---|
| | 23 | 24 | 25 | 26 | 27 |
| | Sample Number(s) | | | | |
| Constituent | 472 to 476 | 477 to 481 | 482 to 485 | 486 to 490 | 491 to 494 |
| Insolubles | 0.26 | 0.05 | 0.06 | 0.51 | 0.31 |
| $SiO_2$ | 1.66 | 0.33 | 1.95 | 9.46 | 4.76 |
| $Fe_2O_3$ | 0.11 | 0.09 | 0.06 | 0.18 | 0.30 |
| $Al_2O_3$ | 0.37 | 0.09 | 0.17 | 0.90 | 0.74 |
| CaO | 48.59 | 57.15 | 54.87 | 46.82 | 31.21 |
| MgO | 6.46 | 0.38 | 0.96 | 3.54 | 18.79 |
| L.O.I. | 42.47 | 43.41 | 42.86 | 39.62 | 44.21 |
| $H_2O$ | 0.07 | 0.12 | 0.12 | 0.03 | 0.02 |
| TOTAL | 99.99 | 101.62 | 101.05 | 100.06 | 100.34 |
| $CaCO_3$ | 86.77 | 102.05 | 97.98 | 83.61 | 55.73 |
| $MgCO_3$ | 13.51 | 0.79 | 2.01 | 7.40 | 39.30 |

## Table A-2. Chemical analyses, Crowsnest Pass area (after Goudge, 1945)

| Constituent | Sample Number 2 | 2A | 3 | 3A | 3B | 3C | 4 | 4A | 5 | 5A |
|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 1.04 | 0.46 | 0.42 | 1.04 | 2.66 | 6.82 | 0.58 | 0.50 | 0.64 | 0.80 |
| $Fe_2O_3$ | 0.20 | 0.15 | 0.06 | 0.09 | 0.21 | 0.35 | 0.18 | 0.06 | 0.17 | 0.03 |
| $Al_2O_3$ | 0.42 | 0.35 | 0.08 | 0.19 | 0.39 | 0.55 | 0.10 | 0.08 | 0.13 | 0.17 |
| $Ca_3(PO_4)_2$ | 0.02 | 0.02 | 0.09 | 0.11 | 0.09 | 0.09 | 0.07 | 0.11 | 0.04 | 0.04 |
| $CaCO_3$ | 96.34 | 77.41 | 97.84 | 96.81 | 68.29 | 60.23 | 97.00 | 98.25 | 94.66 | 97.84 |
| $MgCO_3$ | 2.01 | 22.30 | 1.90 | 1.98 | 29.15 | 32.62 | 2.34 | 1.62 | 4.22 | 1.30 |
| TOTAL | 100.03 | 100.69 | 100.39 | 100.22 | 100.79 | 100.66 | 100.27 | 100.62 | 99.84 | 100.18 |
| S | 0.03 | tr | nil | nil | 0.02 | 0.03 | tr | nil | tr | nil |
| CaO | 53.96 | 43.36 | 54.82 | 54.24 | 38.29 | 33.78 | 54.36 | 55.08 | 53.02 | 54.82 |
| MgO | 0.96 | 10.66 | 0.91 | 0.95 | 13.94 | 15.60 | 1.12 | 0.77 | 2.02 | 0.62 |

**Table A-3. Chemical analyses, Blairmore area (this report)**

| | Chemical Analysis Number | | | |
|---|---|---|---|---|
| | 8 | 9 | 10 | 11 |
| | Sample Number(s) | | | |
| | 41 to 48 | 49,50 | 51,52 | 53 to 59 |
| Constituent | | | | |
| Insolubles | 0.54 | 0.06 | 0.28 | 0.95 |
| $SiO_2$ | 17.09 | 0.21 | 9.69 | 7.56 |
| $Fe_2O_3$ | 0.46 | 0.04 | 0.07 | 0.20 |
| $Al_2O_3$ | 0.15 | 0.20 | 0.25 | 0.79 |
| CaO | 37.74 | 55.69 | 48.13 | 42.41 |
| MgO | 6.81 | 0.63 | 2.09 | 7.24 |
| L.O.I. | 36.77 | 43.23 | 39.54 | 40.89 |
| $H_2O$ | 0.12 | 0.09 | 0.05 | 0.03 |
| TOTAL | 99.68 | 100.15 | 100.10 | 100.07 |
| $CaCO_3$ | 67.39 | 99.45 | 85.95 | 75.73 |
| $MgCO_3$ | 14.24 | 1.32 | 4.37 | 15.14 |

**Table A-4. Chemical analyses, Blairmore area (after Goudge, 1945)**

| | Sample Number | | | | |
|---|---|---|---|---|---|
| | 1 | 1A | 1B | 1C | 1X |
| Constituent | | | | | |
| $SiO_2$ | 1.00 | 0.62 | 8.38 | 0.18 | 0.70 |
| $Fe_2O_3$ | 0.08 | 0.07 | 0.17 | 0.04 | 0.04 |
| $Al_2O_3$ | 0.20 | 0.07 | 0.21 | 0.12 | 0.18 |
| $Ca_3(PO_4)_2$ | 0.22 | 0.11 | 0.09 | 0.09 | 0.11 |
| $CaCO_3$ | 88.91 | 96.52 | 64.75 | 98.87 | 97.23 |
| $MgCO_3$ | 10.21 | 2.83 | 27.27 | 1.20 | 2.36 |
| TOTAL | 100.62 | 100.22 | 100.87 | 100.50 | 100.62 |
| S | 0.06 | tr | 0.03 | tr | tr |
| CaO | 49.91 | 54.11 | 36.37 | 55.42 | 54.51 |
| MgO | 4.88 | 1.35 | 13.04 | 0.57 | 1.13 |

## Table A-5. Chemical analyses, Exshaw area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| | Sample Number(s) | | | | | | | | |
| | 62 (composite) | 63 | 64 (composite) | 65 (composite) | 66 (composite) | 67 (composite) | 68 (composite) | 69-1 to -8 | 69-10 to -15 |
| Constituent | | | | | | | | | |
| Insolubles | 2.53 | 0.01 | 0.96 | 0.17 | 0.51 | 0.61 | 0.46 | 0.17 | 1.08 |
| $SiO_2$ | 20.09 | 0.84 | 24.87 | 0.49 | 6.18 | 18.60 | 27.91 | 7.19 | 21.82 |
| $Fe_2O_3$ | 1.21 | 0.11 | 0.49 | 0.12 | 0.50 | 0.49 | 0.11 | 0.19 | 0.75 |
| $Al_2O_3$ | 4.13 | 0.07 | 1.09 | 0.22 | 1.40 | 0.89 | 0.78 | 0.16 | 1.41 |
| CaO | 38.43 | 56.17 | 38.86 | 28.11 | 50.88 | 43.41 | 28.32 | 38.51 | 39.96 |
| MgO | 3.07 | 0.66 | 2.67 | 20.07 | 1.48 | 1.96 | 9.10 | 11.11 | 1.98 |
| L.O.I. | 31.17 | 43.24 | 32.46 | 48.31 | 39.90 | 34.74 | 31.91 | 41.58 | 32.76 |
| $H_2O$ | 0.06 | 0.12 | 0.06 | 0.02 | 0.06 | 0.13 | 0.06 | 0.05 | 0.07 |
| TOTAL | 100.69 | 101.21 | 101.46 | 97.51 | 100.91 | 100.83 | 98.65 | 98.96 | 99.84 |
| $CaCO_3$ | 68.62 | 100.30 | 69.39 | 50.20 | 90.86 | 77.52 | 50.57 | 68.77 | 71.36 |
| $MgCO_3$ | 6.42 | 1.38 | 5.58 | 41.98 | 3.10 | 4.10 | 19.03 | 23.24 | 4.14 |

## Table A-5. (continued)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 69-16 to -17 | 70 (composite) | 71 | 72-1 to -6 | 72-7 to -15 | 73 (composite) | 74 (composite) | 75 (composite) | 76 (composite) |
| Insolubles | 0.18 | 0.07 | 0.08 | 0.11 | 0.15 | 0.13 | 0.49 | 0.07 | 0.02 |
| $SiO_2$ | 2.60 | 1.26 | 0.49 | 1.09 | 1.24 | 1.67 | 19.69 | 0.82 | 0.63 |
| $Fe_2O_3$ | 0.20 | 0.24 | 0.14 | 0.31 | 0.46 | 0.27 | 0.37 | 0.21 | 0.10 |
| $Al_2O_3$ | 0.31 | 0.46 | 0.23 | 0.22 | 0.11 | 0.60 | 0.57 | 0.15 | 0.32 |
| CaO | 49.97 | 49.48 | 30.72 | 30.56 | 31.33 | 30.58 | 43.60 | 46.65 | 32.70 |
| MgO | 4.87 | 5.54 | 20.68 | 20.42 | 20.34 | 20.67 | 1.49 | 9.56 | 20.45 |
| L.O.I. | 43.17 | 43.74 | 47.89 | 47.59 | 46.74 | 46.23 | 34.56 | 44.08 | 46.37 |
| $H_2O$ | 0.07 | 0.08 | 0.00 | 0.08 | 0.03 | 0.30 | 0.30 | 0.21 | 0.19 |
| TOTAL | 101.37 | 101.87 | 100.63 | 100.38 | 100.40 | 100.45 | 101.07 | 101.75 | 100.78 |
| $CaCO_3$ | 89.23 | 88.36 | 54.86 | 54.57 | 55.95 | 54.61 | 77.86 | 83.30 | 58.39 |
| $MgCO_3$ | 10.19 | 11.59 | 43.25 | 42.71 | 42.54 | 43.23 | 3.12 | 19.99 | 42.77 |

## Table A-5. (continued)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 77 (composite) | 78 (composite) | 495 to 505 | 506 to 515 (excl. 510) | 516 to 525 | 526 to 535 | 536 to 545 | 546 to 555 | 556 to 560 |
| Insolubles | 0.02 | 0.00 | 0.00 | 0.03 | 0.00 | 0.05 | 0.01 | 0.14 | 0.04 |
| $SiO_2$ | 1.58 | 0.69 | 0.27 | 0.47 | 0.59 | 0.24 | 0.53 | 0.54 | 0.61 |
| $Fe_2O_3$ | 0.21 | 0.10 | 0.09 | 0.19 | 0.14 | 0.14 | 0.12 | 0.11 | 0.13 |
| $Al_2O_3$ | 0.81 | 0.32 | 0.16 | 0.11 | 0.28 | 0.18 | 0.24 | 0.33 | 0.27 |
| CaO | 52.50 | 53.03 | 51.18 | 50.68 | 50.76 | 39.58 | 51.28 | 53.28 | 54.63 |
| MgO | 4.15 | 4.47 | 6.30 | 6.18 | 5.41 | 15.12 | 5.15 | 3.34 | 2.57 |
| L.O.I. | 43.23 | 43.66 | 43.99 | 43.87 | 43.91 | 45.80 | 43.92 | 43.54 | 43.57 |
| $H_2O$ | 0.20 | 0.15 | 0.17 | 0.04 | 0.04 | 0.01 | 0.00 | 0.06 | 0.05 |
| TOTAL | 102.70 | 102.42 | 102.16 | 101.57 | 101.13 | 101.12 | 101.25 | 101.84 | 101.87 |
| $CaCO_3$ | 93.75 | 94.70 | 91.39 | 90.50 | 90.64 | 70.68 | 91.57 | 95.14 | 97.55 |
| $MgCO_3$ | 8.68 | 9.35 | 13.18 | 12.93 | 11.32 | 31.62 | 10.77 | 6.99 | 5.38 |

**Table A-5. (continued)**

| | Chemical Analysis Number | | |
|---|---|---|---|
| | 55 | 56 | 57 |
| | Sample Number(s) | | |
| Constituent | 561 to 569 | 570 | 571 to 584 (excl. 579) |
| Insolubles | 0.12 | 0.16 | 0.74 |
| $SiO_2$ | 4.63 | 1.23 | 7.50 |
| $Fe_2O_3$ | 0.69 | 0.13 | 0.36 |
| $Al_2O_3$ | 2.06 | 0.35 | 1.10 |
| CaO | 42.22 | 31.49 | 47.70 |
| MgO | 8.40 | 20.87 | 4.68 |
| L.O.I. | 41.76 | 45.98 | 40.35 |
| $H_2O$ | 0.04 | 0.04 | 0.08 |
| TOTAL | 99.92 | 100.25 | 102.51 |
| $CaCO_3$ | 75.39 | 56.23 | 85.18 |
| $MgCO_3$ | 17.57 | 43.65 | 9.79 |

## Table A-6. Chemical analyses, Exshaw area (after Goudge, 1945)

| | Sample Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Constituent | 7 | 7A | 7B | 7C | 8 | 8A | 8B | 8C | 8D |
| $SiO_2$ | 0.52 | 0.42 | 0.40 | 0.34 | 0.31 | 0.22 | 0.16 | 0.16 | 0.21 |
| $Fe_2O_3$ | 0.20 | 0.26 | 0.12 | 0.14 | 0.14 | 0.13 | 0.10 | 0.12 | 0.12 |
| $Al_2O_3$ | 0.22 | 0.04 | 0.18 | 0.16 | 0.08 | 0.09 | tr | tr | 0.14 |
| $Ca_3(PO_4)_2$ | 0.04 | tr | tr | tr | 0.01 | tr | tr | 0.01 | 0.02 |
| $CaCO_3$ | 56.05 | 55.41 | 55.70 | 98.21 | 98.10 | 98.14 | 99.04 | 99.10 | 87.71 |
| $MgCO_3$ | 42.79 | 43.58 | 43.98 | 1.20 | 1.08 | 2.03 | 0.61 | 0.40 | 11.69 |
| TOTAL | 99.82 | 99.71 | 100.38 | 99.05 | 99.72 | 100.61 | 99.91 | 99.79 | 99.89 |
| S | tr | tr | nil | nil | tr | tr | nil | 0.01 | tr |
| CaO | 31.41 | 31.03 | 31.19 | 55.00 | 54.96 | 54.97 | 55.84 | 56.00 | 49.13 |
| MgO | 20.46 | 20.84 | 21.03 | 0.57 | 0.52 | 0.97 | 0.29 | 0.19 | 5.59 |

**Table A-6. (continued)**

| Constituent | Sample Number 8E | 8F | 8G | 9 | 9A | 9B | 9C | 9D | 9E |
|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 0.18 | 0.31 | 0.70 | 1.25 | 0.68 | 1.06 | 0.92 | 2.04 | 0.78 |
| $Fe_2O_3$ | 0.35 | 0.15 | 0.20 | 0.25 | 0.11 | 0.32 | 0.27 | 0.28 | 0.21 |
| $Al_2O_3$ | 0.10 | 0.14 | 0.21 | 0.20 | 0.21 | 0.18 | 0.13 | 0.76 | 0.15 |
| $Ca_3(PO_4)_2$ | 0.02 | 0.09 | 0.07 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| $CaCO_3$ | 66.05 | 85.84 | 91.61 | 94.90 | 93.55 | 68.46 | 92.66 | 81.57 | 89.52 |
| $MgCO_3$ | 33.73 | 13.55 | 7.43 | 3.21 | 5.31 | 30.11 | 5.40 | 15.68 | 8.78 |
| TOTAL | 100.43 | 100.08 | 100.22 | 99.83 | 99.88 | 100.15 | 99.40 | 100.35 | 99.46 |
| S | 0.01 | nil | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | tr |
| CaO | 37.00 | 48.12 | 51.34 | 53.17 | 52.40 | 38.35 | 51.90 | 45.69 | 50.14 |
| MgO | 16.13 | 6.48 | 3.55 | 1.53 | 2.55 | 14.40 | 2.58 | 7.50 | 4.20 |

**Table A-6. (continued)**

| Constituent | Sample Number 9F | 10 | 10A | 10B | 11A | 11B | 12 | 12A |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 1.34 | 0.36 | 1.10 | 1.08 | 0.86 | 0.42 | 1.98 | 4.24 |
| $Fe_2O_3$ | 0.16 | 0.17 | 0.26 | 0.29 | 0.28 | 0.20 | 0.16 | 0.50 |
| $Al_2O_3$ | 0.28 | 0.19 | 0.08 | 0.11 | 0.30 | 0.08 | 0.24 | 0.30 |
| $Ca_3(PO_4)_2$ | 0.04 | 0.02 | tr | 0.02 | 0.04 | 0.02 | 0.07 | 0.11 |
| $CaCO_3$ | 86.32 | 55.39 | 97.25 | 99.03 | 97.50 | 98.12 | 95.89 | 86.80 |
| $MgCO_3$ | 12.05 | 44.28 | 0.59 | 8.22 | 0.92 | 0.74 | 1.64 | 8.40 |
| TOTAL | 100.19 | 100.41 | 99.28 | 99.75 | 99.90 | 99.58 | 99.98 | 100.35 |
| S | tr | tr | tr | 0.01 | 0.01 | 0.01 | tr | 0.01 |
| CaO | 48.36 | 31.03 | 54.46 | 50.43 | 54.62 | 54.96 | 53.74 | 48.67 |
| MgO | 5.76 | 21.17 | 0.28 | 3.93 | 0.44 | 0.35 | 0.78 | 4.02 |

## Table A-7. Chemical analyses, Exshaw area (after Matthews, 1961)

*Chemical Analyses of Samples from Section A-A′ (Analyses by Loders Lime Ltd.)*

| Constituent | Sample Number 12 | 11 | 8 | 17 | 18 | 19 | 9 | Average (Weighted as to Width) |
|---|---|---|---|---|---|---|---|---|
| Width (ft) | 11 | 26 | 14 | 74 | 32 | 48 | 90 | 295 |
| $SiO_2$ | 0.89 | 5.71 | 0.50 | 0.66 | 1.80 | 0.93 | 1.17 | 1.38 |
| Combined Oxides | 0.77 | 1.01 | 0.79 | 0.55 | 0.85 | 0.47 | 0.89 | 0.73 |
| CaO | 54.09 | 47.41 | 53.79 | 54.48 | 47.70 | 54.76 | 52.94 | 52.70 |
| MgO | 0.88 | 3.64 | 0.76 | 0.76 | 5.29 | 0.67 | 1.07 | 1.59 |
| Ignition Loss | 43.47 | 42.05 | 43.50 | 43.53 | 44.43 | 43.63 | 43.77 | 43.70 |
| TOTAL | 100.10 | 99.82 | 99.34 | 99.98 | 100.07 | 100.46 | 99.84 | 100.10 |
| Equivalent $CaCO_3$ | 96.40 | 84.50 | 95.70 | 97.00 | 85.00 | 97.50 | 94.20 | 93.80 |
| Equivalent $MgCO_3$ | 1.84 | 7.60 | 1.59 | 1.59 | 11.00 | 1.40 | 2.24 | 3.30 |

## Tabie A-7. (continued)

*Chemical Analyses of Samples from Section B-B´(Analyses by Loders Lime Ltd.)*

| Constituent | Sample Number 13* | 14 | 15 | 16 | Average (Weighted as to Width) |
|---|---|---|---|---|---|
| Width (ft) | 90 | 95 | 43 | 15 | 243 |
| $SiO_2$ | 2.91 | 0.88 | 1.15 | 7.97 | 2.13 |
| Combined Oxides | 0.66 | 0.89 | 1.13 | 0.94 | 0.85 |
| CaO | 53.03 | 52.60 | 53.78 | 49.19 | 52.77 |
| MgO | 0.89 | 1.04 | 0.59 | 0.93 | 0.89 |
| Ignition Loss | 42.18 | 43.99 | 43.41 | 40.63 | 42.99 |
| TOTAL | 99.67 | 99.40 | 100.06 | 99.66 | 99.63 |
| Equivalent $CaCO_3$ | 94.39 | 93.62 | 95.72 | 87.40 | 93.93 |
| Equivalent $MgCO_3$ | 1.86 | 2.18 | 1.23 | 1.94 | 1.86 |

*Average of analyses made by Loders Lime Ltd. and Canada Cement Company Ltd.

**Table A-8. Chemical analyses, Exshaw area (after Canadian Pacific Railway, 1949)**

| | Sample Number | | | | | |
|---|---|---|---|---|---|---|
| Constituent | 12 | 13 | 14 | 15 | 16 | 17 |
| Insolubles | 3.53 | 1.80 | 0.33 | 0.30 | 0.90 | 0.60 |
| Iron Oxide ($Fe_2O_3$) | 0.20 | 0.11 | 0.05 | 0.05 | 0.08 | 0.08 |
| Alumina ($Al_2O_3$) | 0.25 | 0.19 | 0.15 | 0.10 | 0.12 | 0.10 |
| Lime (CaO) | 46.52 | 40.80 | 53.88 | 54.51 | 51.27 | 48.48 |
| Magnesium Oxide (MgO) | 5.80 | 11.60 | 1.66 | 0.72 | 3.47 | 5.93 |
| Sulphur (S) | 0.05 | 0.04 | 0.03 | 0.03 | 0.05 | 0.05 |
| Phosphorus (P) | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 |
| Carbon Dioxide ($CO_2$) | 42.80 | 44.60 | 44.08 | 43.50 | 44.00 | 44.50 |
| TOTAL | 99.20 | 99.17 | 100.21 | 99.24 | 96.92 | 99.56 |
| $CaCO_3$ | 83.07 | 72.96 | 96.21 | 97.39 | 91.55 | 86.57 |
| $MgCO_3$ | 1.62 | 24.24 | 3.47 | 1.50 | 7.25 | 12.39 |

**Table A-9. Chemical analysis, Exshaw area (provided by Steel Brothers (Canada) Ltd.)**

| Constituent | No. 449 |
|---|---|
| Ignition Loss | 42.9 |
| $SiO_2$ | 0.8 |
| $R_2O_3$ | 0.3 |
| CaO | 55.6 |
| MgO | 0.4 |
| TOTAL | 100.0 |
| $CaCO_3$ | 99.4 |
| $MgCO_3$ | 0.8 |

## Table A-10. Chemical analyses, Nordegg area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 100 to 102 | 103, 104 | 110 to 112A | 112 to 117 | 122, 123 | 124, 125 | 126 | 127 to 131 | 132 |
| Insolubles | 1.12 | 0.17 | 1.62 | 0.00 | 0.01 | 0.13 | 0.00 | 0.88 | 0.19 |
| $SiO_2$ | 21.29 | 2.33 | 29.05 | 0.65 | 0.76 | 2.32 | 0.47 | 21.12 | 7.87 |
| $Fe_2O_3$ | 0.94 | 0.20 | 0.59 | 0.10 | 0.09 | 0.16 | 0.16 | 0.66 | 0.34 |
| $Al_2O_3$ | 1.63 | 0.48 | 2.25 | 0.27 | 0.46 | 0.39 | 0.20 | 0.92 | 0.49 |
| CaO | 39.19 | 44.45 | 23.58 | 29.23 | 40.60 | 29.64 | 30.24 | 39.10 | 45.70 |
| MgO | 4.68 | 10.08 | 13.53 | 21.12 | 12.90 | 20.68 | 21.35 | 3.15 | 5.41 |
| L.O.I. | 33.74 | 43.55 | 31.69 | 46.58 | 44.42 | 44.99 | 45.62 | 33.51 | 40.14 |
| $H_2O$ | 0.15 | 0.12 | 0.10 | 0.04 | 0.02 | 0.04 | 0.03 | 0.11 | 0.09 |
| TOTAL | 101.74 | 101.38 | 102.41 | 97.99 | 99.26 | 98.35 | 98.07 | 99.45 | 100.23 |
| $CaCO_3$ | 69.98 | 79.34 | 42.11 | 52.20 | 72.50 | 52.93 | 54.00 | 69.82 | 81.61 |
| $MgCO_3$ | 9.79 | 21.08 | 28.30 | 44.17 | 26.98 | 43.25 | 44.65 | 6.59 | 11.32 |

## Table A-10. (continued)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 133 | 134 | 135 to 136 | 137, 138 | 139,142 | 148 | 149, 150 | 158 to 160 | 161 to 165 |
| Insolubles | 0.45 | 0.00 | 1.37 | 0.05 | 0.04 | 0.03 | 0.07 | 2.09 | 1.93 |
| $SiO_2$ | 8.29 | 22.49 | 17.68 | 0.31 | 0.58 | 0.85 | 0.31 | 20.84 | 39.71 |
| $Fe_2O_3$ | 1.84 | 1.96 | 0.91 | 0.06 | 0.08 | 0.11 | 0.11 | 1.13 | 0.90 |
| $Al_2O_3$ | 1.74 | 6.44 | 2.20 | 0.07 | 0.02 | 0.24 | 0.08 | 3.28 | 2.75 |
| CaO | 43.44 | 29.02 | 25.79 | 56.03 | 51.45 | 54.96 | 30.23 | 29.69 | 17.95 |
| MgO | 4.86 | 6.48 | 15.59 | 0.76 | 4.80 | 0.73 | 21.50 | 10.06 | 11.80 |
| L.O.I. | 37.27 | 30.31 | 36.67 | 43.27 | 43.72 | 42.70 | 47.30 | 33.58 | 26.24 |
| $H_2O$ | 0.10 | 0.11 | 0.09 | 0.05 | 0.12 | 0.11 | 0.02 | 0.11 | 0.12 |
| TOTAL | 97.99 | 96.81 | 100.30 | 100.60 | 100.81 | 99.73 | 99.62 | 100.78 | 101.40 |
| $CaCO_3$ | 77.57 | 51.82 | 46.05 | 100.05 | 91.87 | 98.14 | 53.98 | 53.02 | 32.05 |
| $MgCO_3$ | 10.16 | 13.55 | 32.61 | 1.59 | 100.04 | 1.53 | 44.97 | 21.04 | 24.68 |

**Table A-10. (continued)**

| | Chemical Analysis Number | |
|---|---|---|
| | 76 | 77 |
| | Sample Number(s) | |
| Constituent | 166 | 167, 168 |
| Insolubles | 0.10 | 0.00 |
| $SiO_2$ | 0.37 | 0.29 |
| $Fe_2O_3$ | 0.08 | 0.04 |
| $Al_2O_3$ | 0.08 | 0.08 |
| CaO | 29.64 | 56.29 |
| MgO | 20.50 | 0.81 |
| L.O.I. | 47.39 | 43.76 |
| $H_2O$ | 0.09 | 0.02 |
| TOTAL | 98.25 | 101.29 |
| $CaCo_3$ | 52.93 | 100.52 |
| $MgCO_3$ | 42.88 | 1.69 |

## Table A-11. Chemical analyses, Nordegg area (after Goudge, 1945)

| Constituent | 20 | 21 | 21A | 22 | 22A | 23 |
|---|---|---|---|---|---|---|
| | Sample Number | | | | | |
| $SiO_2$ | 5.26 | 0.90 | 0.68 | 0.42 | 0.24 | 1.60 |
| $Fe_2O_3$ | 0.40 | 0.19 | 0.20 | 0.06 | 0.04 | 0.30 |
| $Al_2O_3$ | 1.73 | 0.33 | 0.42 | 0.17 | 0.21 | 0.57 |
| $Ca_3(PO_4)_2$ | 0.13 | tr | tr | 0.02 | 0.02 | 0.02 |
| $CaCO_3$ | 85.62 | 57.29 | 60.20 | 95.25 | 97.96 | 55.14 |
| $MgCO_3$ | 6.56 | 41.33 | 39.46 | 4.20 | 2.00 | 42.83 |
| TOTAL | 99.79 | 100.04 | 100.97 | 100.12 | 100.47 | 100.46 |
| S | 0.15 | 0.01 | 0.02 | 0.01 | tr | 0.03 |
| CaO | 48.02 | 32.08 | 33.71 | 53.37 | 54.87 | 30.89 |
| MgO | 3.14 | 19.76 | 18.87 | 2.01 | 0.95 | 20.48 |
| Ratio of CaO to MgO | 15:1 | 1.62:1 | 1.78:1 | 27:1 | 58:1 | 1.50:1 |

## Table A-12. Chemical analyses, Nordegg area (after Matthews, 1961)

| Constituent | Magnesian Stone S1 | Magnesian Stone S3 | Sample Number S5 | BED A S7 | S9 |
|---|---|---|---|---|---|
| $SiO_2$ | 0.80 | 0.30 | 0.30 | 0.18 | 0.30 |
| $Fe_2O_3$ | 0.04 | 0.04 | 0.06 | 0.03 | 0.13 |
| $Al_2O_3$ | 0.12 | 0.10 | 0.08 | 0.07 | 0.07 |
| CaO | 35.20 | 53.30 | 55.00 | 54.90 | 54.50 |
| MgO | 16.00 | 2.02 | 0.29 | 0.54 | 0.72 |
| Ig. Loss | 47.40 | 44.10 | 43.95 | 44.20 | 44.20 |
| $SO_4$ | tr | tr | tr | tr | tr |
| $PO_4$ | nil | nil | nil | nil | nil |
| TOTAL | 99.56 | 99.86 | 99.68 | 99.92 | 99.92 |
| Equiv. $CaCO_3$ | 62.83 | 95.14 | 98.18 | 97.99 | 97.28 |
| Equiv. $MgCO_3$ | 33.44 | 4.22 | 0.60 | 1.13 | 1.50 |

## Table A-13.

### Chemical analysis, Nordegg area (after Parks, 1916)

| Constituent | Sample |
|---|---|
| Insoluble Mineral Matter | 47.36 |
| Soluble Silica | 0.36 |
| Ferric Oxide | 0.14 |
| Ferrous Oxide | 0.57 |
| Alumina | 0.45 |
| Calcium Carbonate | 33.03 |
| Magnesium Carbonate | 12.62 |
| TOTAL | 94.53 |

## Table A-14. Chemical analyses, Cadomin area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 237 to 246 | 247 to 256 | 257 to 268A | 270 to 281 | 282 to 292 | 293 to 303 | 304 to 314 | 315 to 325 | 326 to 336 |
| Insolubles | 0.04 | 0.07 | 0.07 | 0.11 | 0.06 | 0.06 | 0.08 | 0.05 | 0.03 |
| $SiO_2$ | 1.31 | 1.89 | 1.25 | 1.26 | 1.09 | 1.15 | 1.19 | 1.22 | 1.86 |
| $Fe_2O_3$ | 0.09 | 0.12 | 0.14 | 0.18 | 0.18 | 0.16 | 0.13 | 0.10 | 0.14 |
| $Al_2O_3$ | 0.26 | 0.30 | 0.20 | 0.27 | 0.33 | 0.33 | 0.27 | 0.48 | 0.31 |
| CaO | 50.22 | 48.61 | 51.62 | 51.42 | 51.94 | 52.43 | 53.70 | 52.38 | 53.17 |
| MgO | 4.40 | 5.03 | 2.81 | 2.92 | 2.44 | 2.17 | 0.91 | 2.45 | 1.54 |
| L.O.I. | 43.32 | 42.96 | 43.19 | 43.15 | 43.13 | 43.10 | 42.94 | 43.24 | 43.24 |
| $H_2O$ | 0.08 | 0.12 | 0.04 | 0.04 | 0.06 | 0.05 | 0.05 | 0.00 | 0.02 |
| TOTAL | 99.72 | 99.10 | 99.32 | 99.35 | 99.23 | 99.45 | 99.27 | 99.92 | 100.31 |
| $CaCO_3$ | 89.68 | 86.80 | 92.18 | 91.50 | 92.75 | 93.62 | 95.89 | 93.53 | 94.95 |
| $MgCO_3$ | 9.20 | 10.52 | 5.88 | 6.11 | 5.10 | 4.54 | 1.90 | 5.12 | 3.22 |

**Table A-14. (continued)**

| | Chemical Analysis Number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
| | Sample Number(s) | | | | | | | | | |
| Constituent | 337 to 346 | 347 to 357 | 358 to 367 | 368 to 377 | 378 to 382 | 383 to 384 | 385 to 389 | 390 to 393 | 394 to 395 | 397 to 401 |
| Insolubles | 0.02 | 0.00 | 0.03 | 0.02 | 0.19 | 0.18 | 0.15 | 0.03 | 0.03 | 0.03 |
| $SiO_2$ | 3.20 | 1.00 | 1.00 | 1.10 | 0.99 | 0.99 | 4.85 | 4.92 | 1.76 | 2.35 |
| $Fe_2O_3$ | 0.16 | 0.13 | 0.17 | 0.15 | 0.12 | 0.31 | 0.55 | 0.93 | 0.28 | 0.77 |
| $Al_2O_3$ | 0.46 | 0.32 | 0.32 | 0.35 | 0.40 | 0.38 | 1.17 | 0.57 | 0.26 | 0.15 |
| CaO | 48.19 | 53.40 | 52.12 | 51.50 | 45.33 | 30.20 | 29.22 | 28.94 | 29.36 | 44.11 |
| MgO | 4.52 | 1.54 | 2.00 | 2.56 | 8.44 | 20.53 | 21.48 | 19.75 | 20.86 | 7.74 |
| L.O.I. | 43.06 | 53.05 | 43.53 | 43.77 | 44.76 | 47.38 | 42.14 | 44.80 | 46.80 | 44.02 |
| $H_2O$ | 0.00 | 0.05 | 0.01 | 0.01 | 0.05 | 0.01 | 0.09 | 0.09 | 0.05 | 0.07 |
| TOTAL | 99.61 | 99.49 | 99.18 | 99.46 | 100.28 | 99.98 | 99.65 | 100.03 | 99.40 | 99.24 |
| $CaCO_3$ | 86.05 | 95.36 | 93.07 | 91.96 | 80.95 | 53.93 | 52.18 | 51.68 | 52.43 | 78.77 |
| $MgCO_3$ | 9.45 | 3.22 | 4.18 | 5.35 | 17.65 | 42.94 | 44.93 | 41.31 | 43.63 | 16.19 |

Table A-16. Chemical analyses, Cadomin area (after Halferdahl, 1967)

| Constituent | 8-12 | 8-13 | 9-14 | 9-15 | 11-16 | 11-17 | 11-18 | 12-19 | 12-20 |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Number | | | | | | | | |
| | Weight Percent | | | | | | | | |
| CaO | 54.43 | 50.47 | 53.28 | 53.77 | 54.54 | 54.26 | 54.12 | 53.00 | 48.99 |
| MgO | 2.26 | 2.07 | 1.30 | 1.51 | 0.65 | 0.63 | 0.93 | 2.35 | 5.32 |
| $SiO_2$ | 1.73 | 5.60 | 2.31 | 1.05 | 1.31 | 1.65 | 1.34 | 0.59 | 1.56 |
| $Al_2O_3$ | 0.24 | 0.23 | 0.10 | 0.12 | 0.22 | 0.32 | 0.25 | 0.26 | 0.22 |
| $Fe_2O_3$ | 0.10 | 0.12 | 0.08 | 0.11 | 0.13 | 0.15 | 0.10 | 0.06 | 0.12 |
| $Na_2O$ | 0.13 | 0.06 | 0.06 | 0.06 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 |
| $K_2O$ | 0.13 | 0.14 | 0.09 | 0.09 | 0.10 | 0.14 | 0.12 | 0.07 | 0.12 |
| $P_2O_5$ | 0.002 | 0.000 | 0.000 | 0.000 | 0.002 | 0.003 | 0.003 | 0.000 | 0.005 |
| S | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| L.O.I. | 43.16 | 41.16 | 42.70 | 43.38 | 43.08 | 42.92 | 43.01 | 43.74 | 43.67 |
| $H_2O$ | 0.05 | 0.03 | 0.03 | 0.05 | 0.06 | 0.03 | 0.02 | 0.04 | 0.07 |
| TOTAL | 100.23 | 99.88 | 99.95 | 100.14 | 100.16 | 100.16 | 99.95 | 100.17 | 100.13 |
| Available Lime | 88.50 | 77.20 | 89.30 | 92.40 | 92.60 | 90.70 | 92.90 | 92.30 | 83.30 |
| $CaCo_3$ | 93.56 | 90.08 | 95.09 | 95.97 | 97.34 | 96.84 | 96.59 | 94.59 | 87.44 |
| $MgCO_3$ | 4.73 | 4.33 | 2.72 | 3.16 | 1.36 | 1.32 | 1.95 | 4.92 | 11.13 |

**Table A-15. Chemical analyses, Cadomin area (after Goudge, 1945)**

| Constituent | Sample Number 24 | 25 | 25A |
|---|---|---|---|
| $SiO_2$ | 0.98 | 1.14 | 0.98 |
| $Fe_2O_3$ | 0.23 | 0.24 | 0.30 |
| $Al_2O_3$ | 0.29 | 0.22 | 0.22 |
| $Ca_3(PO_4)_2$ | 0.02 | 0.02 | 0.01 |
| $CaCO_3$ | 92.45 | 96.00 | 95.03 |
| $MgCO_3$ | 5.90 | 1.83 | 3.01 |
| TOTAL | 99.87 | 99.45 | 99.55 |
| S | 0.02 | tr | 0.02 |
| CaO | 51.78 | 53.77 | 53.22 |
| MgO | 2.82 | 0.87 | 1.44 |

**Table A-17. Chemical analysis, Cadomin area (after Seibert, 1950)**

| Constituent | Sample |
|---|---|
| Silica | 0.31 |
| Iron Oxide | 0.09 |
| Alumina | 0.09 |
| Calcium Oxide | 55.50 |
| Magnesium Oxide | 0.52 |
| Ignition Loss | 43.85 |
| TOTAL | 100.36 |
| Calcium Carbonate | 98.40 |
| Magnesium Carbonate | 1.08 |

## Table A-18. Chemical analyses, Brûlé area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 97 | 99 | 100 | 101 | 102 | 103 | 113 | 114 | 115 |
| | Sample Number(s) | | | | | | | | |
| Constituent | 610 to 613 | 185 to 195 | 196 to 204 | 205 to 211 | 212 to 224 | 225 to 236 | 700 | 701 | 702 |
| Insolubles | 0.06 | 0.02 | 0.04 | 0.01 | 0.10 | 0.11 | nil | nil | nil |
| $SiO_2$ | 2.18 | 3.19 | 0.84 | 0.56 | 1.52 | 1.43 | 2.39 | 1.58 | 45.55 |
| $Fe_2O_3$ | 0.37 | 0.37 | 0.17 | 0.08 | 0.11 | 0.12 | 0.02 | 0.02 | 0.06 |
| $Al_2O_3$ | 0.47 | 0.94 | 0.33 | 0.18 | 0.39 | 0.44 | 0.48 | 0.44 | 0.69 |
| CaO | 54.50 | 50.47 | 52.28 | 54.34 | 51.94 | 53.73 | 48.00 | 47.44 | 30.01 |
| MgO | 1.53 | 2.07 | 1.86 | 1.04 | 2.08 | 1.17 | 5.04 | 5.83 | 0.88 |
| L.O.I. | 42.98 | 42.49 | 43.82 | 43.67 | 43.53 | 42.44 | 43.36 | 43.91 | 23.78 |
| $H_2O$ | 0.02 | 0.02 | 0.07 | 0.01 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 |
| TOTAL | 102.11 | 99.57 | 99.41 | 99.89 | 99.75 | 99.50 | 99.34 | 100.29 | 101.00 |
| $CaCO_3$ | 97.32 | 90.12 | 93.36 | 97.03 | 92.75 | 95.95 | 85.92 | 84.97 | 53.72 |
| $MgCO_3$ | 3.20 | 4.33 | 3.89 | 2.18 | 4.35 | 2.45 | 10.53 | 12.18 | 1.84 |

**Table A-19. Chemical analysis, Brûlé area (after Goudge, 1945)**

| Constituent | Sample Number 26 |
|---|---|
| $SiO_2$ | 1.32 |
| $Fe_2O_3$ | 0.20 |
| $Al_2O_3$ | 0.60 |
| $Ca_3(PO_4)_2$ | 0.02 |
| $CaCO_3$ | 91.39 |
| $MgCO_3$ | 6.29 |
| TOTAL | 100.02 |
| S | tr |
| CaO | 51.30 |
| MgO | 3.01 |

## Table A-20. Chemical analyses, Fort McMurray area (this report)

| | Chemical Analysis Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 |
| | Sample Number(s) | | | | | | | | |
| | 595 (composite) | 601 (composite) | 602 | 603 | 604 | 605 | 606 (composite) | 607 | 608 |
| Constituent | | | | | | | | | |
| Insolubles | 0.15 | 0.07 | 0.08 | 0.07 | 0.06 | 0.06 | 0.00 | 0.00 | 0.04 |
| $SiO_2$ | 4.94 | 5.68 | 3.43 | 3.50 | 3.75 | 5.29 | 5.24 | 9.70 | 2.38 |
| $Fe_2O_3$ | 0.96 | 0.87 | 1.06 | 0.59 | 0.61 | 0.84 | 15.30 | 0.99 | 0.87 |
| $Al_2O_3$ | 1.68 | 1.73 | 1.33 | 1.28 | 1.28 | 1.58 | 3.64 | 2.49 | 0.99 |
| CaO | 48.18 | 49.39 | 50.23 | 51.00 | 50.55 | 49.01 | 37.13 | 44.47 | 51.18 |
| MgO | 2.04 | 1.24 | 1.53 | 1.57 | 1.36 | 1.14 | 1.29 | 2.44 | 1.13 |
| L.O.I. | 41.25 | 40.67 | 41.29 | 41.86 | 41.95 | 40.92 | 36.82 | 38.84 | 41.76 |
| $H_2O$ | 0.06 | 0.11 | 0.10 | 0.08 | 0.11 | 0.11 | 0.21 | 0.11 | 0.12 |
| TOTAL | 99.26 | 99.76 | 99.05 | 99.95 | 99.67 | 98.95 | 99.63 | 99.04 | 98.47 |
| $CaCO_3$ | 86.04 | 88.20 | 89.70 | 91.07 | 90.27 | 87.52 | 66.30 | 79.41 | 91.39 |
| $MgCO_3$ | 4.27 | 2.59 | 3.20 | 3.28 | 2.84 | 2.38 | 2.70 | 5.10 | 2.36 |

# APPENDIX B

## X-RAY FLUORESCENCE DATA FOR INDIVIDUAL SAMPLES

## Table B-1. Data from samples, Crowsnest Pass area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Alexo Formation and Fairholme Group* (Figures 3, 4 and 5) | | | |
| | 14 | 50.9 | 36.1 |
| | 15 | 35.9 | 32.2 |
| | 16 | 67.3 | 7.3 |
| 4 | 17 | 87.3 | 2.6 |
| | 18 | 59.3 | 5.8 |
| | 19 | 91.1 | 2.1 |
| | 20 | 92.0 | 1.7 |
| | 21 | 78.2 | 16.3 |
| | 22 | 50.7 | 39.3 |
| 5 | 23 | 52.7 | 40.8 |
| | 24 | 93.9 | 7.1 |
| | 25 | 51.2 | 38.3 |
| | 26 | 42.1 | 12.1 |
| | 491 | 44.1 | 36.4 |
| 27 | 493 | 50.9 | 37.6 |
| | 494 | 60.0 | 33.5 |
| *Palliser Formation* (Figures 3, 4, 5 and 7) | | | |
| | 7 | 103.6 | 1.0 |
| | 8 | 99.6 | 3.8 |
| | 9 | 102.7 | 1.0 |
| 3 | 10 | 102.7 | 2.1 |
| | 11 | 97.3 | 3.8 |
| | 12 | 92.0 | 4.8 |
| | 13 | 102.7 | 1.7 |
| *Palliser Formation (continued)* (Figures 3, 4, 5 and 7) | | | |
| | 36 | 86.6 | 11.1 |
| | 37 | 83.0 | 4.2 |
| 7 | 38 | 92.9 | 4.2 |
| | 39 | 95.5 | 6.3 |
| | 40 | 100.5 | 1.7 |
| *Banff Formation* (Figures 3, 4, 5 and 7) | | | |
| 2 | 6 | 44.3 | 8.2 |
| | 27 | 67.0 | 4.4 |
| | 28 | 66.1 | 10.7 |
| | 29 | 63.9 | 13.6 |
| | 30 | 62.9 | 9.9 |
| 6 | 31 | 18.9 | 5.9 |
| | 32 | 45.0 | 9.4 |
| | 33 | 53.9 | 9.4 |
| | 34 | 19.6 | 15.7 |
| | 35 | 21.6 | 15.1 |
| *Livingstone Formation* (Figures 3, 4, 5 and 6) | | | |
| | 1 | 102.7 | 2.1 |
| | 2 | 62.1 | 28.9 |
| 1 | 3 | 105.0 | 1.7 |
| | 4 | 67.9 | 30.3 |
| | 5 | 105.4 | 2.3 |

## Table B-1. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Livingstone Formation (continued)* (Figures 3, 4, 5 and 6) | | | |
| | 402 | 105.8 | 2.3 |
| | 403 | 101.1 | 4.4 |
| | 404 | 100.9 | 3.1 |
| | 405 | 106.2 | 1.6 |
| 12 | 406 | 101.1 | 4.7 |
| | 407 | 99.5 | 1.0 |
| | 408 | 104.5 | 1.9 |
| | 409 | 101.8 | 4.7 |
| | 410 | 104.0 | 4.0 |
| | 411 | 103.0 | 2.6 |
| | 412 | 104.1 | 3.3 |
| | 413 | 105.4 | 2.6 |
| 13 | 414 | 103.9 | 1.3 |
| | 415 | 105.5 | 1.0 |
| | 416 | 105.9 | 0.6 |
| | 417 | 61.6 | 31.4 |
| | 418 | 67.9 | 31.6 |
| | 419 | 66.4 | 32.2 |
| | 420 | 56.6 | 40.3 |
| | 421 | 104.5 | 2.7 |
| 14 | 422 | 99.1 | 2.1 |
| | 423 | 101.4 | 1.3 |
| | 424 | 100.0 | 1.5 |
| | 425 | 101.6 | 1.0 |
| | 426 | 101.1 | 1.5 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Livingstone Formation (continued)* (Figures 3, 4, 5 and 6) | | | |
| | 427 | 99.1 | 1.7 |
| | 428 | 54.5 | 33.5 |
| | 429 | 27.3 | 24.7 |
| 15 | 430 | 77.0 | 23.6 |
| | 431 | 63.7 | 30.8 |
| | 432 | 57.1 | 33.5 |
| | 433 | 62.5 | 32.9 |
| | 434 | 85.7 | 13.1 |
| | 435 | 85.7 | 1.6 |
| | 436 | 100.5 | 1.0 |
| 16 | 437 | 101.4 | 1.5 |
| | 438 | 100.7 | 0.8 |
| | 439 | 98.6 | 2.3 |
| | 440 | 97.9 | 3.7 |
| | 441 | 101.6 | 3.3 |
| | 442 | 53.7 | 38.3 |
| | 443 | 54.6 | 39.5 |
| 17 | 444 | 86.2 | 11.6 |
| | 445 | 68.7 | 28.4 |
| | 446 | 99.5 | 2.1 |
| | 447 | 100.0 | 2.5 |
| | 448 | 98.6 | 2.3 |
| 18 | 449 | 96.4 | 2.9 |
| | 450 | 100.0 | 1.6 |
| | 451 | 100.9 | 2.1 |

**Table B-1. (continued)**

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Livingstone Formation (continued)* (Figures 3, 4, 5 and 6) | | | |
| 19 | 452 | 85.0 | 5.9 |
| | 453 | 98.9 | 1.5 |
| | 454 | 97.3 | 3.1 |
| | 455 | 52.9 | 5.4 |
| | 456 | 93.7 | 1.6 |
| | 457 | 68.4 | 14.4 |
| 20 | 458 | 69.8 | 16.5 |
| | 459 | 98.7 | 2.7 |
| | 460 | 101.8 | 2.1 |
| | 461 | 78.7 | 9.8 |
| *Mount Head Formation* (Figures 3, 4 and 6) | | | |
| 21 | 462 | 92.9 | 3.3 |
| | 463 | 83.2 | 1.6 |
| | 464 | 99.5 | 1.7 |
| | 465 | 94.3 | 0.6 |
| | 466 | 101.2 | 0.5 |
| 22 | 467 | 67.1 | 27.2 |
| | 468 | 88.7 | 12.3 |
| | 469 | 60.9 | 34.5 |
| | 470 | 75.2 | 18.4 |
| | 471 | 99.6 | 2.1 |
| *Mount Head Formation (continued)* (Figures 3, 4 and 6) | | | |
| 23 | 472 | 87.9 | 10.5 |
| | 473 | 63.4 | 26.4 |
| | 474 | 75.0 | 21.3 |
| | 475 | 88.6 | 5.4 |
| | 476 | 99.5 | 1.7 |
| 24 | 477 | 100.0 | 1.3 |
| | 478 | 98.6 | 1.5 |
| | 479 | 94.1 | 1.5 |
| | 480 | 100.7 | 1.0 |
| | 481 | 95.2 | 0.8 |
| 25 | 482 | 93.2 | 1.0 |
| | 483 | 95.5 | 3.8 |
| | 484 | 98.2 | 0.5 |
| | 485 | 100.9 | 1.7 |
| 26 | 486 | 95.5 | 3.1 |
| | 487 | 88.4 | 4.2 |
| | 488 | 52.5 | 20.3 |
| | 489 | 70.5 | 2.6 |
| | 490 | 90.9 | 2.3 |

## Table B-2. Data from samples, Blairmore area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Banff Formation* (Figures 8, 9 and 10) | | | |
| | 41 | 26.1 | 17.8 |
| | 42 | 59.5 | 7.5 |
| | 43 | 99.3 | 2.7 |
| 8 | 44 | 69.3 | 11.9 |
| | 45 | 67.3 | 19.9 |
| | 46 | 87.7 | 11.0 |
| | 47 | 62.5 | 26.7 |
| *Livingstone Formation* (Figures 8, 9 and 10) | | | |
| 8 | 48 | 52.7 | 6.7 |
| 9 | 49 | 100.5 | 1.7 |
| | 50 | 100.9 | 1.3 |
| | 51 | 60.2 | 13.6 |
| | 54 | 96.4 | 4.2 |
| | 55 | 48.4 | 26.6 |
| 11 | 56 | 83.2 | 6.1 |
| | 57 | 88.0 | 7.1 |
| | 58 | 43.4 | 33.0 |
| | 59 | 98.4 | 2.1 |

## Table B-3. Data from samples, Exshaw area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Eldon Formation* (Figures 11 and 12) | | | |
| | 77-1 | 51.8 | 40.6 |
| | 77-2 | 66.4 | 6.1 |
| | 77-3 | 82.3 | 6.3 |
| | 77-4 | 90.7 | 6.5 |
| 46 | 77-5 | 89.3 | 6.7 |
| | 77-6 | 89.1 | 8.4 |
| | 77-7 | 96.4 | 1.6 |
| | 77-8 | 87.9 | 6.5 |
| | 77-9 | 91.1 | 9.0 |
| | 77-10 | 100.0 | 1.6 |
| | 78L | 95.9 | 2.1 |
| 47 | 78M | 93.2 | 7.3 |
| | 78U | 83.4 | 13.2 |
| | 495 | 83.4 | 15.6 |
| | 496 | 90.7 | 7.3 |
| | 497 | 86.8 | 13.8 |
| | 498 | 90.2 | 8.8 |
| | 499 | 83.6 | 13.6 |
| 48 | 500 | 92.7 | 7.7 |
| | 501 | 90.5 | 8.2 |
| | 502 | 83.0 | 12.3 |
| | 503 | 88.4 | 9.6 |
| | 504 | 88.7 | 9.9 |
| | 505 | 87.3 | 10.7 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Eldon Formation (continued)* (Figures 11 and 12) | | | |
| | 506 | 77.9 | 20.5 |
| | 507 | 88.4 | 9.9 |
| | 508 | 62.9 | 31.9 |
| | 509 | 97.3 | 2.5 |
| 49 | 511 | 86.2 | 10.7 |
| | 512 | 93.4 | 5.2 |
| | 513 | 95.7 | 4.2 |
| | 514 | 88.9 | 6.5 |
| | 515 | 92.9 | 6.5 |
| | 516 | 91.6 | 7.8 |
| | 517 | 95.5 | 4.0 |
| | 518 | 92.1 | 5.0 |
| | 519 | 91.8 | 6.9 |
| 50 | 520 | 87.9 | 9.4 |
| | 521 | 83.4 | 11.9 |
| | 522 | 82.9 | 13.8 |
| | 523 | 92.9 | 6.5 |
| | 524 | 83.0 | 10.0 |
| | 525 | 73.7 | 22.2 |
| | 526 | 91.1 | 8.6 |
| | 527 | 54.3 | 40.3 |
| 51 | 528 | 53.9 | 43.5 |
| | 529 | 56.6 | 39.3 |
| | 530 | 53.6 | 40.2 |

Table B-3. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Eldon Formation (continued)* (Figures 11 and 12) | | | |
| | 531 | 62.3 | 39.9 |
| | 532 | 57.1 | 36.6 |
| 51 (cont.) | 533 | 79.5 | 17.8 |
| | 534 | 98.7 | 2.3 |
| | 535 | 71.4 | 24.7 |
| | 536 | 91.6 | 7.1 |
| | 537 | 70.7 | 18.3 |
| | 538 | 91.1 | 7.8 |
| | 539 | 91.4 | 6.5 |
| 52 | 540 | 97.5 | 3.3 |
| | 541 | 84.8 | 13.2 |
| | 542 | 86.1 | 9.6 |
| | 543 | 88.4 | 8.4 |
| | 544 | 85.7 | 10.9 |
| | 545 | 92.1 | 6.5 |
| | 546 | 92.9 | 5.9 |
| | 547 | 89.3 | 8.6 |
| | 548 | 86.6 | 11.3 |
| | 549 | 96.4 | 4.4 |
| 53 | 550 | 95.5 | 6.3 |
| | 551 | 95.4 | 4.4 |
| | 552 | 96.4 | 4.4 |
| | 553 | 91.1 | 5.2 |
| | 554 | 98.9 | 2.5 |
| | 555 | 86.4 | 11.1 |
| *Eldon Formation (continued)* (Figures 11 and 12) | | | |
| | 556 | 92.1 | 5.9 |
| | 557 | 90.9 | 7.5 |
| 54 | 558 | 97.0 | 3.7 |
| | 559 | 99.1 | 2.7 |
| | 560 | 97.0 | 3.3 |
| | 561 | 99.1 | 1.7 |
| | 562 | 77.1 | 6.9 |
| | 563 | 78.9 | 7.9 |
| | 564 | 57.1 | 9.0 |
| 55 | 565 | 65.2 | 9.0 |
| | 566 | 63.6 | 12.0 |
| | 567 | 71.4 | 23.0 |
| | 568 | 58.9 | 21.1 |
| | 569 | 49.3 | 37.1 |
| *Cairn Formation* (Figures 11 and 12) | | | |
| 42 | 73-1 | 52.9 | 41.0 |
| | 73-2 | 50.4 | 37.6 |
| 56 | 570 | 52.7 | 39.9 |

**Table B-3. (continued)**

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Southesk Formation* (Figures 11 and 12) | | | |
| | 65-1 | 54.1 | 40.4 |
| | 65-2 | 52.9 | 41.0 |
| 31 | 65-3 | 54.6 | 41.3 |
| | 65-4 | 51.6 | 38.9 |
| | 65-5 | 56.8 | 41.8 |
| 39 | 71 | 52.7 | 40.4 |
| | 72-1 | 55.9 | 35.3 |
| | 72-2 | 51.1 | 39.9 |
| | 72-3 | 51.6 | 41.4 |
| 40 | 72-4 | 50.4 | 39.7 |
| | 72-5 | 51.1 | 42.2 |
| | 72-6 | 48.2 | 39.9 |
| | 72-7 | 50.9 | 41.6 |
| | 72-8 | 52.0 | 41.2 |
| | 72-9 | 52.7 | 42.7 |
| 41 | 72-10 | 51.8 | 39.2 |
| | 72-11 | 52.9 | 38.7 |
| | 72-12 | 50.9 | 39.2 |
| | 72-13 | 50.4 | 39.9 |
| | 72-14 | 46.6 | 37.2 |
| | 72-15 | 58.9 | 33.5 |
| | 76-1 | 53.5 | 41.3 |
| | 76-2 | 51.1 | 41.2 |
| 45 | 76-3 | 36.8 | 37.9 |
| | 76-4 | 53.9 | 37.6 |
| *Southesk Formation (continued)* (Figures 11 and 12) | | | |
| | 76-5 | 53.7 | 39.3 |
| 45 (cont.) | 76-6 | 51.8 | 39.5 |
| | 76-7 | 60.4 | 34.7 |
| *Palliser Formation* (Figures 11 and 12) | | | |
| | 70-1 | 91.1 | 5.6 |
| | 70-2 | 98.4 | 2.9 |
| | 70-3 | 94.6 | 5.2 |
| 38 | 70-4 | 90.0 | 3.3 |
| | 70-5 | 94.6 | 4.7 |
| | 70-6 | 79.8 | 5.0 |
| | 70-7 | 54.6 | 38.5 |
| 44 | 75-1 | 79.8 | 17.3 |
| | 75-2 | 79.5 | 16.3 |
| | 60A | 96.6 | 2.3 |
| | 60B | 98.2 | 2.6 |
| | 60C | 92.0 | 5.9 |
| | 60D | 52.7 | 38.1 |
| | 60E | 91.4 | 6.9 |
| | 60F | 92.0 | 5.6 |
| | 60G | 95.0 | 3.1 |
| | 60H | 89.3 | 6.5 |
| | 60I | 98.2 | 1.7 |
| | 60J | 95.2 | 2.9 |
| | 60K | 89.8 | 5.6 |

## Table B-3. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Banff Formation* (Figures 11 and 12) | | | |
| 28 | 62-1 | 35.0 | 9.6 |
| | 62-2 | 49.8 | 6.5 |
| | 62-3 | 84.8 | 3.1 |
| 29 | 63 | 78.6 | 2.3 |
| 30 | 64-1 | 90.2 | 2.1 |
| | 64-2 | 28.7 | 19.9 |
| | 64-3 | 78.9 | 5.0 |
| | 64-4 | 51.8 | 3.4 |
| | 64-5 | 33.9 | 5.4 |
| 32 | 66-1 | 96.1 | 3.7 |
| | 66-2 | 96.6 | 4.0 |
| | 66-3 | 50.9 | 5.4 |
| | 66-4 | 78.0 | 5.9 |
| | 66-5 | 88.6 | 2.3 |
| 33 | 67-1 | 36.1 | 3.1 |
| | 67-2 | 92.7 | 3.6 |
| | 67-3 | 88.4 | 4.0 |
| | 67-4 | 74.6 | 6.8 |
| 36 | 69-10 | 70.5 | 7.8 |
| | 69-11 | 76.1 | 5.0 |
| | 69-12 | 80.7 | 5.9 |
| | 69-13 | 63.9 | 4.2 |
| | 69-14 | 90.5 | 1.7 |
| | 69-15 | 20.5 | 2.5 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Banff Formation (continued)* (Figures 11 and 12) | | | |
| 37 | 69-16 | 90.5 | 6.7 |
| | 69-17 | 80.0 | 10.0 |
| 43 | 74-1 | 75.0 | 3.7 |
| | 74-2 | 79.0 | 2.9 |
| | 74-3 | 70.0 | 3.7 |
| | 61-1 | 32.1 | 7.3 |
| | 61-2 | 28.0 | 6.8 |
| | 61-3 | 34.5 | 7.3 |
| | 61-4 | 18.4 | 13.2 |
| *Livingstone Formation* (Figures 11 and 12) | | | |
| 34 | 68-1 | 96.6 | 5.4 |
| | 68-2 | 36.1 | 25.1 |
| | 68-3 | 34.1 | 27.0 |
| 35 | 69-1 | 94.6 | 3.7 |
| | 69-2 | 60.0 | 38.3 |
| | 69-3 | 52.1 | 37.9 |
| | 69-4 | 66.1 | 27.4 |
| | 69-5 | 95.9 | 5.4 |
| | 69-6 | 36.1 | 9.4 |
| | 69-7 | 65.2 | 27.0 |
| | 69-8 | 79.6 | 16.5 |
| | 69-9 | 93.7 | 5.9 |

## Table B-3. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Livingstone Formation (continued)* (Figures 11 and 12) | | | |
| | 79 | 100.4 | 1.3 |
| | 80 | 101.8 | 1.3 |
| | 81 | 101.8 | 1.6 |
| | 82 | 100.4 | 1.7 |
| | 83 | 102.9 | 1.7 |
| | 84 | 100.9 | 1.7 |
| | 85 | 100.4 | 0.8 |
| | 86 | 101.1 | 1.0 |
| | 87 | 101.1 | 1.0 |
| | 88 | 100.4 | 1.3 |
| | 89 | 103.2 | 1.3 |
| *Livingstone-Mount Head-Etherington Formations* (Figures 11 and 12) | | | |
| | 571 | 99.1 | 2.1 |
| | 572 | 85.7 | 11.7 |
| | 573 | 100.4 | 0.8 |
| | 574 | 84.8 | 6.5 |
| | 575 | 67.9 | 16.5 |
| | 576 | 92.7 | 1.6 |
| | 577 | 97.3 | 1.3 |
| | 578 | 98.4 | 1.7 |
| | 580 | 90.4 | 1.7 |
| | 581 | 93.2 | 1.6 |
| | 582 | 36.4 | 3.1 |
| | 583 | 37.0 | 35.6 |
| | 584 | 48.7 | 41.4 |

## Table B-4. Data from samples, Nordegg area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Mount Hawk Formation* (Figures 13, 14 and 15) | | | |
| | 158 | 63.6 | 69.0 |
| 74 | 159 | 38.2 | 25.9 |
| | 160 | 32.1 | 27.7 |
| *Alexo Formation* (Figures 13, 14 and 15) | | | |
| | 161 | 46.4 | 32.4 |
| | 162 | 25.0 | 24.7 |
| 75 | 163 | 48.6 | 40.3 |
| | 164 | 3.6 | 6.5 |
| | 165 | 13.0 | 17.3 |
| 76 | 166 | 52.9 | 42.9 |
| *Palliser Formation* (Figures 13, 14 and 15) | | | |
| 59 | 103 | 96.8 | 3.3 |
| | 104 | 56.1 | 35.1 |
| | 105 | 52.7 | 41.2 |
| | 106 | 78.9 | 16.9 |
| | 107 | 52.3 | 40.8 |
| | 108 | 53.6 | 40.4 |
| | 110 | 60.2 | 5.0 |
| 60 | 111 | 53.7 | 41.3 |
| | 112A | 6.6 | 12.5 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 13, 14 and 15) | | | |
| | 112 | 53.0 | 43.5 |
| | 113 | 53.4 | 45.0 |
| 61 | 114 | 53.9 | 40.2 |
| | 115 | 53.7 | 40.3 |
| | 116 | 52.3 | 39.5 |
| | 117 | 53.6 | 38.7 |
| | 118 | 51.8 | 41.8 |
| | 119 | 53.2 | 39.9 |
| | 120 | 65.2 | 28.7 |
| | 121 | 53.4 | 39.2 |
| 62 | 122 | 56.8 | 38.5 |
| | 123 | 88.4 | 10.5 |
| | 124 | 52.1 | 38.9 |
| | 125 | 50.9 | 39.1 |
| *Banff Formation* (Figures 13, 14 and 15) | | | |
| | 100 | 61.8 | 4.4 |
| 58 | 101A | 56.6 | 7.3 |
| | 101B | 26.2 | 6.5 |
| | 102 | 80.5 | 15.1 |
| 64 | 126 | 54.1 | 41.8 |

**Table B-4. (continued)**

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Banff Formation (continued)* (Figures 13, 14 and 15) | | | |
| 65 | 127 | 69.6 | 5.4 |
| | 128 | 80.9 | 4.2 |
| | 129 | 47.3 | 6.5 |
| | 130A | 40.2 | 18.3 |
| | 130B | 37.5 | 15.7 |
| | 131 | 84.3 | 3.1 |
| 66 | 132 | 76.2 | 11.1 |
| 67 | 133 | 74.1 | 9.4 |
| 68 | 134 | 37.7 | 11.5 |
| 69 | 135 | 43.7 | 30.3 |
| | 136 | 37.1 | 32.9 |
| *Pekisko Formation* (Figures 13, 14 and 15) | | | |
| 70 | 137 | 98.2 | 3.1 |
| | 138 | 97.5 | 2.7 |
| 71 | 139 | 61.6 | 35.8 |
| | 140A | 55.7 | 37.0 |
| | 140B | 88.4 | 9.9 |
| | 141 | 92.9 | 7.3 |
| | 142 | 102.9 | 2.3 |
| | 143 | 58.2 | 37.2 |
| | 144 | 57.0 | 37.4 |
| *Pekisko Formation (continued)* (Figures 13, 14 and 15) | | | |
| | 145 | 95.7 | 2.9 |
| | 146 | 91.6 | 2.1 |
| | 147 | 98.2 | 2.5 |
| 77 | 167 | 101.2 | 2.9 |
| | 168 | 98.2 | 2.5 |
| *Shunda Formation* (Figures 13, 14 and 15) | | | |
| 72 | 148 | 93.7 | 1.6 |
| *Rundle Group, Undivided* (Figures 13, 14 and 15) | | | |
| 73 | 149 | 54.1 | 47.3 |
| | 150 | 54.1 | 39.2 |
| | 151 | 50.2 | 39.3 |
| | 152 | 50.7 | 40.3 |
| *Fernie Group* (Figures 13, 14 and 15) | | | |
| | 153 | 17.9 | 10.9 |
| | 154 | 25.0 | 13.1 |
| | 155 | 22.7 | 10.7 |
| | 156 | 18.6 | 11.9 |
| | 157 | 17.9 | 9.4 |

## Table B-5. Data from samples, Cadomin area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation* (Figures 16 and 17) | | | |
| | 237 | 89.8 | 8.9 |
| | 238 | 94.6 | 3.1 |
| | 239 | 96.8 | 3.3 |
| | 240 | 97.0 | 3.3 |
| 78 | 241 | 95.4 | 3.7 |
| | 242 | 67.1 | 25.9 |
| | 243 | 73.2 | 20.5 |
| | 244 | 97.0 | 3.8 |
| | 245 | 95.5 | 3.1 |
| | 246 | 92.1 | 4.4 |
| | 247 | 91.4 | 5.9 |
| | 248 | 97.3 | 1.3 |
| | 249 | 93.4 | 3.3 |
| | 250 | 80.4 | 6.3 |
| 79 | 251 | 93.6 | 2.3 |
| | 252 | 95.0 | 3.3 |
| | 253 | 95.5 | 4.2 |
| | 254 | 95.0 | 2.6 |
| | 255 | 58.2 | 35.1 |
| | 256 | 76.8 | 20.9 |
| | 257 | 76.2 | 19.3 |
| | 258 | 98.2 | 5.2 |
| | 259 | 97.3 | 2.5 |
| 80 | 260 | 97.3 | 1.3 |
| | 261 | 82.1 | 12.5 |
| | 262 | 97.1 | 2.1 |
| | 263 | 97.1 | 3.7 |
| *Palliser Formation (continued)* (Figures 16 and 17) | | | |
| | 264 | 97.1 | 2.6 |
| | 265 | 98.7 | 0.8 |
| | 266 | 95.7 | 1.6 |
| 80 (cont.) | 267 | 97.9 | 1.3 |
| | 268 | 96.8 | 3.1 |
| | 268A | 93.6 | 3.1 |
| | 270 | 59.5 | 29.9 |
| | 271 | 91.8 | 5.4 |
| | 272 | 93.6 | 4.4 |
| | 273 | 92.5 | 5.6 |
| | 274 | 96.1 | 1.9 |
| | 275 | 98.2 | 2.3 |
| 81 | 276 | 96.2 | 2.6 |
| | 277 | 91.2 | 2.3 |
| | 278 | 95.9 | 2.5 |
| | 279 | 77.3 | 2.6 |
| | 280 | 94.6 | 4.7 |
| | 281 | 88.9 | 6.3 |
| | 282 | 95.7 | 2.6 |
| | 283 | 90.0 | 5.2 |
| | 284 | 97.0 | 2.1 |
| | 285 | 88.0 | 4.4 |
| 82 | 286 | 93.7 | 5.6 |
| | 287 | 98.2 | 2.9 |
| | 288 | 85.0 | 10.5 |
| | 289 | 86.6 | 11.0 |
| | 290 | 97.9 | 2.9 |

## Table B-5. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 16 and 17) | | | |
| 82 (cont.) | 291 | 93.4 | 5.4 |
| | 292 | 100.0 | 2.1 |
| | 293 | 98.9 | 2.7 |
| | 294 | 95.0 | 2.9 |
| | 295 | 93.7 | 3.8 |
| | 296 | 95.7 | 2.3 |
| | 297 | 96.8 | 2.1 |
| 83 | 298 | 92.9 | 5.9 |
| | 299 | 83.9 | 10.5 |
| | 300 | 100.0 | 1.3 |
| | 301 | 97.9 | 3.1 |
| | 302 | 95.5 | 4.2 |
| | 303 | 92.3 | 5.2 |
| | 304 | 96.7 | 4.2 |
| | 305 | 99.5 | 1.7 |
| | 306 | 96.1 | 3.8 |
| | 307 | 96.2 | 3.1 |
| | 308 | 96.2 | 2.5 |
| 84 | 309 | 98.2 | 2.1 |
| | 310 | 98.0 | 1.7 |
| | 311 | 96.2 | 1.7 |
| | 312 | 99.6 | 1.5 |
| | 313 | 100.4 | 1.6 |
| | 314 | 99.5 | 1.7 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 16 and 17) | | | |
| | 315 | 97.9 | 2.7 |
| | 316 | 80.4 | 13.6 |
| | 317 | 99.1 | 2.1 |
| | 318 | 96.4 | 2.1 |
| | 319 | 93.4 | 2.7 |
| 85 | 320 | 80.4 | 15.1 |
| | 321 | 87.3 | 7.5 |
| | 322 | 95.9 | 1.3 |
| | 323 | 98.2 | 1.6 |
| | 324 | 93.7 | 1.7 |
| | 325 | 100.0 | 1.6 |
| | 326 | 99.1 | 1.3 |
| | 327 | 95.0 | 3.6 |
| | 328 | 76.8 | 11.5 |
| | 329 | 95.0 | 3.3 |
| | 330 | 100.0 | 1.6 |
| 86 | 331 | 93.7 | 1.7 |
| | 332 | 92.3 | 3.6 |
| | 333 | 97.7 | 2.3 |
| | 334 | 91.4 | 3.8 |
| | 335 | 97.7 | 4.7 |
| | 336 | 92.7 | 2.3 |

## Table B-5. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 16 and 17) | | | |
| | 337 | 90.5 | 3.8 |
| | 338 | 77.7 | 11.9 |
| | 339 | 85.4 | 6.9 |
| | 340 | 79.6 | 4.2 |
| 87 | 342 | 90.2 | 5.8 |
| | 343 | 93.7 | 2.6 |
| | 344 | 92.9 | 3.8 |
| | 345 | 101.1 | 1.0 |
| | 346 | 60.4 | 31.0 |
| | 347 | 92.9 | 3.7 |
| | 348 | 97.7 | 2.7 |
| | 349 | 96.7 | 1.9 |
| | 350 | 90.2 | 2.1 |
| | 351 | 97.3 | 1.5 |
| 88 | 352 | 96.1 | 1.9 |
| | 353 | 90.0 | 3.3 |
| | 354 | 100.4 | 2.6 |
| | 355 | 100.0 | 2.6 |
| | 356 | 94.6 | 6.3 |
| | 357 | 97.1 | 4.4 |
| | 358 | 98.6 | 2.7 |
| | 359 | 98.2 | 2.7 |
| | 360 | 101.4 | 2.6 |
| 89 | 361 | 96.8 | 3.8 |
| | 362 | 98.7 | 2.5 |
| | 363 | 91.2 | 6.8 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 16 and 17) | | | |
| | 364 | 93.7 | 6.8 |
| 89 (cont.) | 365 | 98.7 | 2.7 |
| | 366 | 93.9 | 6.3 |
| | 367 | 94.1 | 4.4 |
| | 368 | 101.4 | 2.6 |
| | 369 | 99.6 | 2.5 |
| | 370 | 91.8 | 7.9 |
| | 371 | 91.1 | 7.3 |
| 90 | 372 | 96.8 | 3.3 |
| | 374 | 95.5 | 5.9 |
| | 375 | 97.1 | 3.3 |
| | 376 | 101.1 | 2.6 |
| | 377 | 100.0 | 3.7 |
| | 378 | 102.9 | 2.3 |
| | 379 | 65.2 | 28.9 |
| 91 | 380 | 102.7 | 33.3 |
| | 381 | 102.9 | 3.8 |
| | 382 | 102.5 | 3.3 |
| *Pekisko Formation* (Figures 16 and 17) | | | |
| 92 | 383 | 56.6 | 40.6 |
| | 384 | 56.2 | 40.8 |

## Table B-5. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Pekisko Formation (continued)* (Figures 16 and 17) | | | |
| 93 | 385A | 98.2 | 3.8 |
| | 385B | 35.7 | 22.2 |
| | 386 | 33.9 | 30.3 |
| | 387 | 64.6 | 34.5 |
| | 388 | 89.6 | 11.1 |
| | 389 | 63.7 | 35.0 |
| 96 | 397 | 88.0 | 12.1 |
| | 398 | 79.5 | 17.8 |
| | 399 | 87.5 | 12.8 |
| | 400 | 90.5 | 11.5 |
| | 401 | 62.5 | 24.3 |
| *Turner Valley Formation* (Figures 16 and 17) | | | |
| 94 | 390 | 55.4 | 31.2 |
| | 391 | 58.0 | 41.0 |
| | 392 | 43.3 | 37.6 |
| | 393 | 45.4 | 38.7 |
| 95 | 394 | 54.5 | 41.0 |
| | 395 | 53.2 | 42.4 |

## Table B-6. Data from samples, Brûlé area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Mount Hawk Formation* (Figures 18 and 19) | | | |
| | 185 | 90.7 | 2.1 |
| | 186 | 90.5 | 2.7 |
| | 187 | 89.8 | 2.3 |
| | 188 | 68.7 | 13.0 |
| | 189 | 85.4 | 4.2 |
| 99 | 190 | 57.5 | 16.9 |
| | 191 | 91.1 | 3.1 |
| | 192 | 95.4 | 3.6 |
| | 193 | 82.0 | 4.4 |
| | 194 | 94.1 | 1.5 |
| | 195 | 96.1 | 1.9 |
| *Palliser Formation* (Figures 18 and 19) | | | |
| | 610 | 96.4 | 2.3 |
| 97 | 611 | 92.7 | 4.2 |
| | 612 | 91.6 | 6.1 |
| | 613 | 95.9 | 3.3 |
| | 196 | 95.4 | 2.7 |
| | 197 | 97.5 | 4.4 |
| | 198 | 98.9 | 3.3 |
| | 199 | 96.1 | 2.6 |
| 100 | 200 | 92.0 | 4.4 |
| | 201 | 96.2 | 2.6 |
| | 202 | 93.7 | 4.2 |
| | 203 | 87.7 | 7.1 |
| | 204 | 96.8 | 4.6 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 18 and 19) | | | |
| | 205 | 100.9 | 1.7 |
| | 206 | 97.5 | 2.5 |
| | 207 | 100.0 | 1.3 |
| 101 | 208 | 95.9 | 4.6 |
| | 209 | 97.0 | 4.2 |
| | 210 | 94.6 | 5.4 |
| | 211 | 99.6 | 1.3 |
| | 212 | 89.6 | 4.8 |
| | 213 | 96.4 | 1.6 |
| | 214 | 92.1 | 4.2 |
| | 215 | 90.0 | 3.7 |
| | 216 | 93.4 | 3.6 |
| | 217 | 96.8 | 1.0 |
| 102 | 218 | 89.3 | 6.3 |
| | 219 | 96.4 | 2.9 |
| | 220 | 87.9 | 6.3 |
| | 221 | 95.5 | 3.7 |
| | 222 | 96.8 | 3.7 |
| | 223 | 96.6 | 3.8 |
| | 224 | 89.3 | 6.3 |
| | 225 | 87.5 | 8.9 |
| | 226 | 98.9 | 1.7 |
| | 227 | 98.6 | 0.6 |
| 103 | 228 | 98.6 | 0.6 |
| | 229 | 97.3 | 1.7 |
| | 230 | 96.4 | 1.6 |
| | 231 | 89.5 | 2.1 |

## Table B-6. (continued)

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Palliser Formation (continued)* (Figures 18 and 19) | | | |
| | 232 | 97.3 | 1.9 |
| | 233 | 94.5 | 1.6 |
| 103 (cont.) | 234 | 100.2 | 1.7 |
| | 235 | 94.1 | 1.6 |
| | 236 | 93.7 | 1.5 |
| | 173 | 95.2 | 4.0 |
| | 174 | 90.0 | 4.8 |
| | 175 | 96.6 | 2.9 |
| | 176 | 95.0 | 2.3 |
| | 177 | 92.3 | 4.0 |
| | 178 | 92.5 | 4.7 |
| | 178A | 87.1 | 6.5 |
| | 179 | 93.2 | 4.2 |
| | 180 | 91.1 | 6.5 |
| | 181 | 93.2 | 4.4 |
| | 182 | 93.0 | 2.6 |
| | 183 | 95.4 | 4.8 |
| | 184 | 97.3 | 5.2 |

## Table B-7. Data from samples, Fort McMurray area

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Calumet Member, Waterways Formation* (Figures 20 and 21) | | | |
| | 607 | 71.8 | 4.4 |
| *Christina Member, Waterways Formation* (Figures 20 and 21) | | | |
| | 606L | 89.5 | 2.5 |
| | 606-1 | 90.7 | 2.3 |
| | 606-2 | 85.0 | 2.7 |
| 110 | 606-3 | 80.4 | 2.9 |
| | 606-4 | 75.9 | 2.3 |
| | 606-5 | 9.6 | 1.6 |
| *Moberly Member, Waterways Formation* (Figures 20 and 21) | | | |
| | 595L | 76.1 | 3.3 |
| 104 | 595M | 89.3 | 3.8 |
| | 595U | 78.6 | 1.0 |
| | 601L | 82.1 | 2.7 |
| 105 | 601M | 87.3 | 2.3 |
| | 601U | 74.3 | 2.1 |
| | 602L | 85.0 | 2.6 |
| 106 | 602M | 89.5 | 1.9 |
| | 602U | 78.6 | 4.2 |
| 108 | 604L | 89.1 | 2.5 |
| | 604U | 84.6 | 3.3 |

| Chemical Analysis Number | Individual Sample Number | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|
| *Moberly Member, Waterways Formation (continued)* (Figures 20 and 21) | | | |
| 109 | 605L | 87.9 | 2.3 |
| | 605U | 77.9 | 2.6 |
| 112 | 608 | 84.8 | 2.6 |
| | 486 | 56.6 | 5.4 |
| | 587 | 87.5 | 4.7 |
| | 587U | 80.0 | 4.6 |
| | 588 | 75.9 | 5.2 |
| | 589 | 82.7 | 2.7 |
| | 590 | 88.4 | 3.3 |
| | 591L | 85.9 | 2.7 |
| | 591U | 79.8 | 4.4 |
| | 592L | 93.4 | 1.6 |
| | 592U | 86.1 | 0.0 |
| | 593L | 93.9 | 1.7 |
| | 593U | 83.7 | 3.3 |
| | 594L | 83.9 | 2.3 |
| | 594U | 80.4 | 4.2 |
| | 596L | 90.2 | 4.4 |
| | 596U | 83.4 | 4.8 |
| | 597L | 88.9 | 3.7 |
| | 598L | 87.5 | 2.3 |
| | 598U | 79.1 | 4.0 |
| | 599L | 85.9 | 2.7 |
| | 599U | 72.3 | 0.0 |
| | 600UM | 51.6 | 2.9 |
| | 600U | 90.0 | 2.3 |

## APPENDIX C

## EXCERPTS FROM GOUDGE (1945)

**DESCRIPTION OF THE CROWSNEST PASS AREA**
***(from pages 100 to 104).***

"The Kettle Valley branch of the Canadian Pacific railway passes through the Rocky mountains via the Crowsnest pass, which is flanked on either side by mountains of Devono-Carboniferous limestone. The first section of limestone in the pass, close to the railway, is seen at Crowsnest lake, where from just east of a cave from which issues an underground stream (the headwaters of Crowsnest river or Oldman river) the limestone striking N. 55° W, and dipping southwest at an angle of 32 degrees is exposed for over 2½ miles along the track to near the British Columbia boundary.

"East of the cave is a thickness of several hundreds of feet of interbedded calcium limestone, dolomite, and shale, the shale becoming increasingly prominent to the eastward until all is shale and shaly limestone. Near the east end of Crowsnest lake the Devono-Carboniferous rocks are in contact with Cretaceous rocks.

"Westward from the cave is a band, over 1,000 feet thick, of massively bedded high-calcium limestone, and mottled magnesian limestone that extends up the mountain. The basal 150 feet is fine-grained, dark brownish grey, high-calcium limestone, from which Sample 2 was taken.

"Above this, and composing most of the lower and central sections of the band, is fine-grained, grey limestone heavily mottled with fine-grained brown-weathering magnesian material. Sample 2A, taken from a 100-foot thickness of this mottled limestone, shows it to have a lower content of silica than the high-calcium limestone beneath it, but the magnesium carbonate content is midway between that of high-calcium limestone and dolomite. The upper 400 feet of the massive limestone is mostly unmottled, but there are occasional mottled beds. The mottling is always parallel to the bedding and is confined to certain beds.

"Overlying the massively bedded limestone that is free from chert is 700 feet of cherty and shaly limestone and shale which in turn is overlain by 600 feet of extremely cherty, grey, calcium limestone, in which is an occasional band of pure limestone. Succeeding this is 400 feet of medium-grained high-calcium limestone in which are a few cherty beds of siliceous magnesian limestone. At the top of the part of the section are located the quarries of Summit Lime Works.

". . . These quarries are all of the side-hill type and are at the same elevation, their floors being about 65 feet above the railway tracks, or level with the tops of the kilns. No. 1 quarry, most easterly of the three, is a short distance east of the kilns and is worked only in winter. It has been worked into the mountainside for 100 feet across a width of 140 feet and has a face 100 feet high. The limestone is medium-grained, light grey, and heavily bedded, but badly fractured. Running through the eastern part of the quarry is a 6-foot band of fine-grained magnesian limestone that is discarded in quarrying. Because of the dip of the strata this magnesian band will pass out of the quarry as the latter is worked back into the mountainside. Sample 3 was taken in this quarry, with the magnesian band excluded.

"Five hundred and fifty feet west is a small quarry (No. 2) not now used, in which is exposed interbanded high-calcium limestone and magnesian limestone, the latter predominating. In between this and No. 1 quarry are three small openings made to test the rock. In the first, which is 130 feet west of No. 1 quarry, fine-grained, drab magnesian limestone is exposed; in the next, which is 150 feet farther west, interbedded high-calcium limestone and highly magnesian limestone are exposed; and in the third, 200 feet farther west, is medium-grained, grey, fossiliferous high-calcium limestone that crumbles to dust in the kilns and has not been quarried. This pit is separated from No. 2 quarry by 50 feet of magnesian limestone.

"No. 3 quarry, which is being operated, is separated from No. 2 quarry by 40 feet of highly magnesian limestone. No. 3 quarry has been worked into the mountainside for 200 feet across a width of 80 feet. The sloping face is now 300 feet high. The limestone is medium-grained, brownish grey, and is in fairly heavy beds that strike N. 45° W. and dip southwest at an angle of 45 degrees. Sample 3A was taken in this quarry across the width of 80 feet. Sample 3B was taken from the magnesian limestone separating No. 2 and No. 3 quarries and Sample 3C was taken from the cherty magnesian limestone overlying the stone being worked in No. 3 quarry. This cherty limestone extends for 400 yards to the west . . .

"On the southern side of the pass, steeply dipping beds of cherty limestone, mottled magnesian limestone, high-calcium limestone, and black shale are exposed along the highway for a mile opposite Crowsnest lake. East of Glacier creek is a band of high-calcium limestone in a quarriable position.

"On the north side of the pass and westward from the company's quarry, limestone is exposed adjacent to the railway for 1½ miles to the contact with the overlying quartzite. It dips southwest at angles of from 35 degrees to 45 degrees. Most of the limestone is of the cherty calcium type and there are lesser thicknesses of high-calcium limestone and of impure, highly magnesian limestone. Four of the bands of pure limestone are worthy of special mention. The first two of these are just opposite the east end of Island lake, where one forms a spur of rock jutting out from the mountain to the east, and rises to a height of about 600 feet. At the base of this spur, on the west side, cherty limestone occurs overlying the pure limestone, but above this the entire spur consists of medium-grained, light grey, high-calcium limestone. The aggregate thickness of the beds of pure stone is at least

150 feet. There is little soil on the spur and its eastern flank is almost a cliff. Sample 4 was taken from the strata composing the spur. Underlying this is a mashed limestone formation having the appearance of a conglomerate, and large limestone boulders protrude from the outcrops. This in turn is underlain by 100 feet of medium- to coarse-grained, light grey high-calcium limestone comprising the other band referred to, and represented by Sample 4A. From here east to the company's quarry the limestone exposed is cherty and otherwise impure.

"The other two prominent bands of pure limestone are opposite the island in Island lake. They are in a less favourable position for quarrying, however, as are the bands just described. The westernmost of these two bands is exposed on the western slope of a hill and is about 40 feet thick. It consists of fine-grained, dark blue limestone and is represented by Sample 5. It is overlain by shaly limestone and underlain by cherty limestone, strikes N. 40° W., and dips southwest at an angle of 35 degrees. Two hundred feet east is the second band, consisting of 30 feet or more of medium-grained, light grey high-calcium limestone. It is exposed in the western side of a valley leading from a tiny lake at the base of the mountain to Island lake. The strike and dip are the same as those of the band above it. Thus, it dips into the hillside and can be made available only by mining. Sample 5A was taken from this band.

"From this locality to the interprovincial boundary only impure magnesian limestone and siliceous calcium limestone are exposed. The contact with the overlying quartzite is near the boundary."

### DESCRIPTION OF THE BLAIRMORE AREA
***(from pages 98 to 100)***

"Southeast of Frank a very large area is covered to a considerable depth with blocks of Carboniferous limestone that fell from Turtle mountain in the great Frank rockslide of 1903. The Frank Lime Company built three draw-kilns at Frank with the intention of using the limestone from the slide for making lime, but it was found impossible to select a sufficiently uniform grade to make a high-grade lime. Much of the limestone available in the slide material is very cherty, some is highly magnesian and siliceous, and only a relatively small proportion is of the pure high-calcium type . . .

"Just east of Blairmore at the base of Turtle mountain and on the south side of the railway, is the abandoned quarry of the Rocky Mountains Cement Company, Limited, which began operations in 1909 and closed down 1915. Previously the quarry was worked to supply a lime plant. On this property the strata strike N. 26° W. and dip southwest at an angle of 65 degrees. The quarry has been worked along the strike for 300 feet into the north face of Turtle mountain and has a face 100 feet high. There is a wide variation in type and quality of the limestone exposed, and several openings were made in search of a wide band of low-magnesia limestone. The widest band observed is in the main quarry, where the succession of strata from west to east is as follows:-

15 feet — Very cherty, fine-grained, bluish grey limestone.

23 feet — Cherty and siliceous, somewhat magnesian limestone.

21 feet — Variable limestone, some high-calcium, and some cherty and otherwise siliceous.

8 feet — Siliceous, fine-grained, bluish grey magnesian limestone that has been left as a wall between the two openings.

40 ½ feet — Fine-grained, dark grey calcium limestone containing some cherty and magnesian bands. Sample 1 was taken from this band.

40 feet — Medium-grained, grey, highly fossiliferous high-calcium limestone. Sample 1A represents this band.

18 feet — Composed of 10 feet of very cherty, fine-grained magnesian limestone; 3 feet of coarse-grained, pure high-calcium limestone containing one 3-inch streak of siliceous limestone, and 5 feet of cherty and otherwise siliceous, fine-grained magnesian limestone. Sample 1B was taken across this 18-foot zone excluding chert nodules.

24 feet — Mostly pure, high-calcium, medium-grained, grey, highly fossiliferous limestone. The last 4 feet contains peculiar cavities up to 1 inch in diameter. Sample 1C was taken from this 24-foot section. This is the eastern edge of the quarry.

"Eastward from the quarry the outcrops reveal mostly cherty limestone with minor bands of pure high-calcium limestone. West of the quarry the limestone is mostly siliceous, and about 250 feet west are beds of calcareous quartzite with, still farther west, more beds of limestone, and then more shaly and thin-bedded quartzite . . ."

"Across the Crowsnest river from the company's property is a small quarry and kiln at the base of Bluff mountain that was worked until 1930 for making lime. A 30-foot band of medium-grained, grey, high-calcium limestone, similar to the best of that exposed in the quarry at the cement plant, occurs at this place. Sample 1X was taken from the 30-foot band. The lime produced was white and of good quality."

### DESCRIPTION OF THE EXSHAW AREA
***(from pages 106 to 110)***

"At Kananaskis the Devono-Carboniferous limestone composing the major part of the first range of the Rocky mountains is well exposed close to the railway, which passes through the mountains via the valley of the Bow river. For 6 miles, from Kananaskis to The Gap, the river has cut through the mountains almost at right angles to their axis, and excellent sections of the strata are exposed. The easternmost mountain, just north of the railway at Kananaskis, is composed very largely of pure dolomite with lesser bands of high-calcium limestone interbedded with mottled magnesian limestone at the summit and the base. The strata strike N. 60° W. and dip at an angle of 35 degrees southwest. The dolomite is mostly fine-grained, steel-blue and dark brown, and in broken beds up to 6 inches in thickness, but one band 70 feet thick was observed that was coarse-grained and light grey. Sample 7 was taken across a 200-foot band of steel-blue dolomite that weathers grey, Sample 7A was taken from a 500-foot width of the brown, rusty-weathering dolomite, and Sample 7B from a 70-foot band of the light grey dolomite. Some of the dolomite is in large lenticular masses rather than in bands of great length, and when traced along its strike the dolomite turns abruptly into high-calcium limestone. Sample 7C was taken from the high-calcium limestone at a distance of 3 feet from where the stratum changed abruptly from dolomite similar in composition to Sample 7B. In the 3-foot transitional zone, dolomitization was in evidence along bedding planes and fractures. The dolomite lenses are, however, very large. Some cherty bands were observed, but they are thin and infrequent and thicknesses of hundreds of feet of strata are free from chert. Some bands of high-calcium limestone mottled with dolomite also occur.

"(Loder's Lime Company, Limited) has been producing lime from Devonian limestone at Kananaskis since 1880, when the original plant was built east of Kananaskis station. The present plant is about ¾ mile west of the station and just north of the railway. At this place a low spur of high-calcium limestone and dolomite projects in a southerly direction from the mountain to the railway. The high-calcium portion of this spur is being quarried for use in making lime. The quarry is about 500 feet north of the plant and the floor is level with the tops of the kilns. A narrow gauge railway runs from the quarry to the charging floor of the kilns. The quarry is 700 feet long and 150 feet wide, but only half of this width is being worked. It is being extended along the strike northwestward toward the mountain. The present face is 90 feet high and will increase in height as the quarry is continued to the northwest. The strata strike N. 55° W. and dip southwest at 75 degrees. A fault plane forms the western wall of the quarry. A section across the quarry from west to east is as follows:-

6 feet — Nearly black, fine-grained high-calcium limestone. Sample 8.

13 feet — Fine-grained, dark grey high-calcium limestone with a narrow band that is faintly mottled with magnesian material. Sample 8A.

22 feet — Grey, fine-grained high-calcium limestone. Sample 8B.

22 feet — Light grey, fine-grained high-calcium limestone. Sample 8C.

"Only the eastern half of the quarry is being worked to obtain stone for making lime. The limestone in the western half has a varying content of magnesium carbonate and has not been worked in recent years. In the past it was quarried and burned separately for use as masons' lime, in which a relatively high magnesia content is not detrimental. The section continues:-

10 feet — Fine-grained, grey high-calcium limestone mottled with dolomite. Sample 8D.

15 feet — Fine-grained, steel-grey dolomitic limestone that is discarded for all purposes. Sample 8E.

40 feet — Fine-grained, dark grey limestone mottled with dolomite. Sample 8F.

23 feet — Fine-grained, nearly black limestone. Sample 8G.

"The high-calcium limestone on the western side of the quarry makes a white lime, whereas the magnesian limestone on the east side makes a cream-coloured lime.

"West of the quarry the limestone includes narrow zones mottled with dolomite, but 72 feet west is as irregular band 66 feet wide of cream-coloured, very pure high-calcium limestone. Another band of the pure, cream-coloured limestone occurs 150 feet west of this, and a small quarry was at one time opened in it near the bottom of the hill southwest of the present quarry. These light-coloured bands are irregular in their trend and cut across the stratification . . .

"At Exshaw the Canada Cement Company, Limited is quarrying limestone for the manufacture of Portland cement from a hill of Devono-Carboniferous limestone just west of the village and adjacent to the railway. The hill is composed of strata striking N. 60° W. and dipping southwest at an angle of 45 degrees. It is 600 feet high and 1,200 feet across the base at right angles to the strike. The quarry is opened along the southwestern flank of the hill and is being extended northwesterly along the strike. It has been worked for 250 feet into the hillside and the sloping wall at the side of the quarry is 450 feet high. Approximately 100 feet of strata relatively low in magnesia are being worked. This series of beds is overlain at the edge of the hill by a toe of mottled magnesian limestone and is underlain by strata too high in magnesium carbonate for use in cement-making. The 100 feet of strata being quarried consist mainly of hard, brittle, fine-grained, dark grey high-calcium limestone, together with minor beds that are mottled with dolomite. The bedding is heavy and individual beds up to 3 feet thick are common. Sample 9 was taken, where opportunity offered, across the 100 feet of strata being quarried for use in the plant. It does not represent all the strata as it was impossible at the time to reach all the beds. Some of the beds are undoubtedly lower in magnesium carbonate than the analysis shows, for several magnesian beds occur interstratified with the others, thus raising the magnesium carbonate content of the whole.

"The succession of beds beneath the series being quarried is as follows:-

- 20 feet — Heavily bedded, fine-grained nearly black limestone partly mottled with dolomitic material. At the top of this part of the section is the prominent bedding plane that forms the sloping wall of most of the quarry. Sample 9A.
- 5 feet — Finely granular, hard, steel-grey, highly magnesian limestone mostly in one bed. Sample 9B.
- 30 feet — Fine-grained, very dark grey limestone in beds up to 3 feet thick, some of which are mottled with dolomite. Calcite occurs as cavity fillings and in short veins. Sample 9C.
- 8 feet — Dark blue, fine-grained limestone mottled heavily with brown dolomitic material and in beds up to 3 feet thick. Sample 9D.
- 18 feet — Fine-grained, dark grey limestone lightly mottled with dolomitic material. Sample 9E.

"At the edge of the hill a maximum thickness of 50 feet of the mottled magnesian limestone overlies the beds being worked, for about 60 feet up the hill, after which it disappears, because the dip of the strata is steeper than the slope of the hill. Sample 9F was taken from this toe of magnesian rock . . .

"The remainder of the strata composing the hill in which the company's quarry is situated is very similar to the strata above described as being immediately beneath the quarry, except that magnesian beds seem to be more numerous. A band of dolomite 10 feet thick runs along the ridge of the hill, and along the east side of the hill is more dolomite, one band being 40 feet thick. Beneath this thick band of dolomite is cherty limestone.

"Westward from the quarry the limestone becomes progressively more impure and shaly, and in places is dolomitic. At the sharp bend in the road about ½ mile west of the quarry, only shale is exposed. Possibly some of the shaly limestone in this vicinity is of the composition required for making rock wool.

"Westward from here, to beyond the west end of Lac des Arcs, shaly, impure limestone and shale, with an occasional band of pure limestone, is exposed. The strata strike N. 60° W. and dip southwest at an angle of 45 degrees. This shaly limestone and shale is overlain by thin-bedded, fine-grained, nearly black dolomite containing yellow chert. Above this, however, is a great thickness of fine-grained, dark blue and dark brown dolomite. Sample 10 was taken from a band 40 feet thick of blue-grey, medium-grained dolomite enclosed in the dark-coloured dolomite and exposed in a quarriable position north of the highway and opposite the centre of a small lake (Gap lake) that lies between the highway and the railway west of Lac des Arcs.

"Northeast of where Sample 10 was taken, and 500 to 600 feet higher up, is a prominent spur composed largely of fine-grained, dark blue high-calcium limestone in faulted contact with overlying mottled magnesian limestone to the west. Sample 10A was taken from the high-calcium limestone, and Sample 10B from the mottled magnesian limestone. The strata dip only at an angle of 18 degrees southwest.

"On the southern slope of Grotto mountain, and about 250 feet above the railway, the Alberta Portland Cement Company opened quarries in the Carboniferous limestone to supply its plant in Calgary, which operated from 1906 to 1914, after which it was dismantled. Nearby is a small quarry from which limestone was obtained for two lime kilns known locally as The Gap Lime Works; but it has not been in operation since 1913.

"The quarries are opened on two ridges of limestone trending along the side of the mountain parallel to the strike of the limestone, which is N. 68° W. The dip is south at 45 degrees. The ridges are faced with high-calcium limestone that overlies cherty and magnesian limestone. This facing is 75 feet thick on the lower of the two ridges, but on the upper ridge, separated from the lower by 100 feet of cherty limestone and siliceous dolomite, the pure limestone is only 20 feet thick. Several quarries have been opened along the ridges, which can be traced for over a mile west along the face of the mountain. The main quarry is 340 feet long, 75 to 100 feet wide, and a maximum thickness of 75 feet of strata has been worked. The limestone is very fine-grained, dark bluish grey, and is in massive, indistinct beds flecked with tiny crystals of black calcite. At the sloping back or base of the quarry is about 10 feet of limestone that contains numerous peculiar pock-marks 1 to 1½ inches in diameter. These tiny pockets are filled with tiny loose calcitized fossils that eventually wash away leaving the pocks. Most of the limestone emits a fetid odour on being struck with a hammer. Sample 11A was taken from the top 25 feet of strata exposed in the quarry, and Sample 11B from the bottom 50 feet.

"In the second and higher ridge several small openings were made, but only 20 feet of limestone is free from chert and it is not so pure as the limestone in the lower ridge. Sample 12 is representative of the upper 18 feet of strata in one of these quarries, and Sample 12A of 5 feet of cherty limestone, excluding the chert nodules themselves. This limestone is similar in appearance to that in the lower ridge and is overlain by cherty calcium limestone."

## DESCRIPTION OF THE NORDEGG AREA
***(from pages 114 to 116)***

"Devono-Carboniferous limestones, composing a large part of the Brazeau range are exposed along the Canadian National Railway to Nordegg, or Brazeau as the railway station is called. The limestone exposures begin at Mile 145.2 about 4½ miles northeast of Nordegg, and continue at intervals to the town itself. Those seen in the first ¾ mile consist mostly of impure magnesian limestone interbedded with shale and with minor amounts of dolomite. Much of the limestone is cherty and some of it has cavities filled with solidified bitumen. The general strike of the strata is east and west and the dip is mostly south at steep angles. A few hundred yards northeast of Mile 146 is a large exposure of impure, fine-grained, dark grey, heavily bedded calcium limestone containing some chert, but with thicknesses of as much as 50 feet of strata free from it. Sample 20 is representative of a 50-foot section of chert-free stone. This limestone, dipping southerly at an angle of 60 degrees, forms a ridge east of the railway for a considerable distance.

"In the cutting at Mile 146, brown, medium-grained, compact dolomite, underlain by cherty dolomite and overlain by mottled magnesian limestone, is exposed to a thickness of 250 feet. Sample 21 was taken from this dolomite, which is massively bedded and contains cavities filled with petroleum. The beds strike N. 70° W. and dip north at an angle of 60 degrees. Between the railway and the mountain to the east the rock is only lightly covered by soil. Farther south, thin-bedded and impure, fine-grained calcium limestone is exposed for a short distance, and after a covered interval of nearly a mile a shaly dolomite is exposed dipping south at a low angle.

"At Mile 147 a small quarry was at one time worked in the impure dolomite, possibly for ballast.

"Three hundred and fifty yards farther west, finely granular, brown dolomite very similar to that of Sample 21 is exposed and is underlain by mottled magnesian limestone. The strata dip southwest at an angle of 10 degrees. Sample 21A was taken from this dolomite, which is probably a repetition of that represented by Sample 21.

"From here westward most of the limestone exposed is impure and shaly. This shaly, thin-bedded limestone is well exposed in the cutting at Mile 148 where it lies in beds dipping southerly at a low angle.

"At Mile 148.5 or 1 mile east of Nordegg, a quarry for ballast has been opened in pure calcium limestone just east of the trestle bridge. Twenty feet of limestone, striking N. 50° W. and dipping southwest at an angle of 14 degrees, is exposed. The top 10 feet of beds consists mostly of fine-grained, nearly black limestone. The beds are 4 to 9 inches thick with wavy bedding planes. Some beds are filled with fossils, and such beds are coarse-grained. Sample 22 was taken from the top 10 feet of limestone. The bottom 10 feet of limestone consists in part of dolomite and in part of high-calcium limestone, together with some mottled magnesian limestone. No sample was taken. In the railway cut east of the quarry, however, where lower beds are exposed, a belt of moderately coarse-grained, pure, grey, heavily bedded high-calcium limestone 40 feet thick appears. Sample 22A was taken from these strata, which are underlain by shaly calcium limestone and overlain by strata similar to those exposed in the bottom 10 feet of the quarry. Vugs filled with solid bitumen are plentiful in certain of the beds in this locality.

"At Mile 149 broken beds of shaly calcium limestone and of cherty dolomite are exposed, but 300 yards farther west, or just outside the railway yard limit, is a cutting exposing 15 feet of fine-grained, grey, porous dolomite in uneven beds and containing many cavities filled with solid bitumen. Sample 23 was taken from the porous dolomite. Four hundred and fifty feet farther westward a brittle, dense, grey dolomite is exposed.

"In the creek bed at Mile 149.4, very impure, black, fine-grained magnesian limestone is exposed in nearly horizontal beds. Parks (1916) gives the following analysis as being representative of this stone:" *(see Appendix A, Table A-13).*

## DESCRIPTION OF THE CADOMIN AREA
***(from pages 117 to 118)***

"Devono-Carboniferous limestones are exposed south of Cadomin along the Mountain Park branch of the Canadian National railway, which follows the McLeod river through the easternmost range of the Rocky mountains. The exposures begin ¾ mile south of Cadomin, or about 1,000 feet north of Mile 25, and continue southerly for 2 miles. The first limestone seen south of Cadomin is fine-grained, brown-grey calcium limestone in broken beds that dip vertically and are in faulted contact with sandstone and shale to the north. Some of the limestone is mottled with magnesian material and some is cherty. It forms a ridge about 500 feet long and 50 to 75 feet high, east of and parallel to the railway.

"South of this the limestone that forms a mountain east of the railway is exposed adjacent to the track. The strata strike east and west and dip south at angles ranging from 35 to 60 degrees. The underlying beds, as exposed along the track for a distance of 300 feet, consist of badly fractured, very fine-grained, brownish grey, calcium limestone, some of which is mottled with brown-weathering magnesian material and some contains nodules of black chert. Sample 24 was taken from these beds as exposed over a distance of 300 feet along the track, excluding any cherty beds.

"Between here and the 25-Mile post and overlying the mottled limestone is a fine-grained, brownish grey high-calcium limestone in broken beds that vary widely in thickness and dip south at an angle of 35 degrees. It is nearly free from mottled magnesian beds and chert. This band of limestone forms the southern slope of the mountain above referred to, and is available in a quarriable position east of the railway. Sample 25 was taken from this type of limestone where exposed for a distance of 200 feet along the track.

"Lime is being made 1 mile south of Cadomin by Mike Errico from limestone similar to that of Sample 21. The plant consists of two pot kilns, only one of which is being used at present. The production is small, and the lime is used locally.

"Southerly from the 25-Mile post most of the limestone exposed is magnesian and impure, some of it being cherty and much being shaly. On the north side of Cadomin creek is a triangular exposure of moderately pure, fine-grained, brownish grey, calcium limestone on a small ridge. Sample 25A was taken from this limestone. Underlying this unmottled limestone is impure magnesian limestone, dipping south at an angle of 25 degrees. South of Cadomin creek the limestone exposed is mostly impure and magnesian in composition and is interbedded with shale. At Mile 26.7, where the limestone exposures end, a cherty and siliceous dolomite is in contact with shale."

## DESCRIPTION OF THE BRÛLÉ AREA
***(from pages 118)***

"West of Brûlé station, limestone can be seen high up on the mountain-side, but the first that is available for quarrying is at Ogre canyon 2½ miles to the south. At this place the limestone forms a ridge that is 275 feet high on the south side of the canyon and that increases rapidly in height on the north side. The strata dip south at angles of from 25 to 35 degrees and present a very steep face to the north. The ridge is composed of interbedded, fine-grained, very dark grey high-calcium limestone and mottled magnesian limestone. Thin films of shale are present in some beds. Bedding is massive and a thickness was observed for 50 feet of limestone without a definite break. Sample 26 is representative of both mottled and unmottled beds and was taken from a 200-foot thickness of strata."

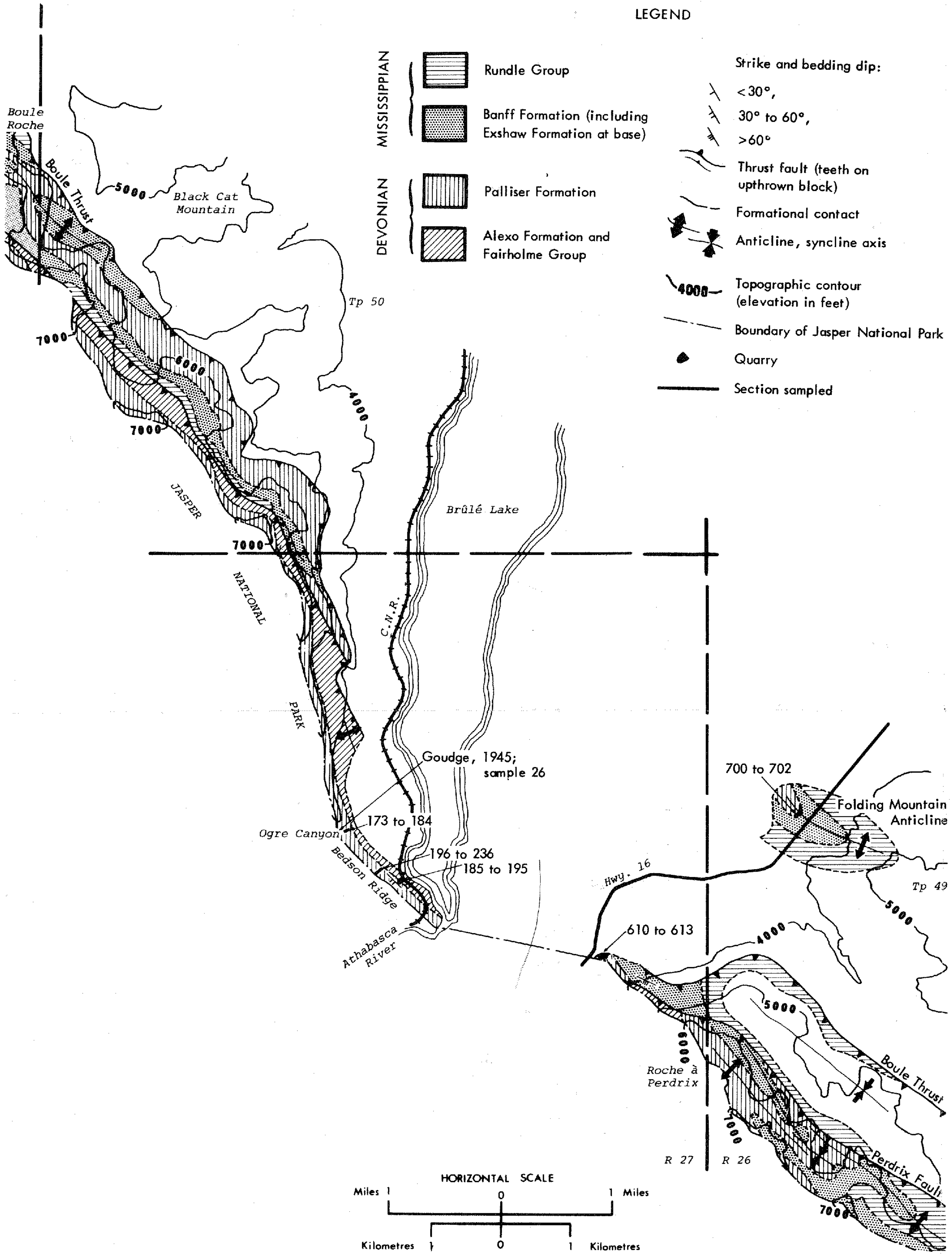


**FIGURE 18. GEOLOGY OF THE BRÛLÉ AREA (after Lang, 1947 and Mountjoy, 1960)**

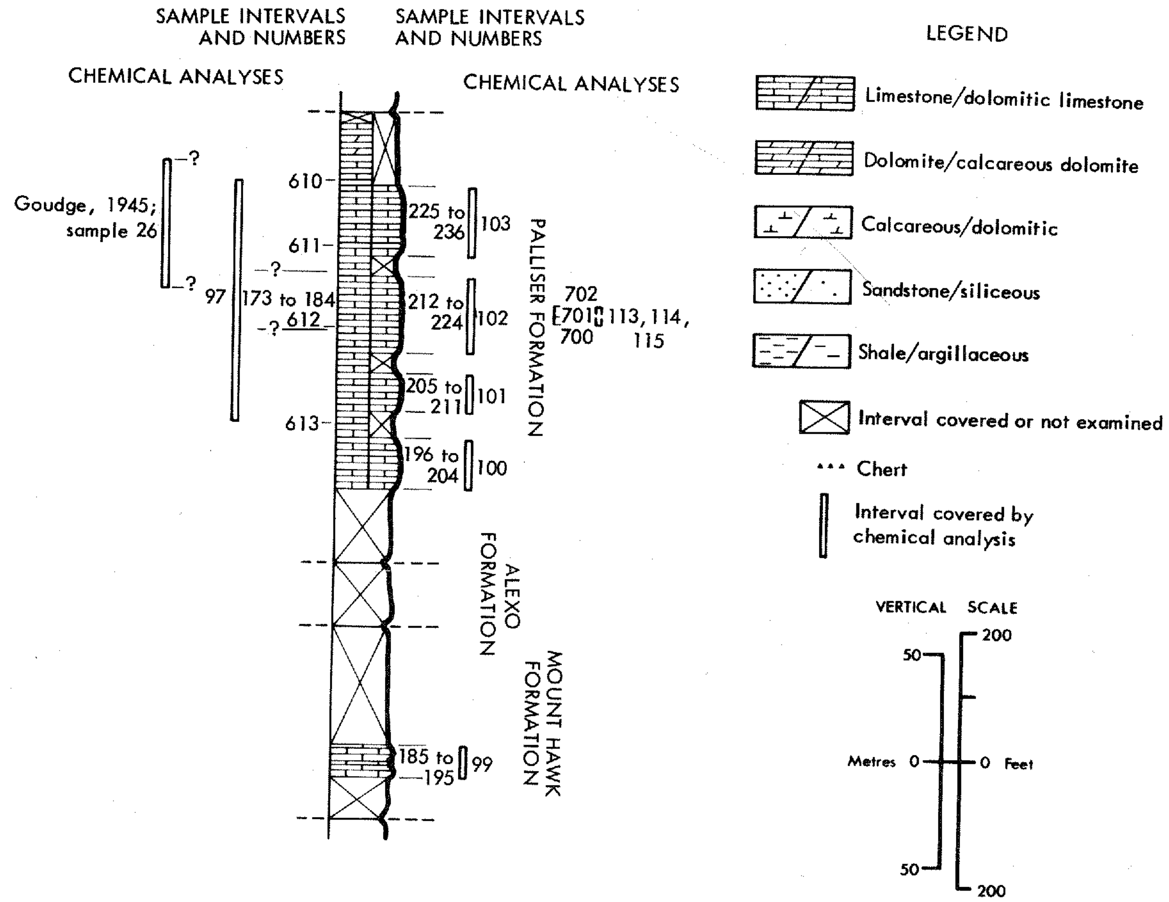


**FIGURE 19. COMPOSITE SECTION, LIMESTONE-BEARING STRATA, BRÛLÉ AREA**

(To accompany Economic Geology Report 4)
Alberta Research Council, 1976

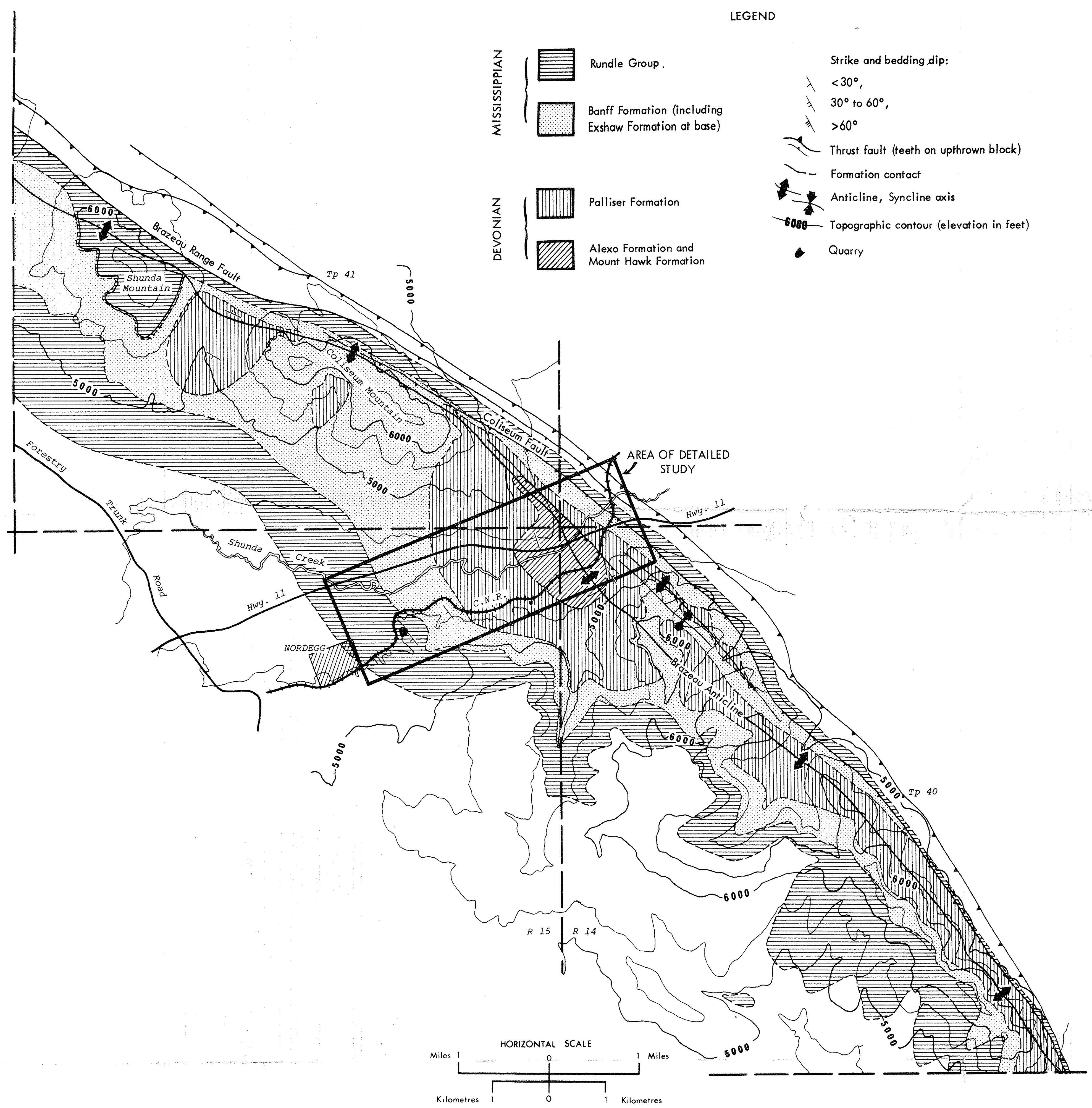


**FIGURE 13. GEOLOGY OF THE NORDEGG AREA (after Erdman, 1950; Douglas, 1956 and 1958)**

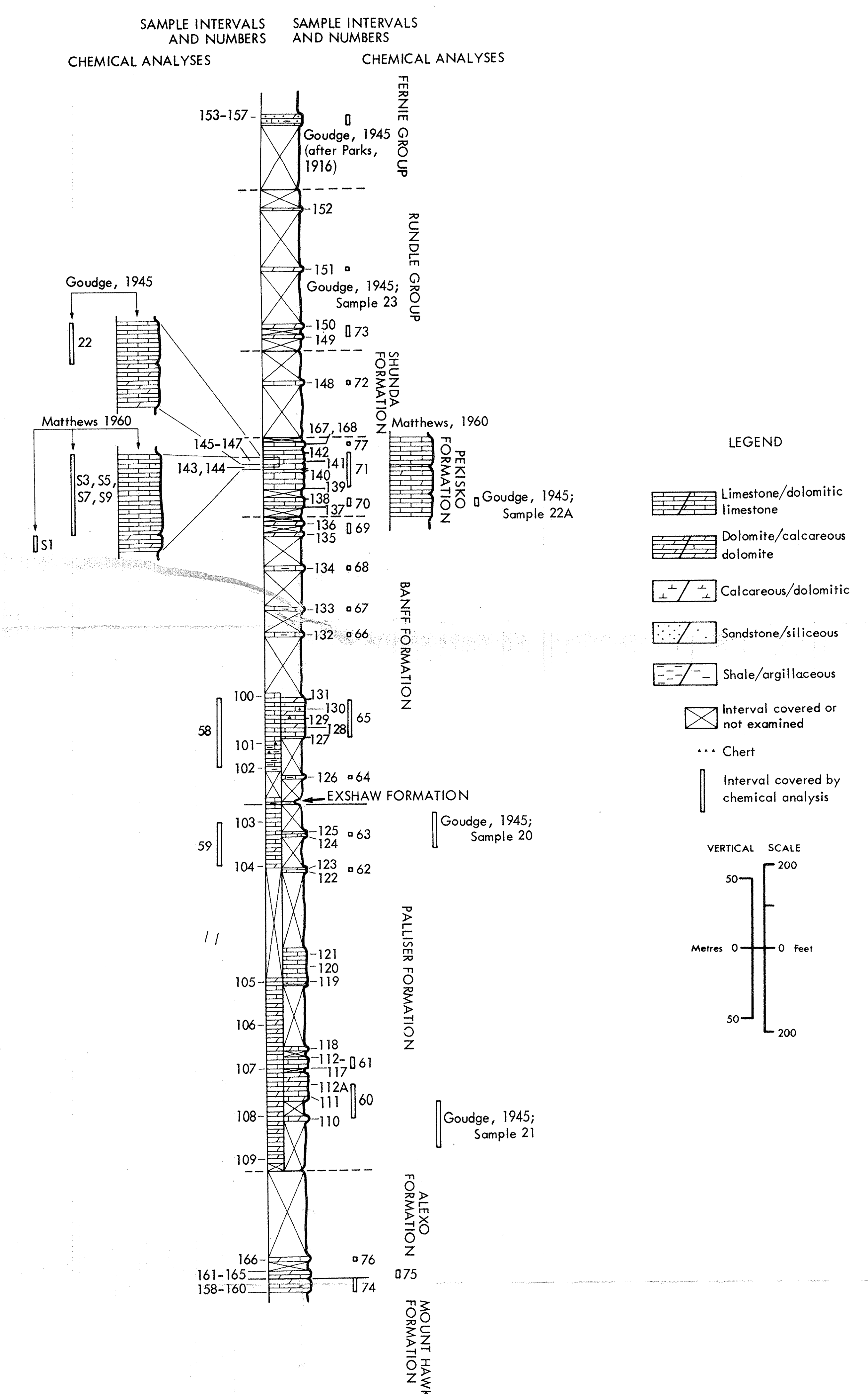


**FIGURE 15. COMPOSITE SECTION, LIMESTONE-BEARING STRATA, NORDEGG AREA**

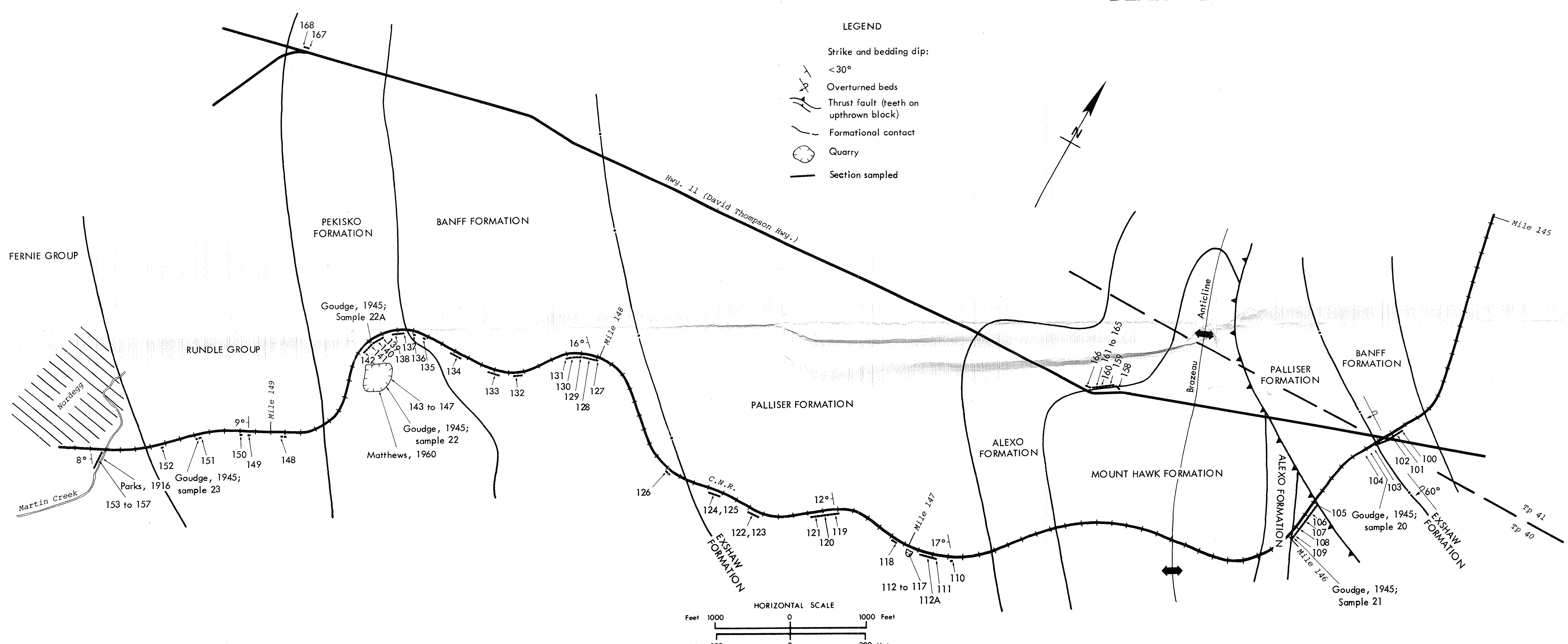


**FIGURE 14. AREA OF DETAILED STUDY, NORDEGG AREA.**

(To accompany Economic Geology Report 4)

Alberta Research Council, 1976

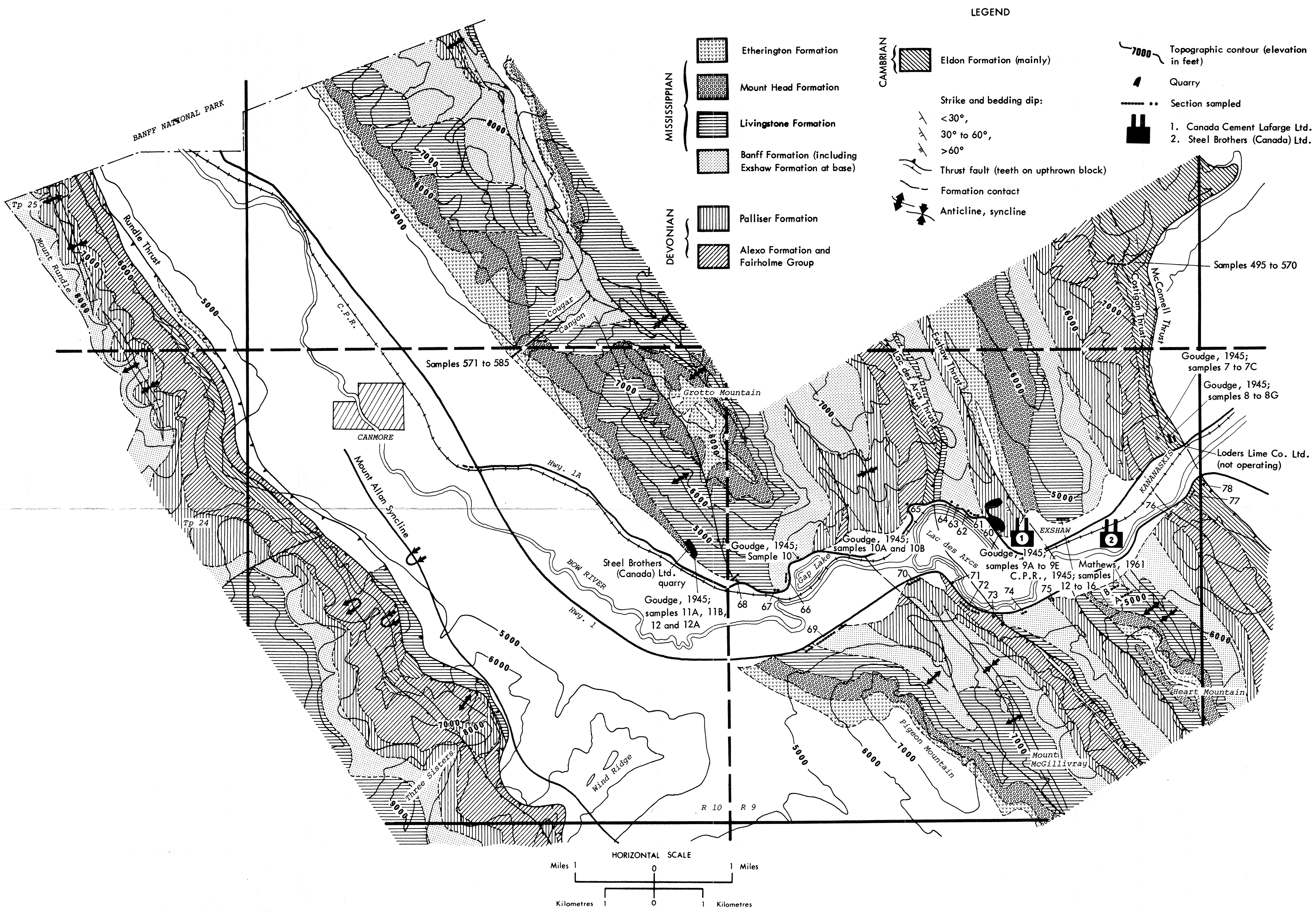


**FIGURE 11. GEOLOGY OF THE EXSHAW AREA (after Price, 1970)**

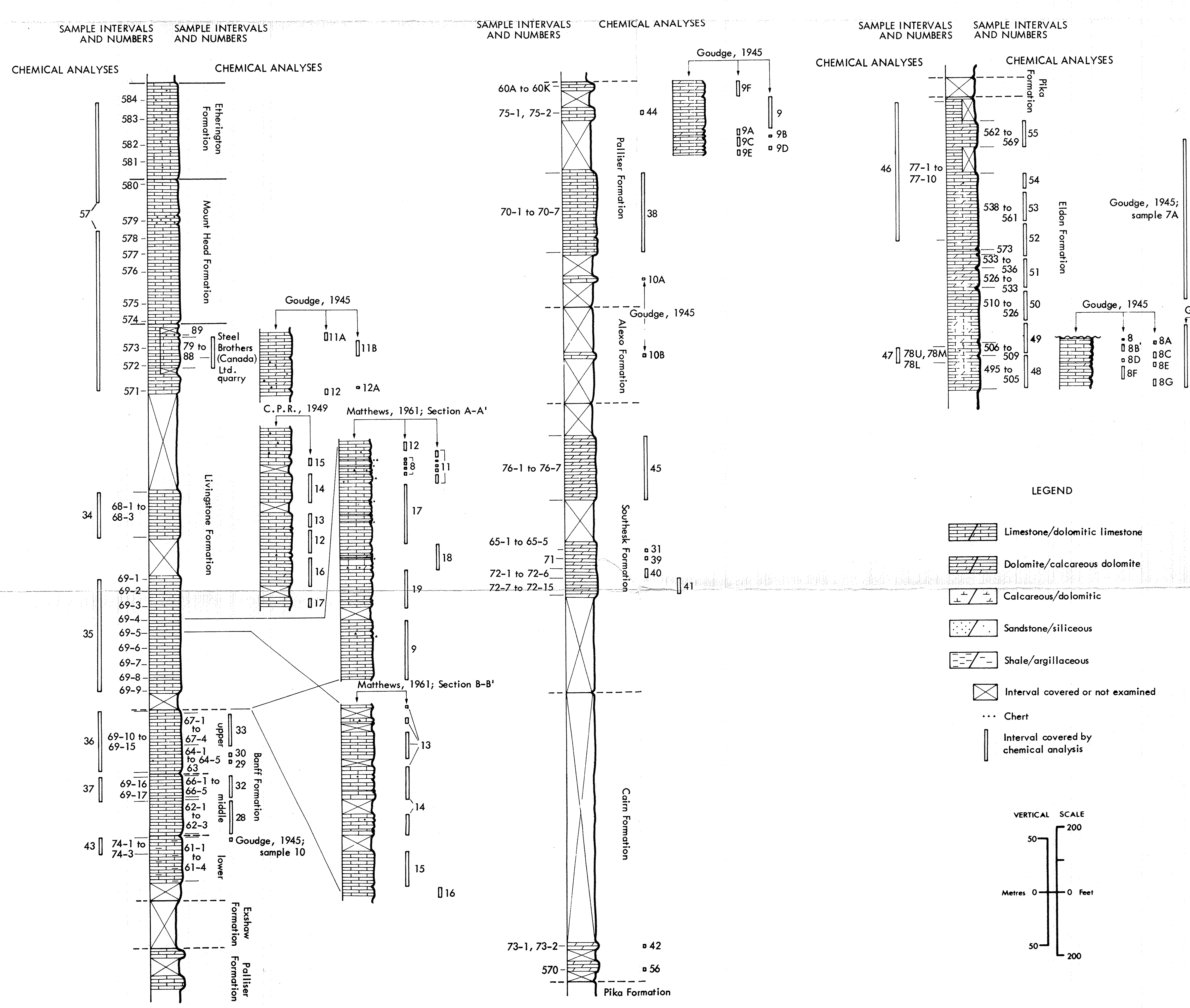


**FIGURE 12. COMPOSITE SECTION, LIMESTONE-BEARING STRATA, EXSHAW AREA**

(To accompany Economic Geology Report 4)
Alberta Research Council, 1976