LIMESTONE/DOLOSTONE

by

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<u>NOTE</u>: This is a preliminary report and is subject to revision with a more comprehensive study. Information presented herein should not be published without prior approval of the Alberta Research Council.

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LIMESTONE/DOLOSTONE

INTRODUCTION

The series of reports attempts to review the status of geology-related studies (published and unpublished) which reflect on the evaluation of a specific resource or commodity.

Literature references are incorporated and classified according to the level and type of field exploration detail supplied.

These reports should provide the background and basis from which:

1. an assessment can be made of the level of exploration information currently available;
2. the most relevant literature can be selected through a system of classified references; and,
3. an economic feasibility for locating and/or developing a primary resource or commodity can be assessed from the geological characteristics and conditions as presently understood in Alberta.

Alberta has abundant sources of Paleozoic limestone/dolostone, they underlie the Sedimentary Basin of Western Canada. The outcrops and subcrops of these carbonates are found in two regions (figure 1):

1) the Interior Plains of the northeast where the Phanerozoic onlaps and surrounds the Canadian Shield of northeastern Alberta; and,
2) the Rocky Mountains Belt of the southwest.

Proximity to the network of principal urban centres and access to the east-west transportation corridors has favoured development of the better exposed carbonates in the mountains, especially in the southern portion of the belt.

1. The Interior Plains of northeastern Alberta: The relatively very low population density of remote northeastern Alberta suggests the

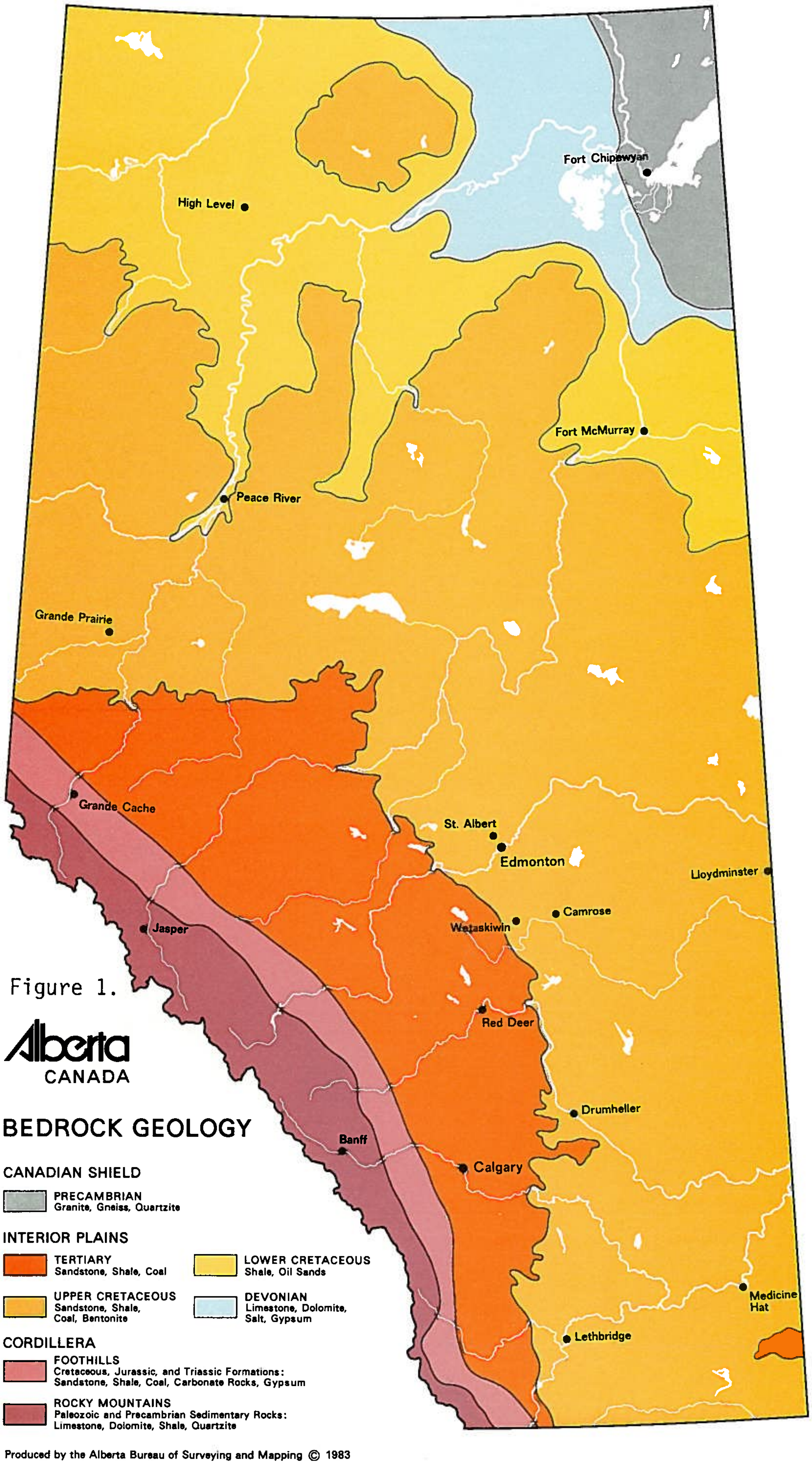
Fort Chipewyan
High Level
Fort McMurray
Peace River
Grande Prairie
Grande Cache
St. Albert
Edmonton
Lloydminster
Camrose
Wetaskiwin
Jasper
Red Deer
Drumheller
Banff
Calgary
Medicine Hat
Lethbridge
Alberta
CANADA
BEDROCK GEOLOGY
CANADIAN SHIELD
PRECAMBRIAN
Granite, Gneiss, Quartzite
INTERIOR PLAINS
TERTIARY
Sandstone, Shale, Coal
LOWER CRETACEOUS
Shale, Oil Sands
UPPER CRETACEOUS
Sandstone, Shale, Coal, Bentonite
DEVONIAN
Limestone, Dolomite, Salt, Gypsum
CORDILLERA
FOOTHILLS
Cretaceous, Jurassic, and Triassic Formations: Sandstone, Shale, Coal, Carbonate Rocks, Gypsum
ROCKY MOUNTAINS
Paleozoic and Precambrian Sedimentary Rocks: Limestone, Dolomite, Shale, Quartzite
Produced by the Alberta Bureau of Surveying and Mapping © 1983

Figure 1.

unlikelihood of extensive industrial development of carbonate rocks in this region. The expansion of open-pit operations in the Athabasca Oil Sands deposit may provide sufficient incentive for a limited industrial limestone development in the Fort McMurray area. Devonian limestone/dolostone floors the open pits and crops out for tens of kilometers along the Athabasca River and its major tributary streams.

2. The Rocky Mountains: Based on past and present production, three industrially important carbonate formations are evident in the Rocky Mountains:

- the Lower Cambrian Eldon Formation
- the Upper Devonian Palliser Formation
- the Mississippian Livingstone Formation

The emphasis in geological studies and evaluations to date has been largely related to the four main east-west transportation corridors (figure 2):

- the Crowsnest Pass
- the Kicking Horse Pass
- the David Thompson Highway (Howse Pass)
- the Yellowhead Pass

Some gaps are apparent in the information matrix summary presented in table 1. In terms of production volumes, the major quarries are situated in the Exshaw and Cadomin areas, serving the two major urban centres of Calgary and Edmonton.

OUTLOOK

1. Aglime (the practice of spreading either crushed carbonate rock or solutions to neutralize acidic soils thereby increasing fertility and productivity) is a fledgling industry in Alberta. However, it could become a major consumer of low-grade carbonate (waste) rock products in the future when the industry is better established and

Figure 2.

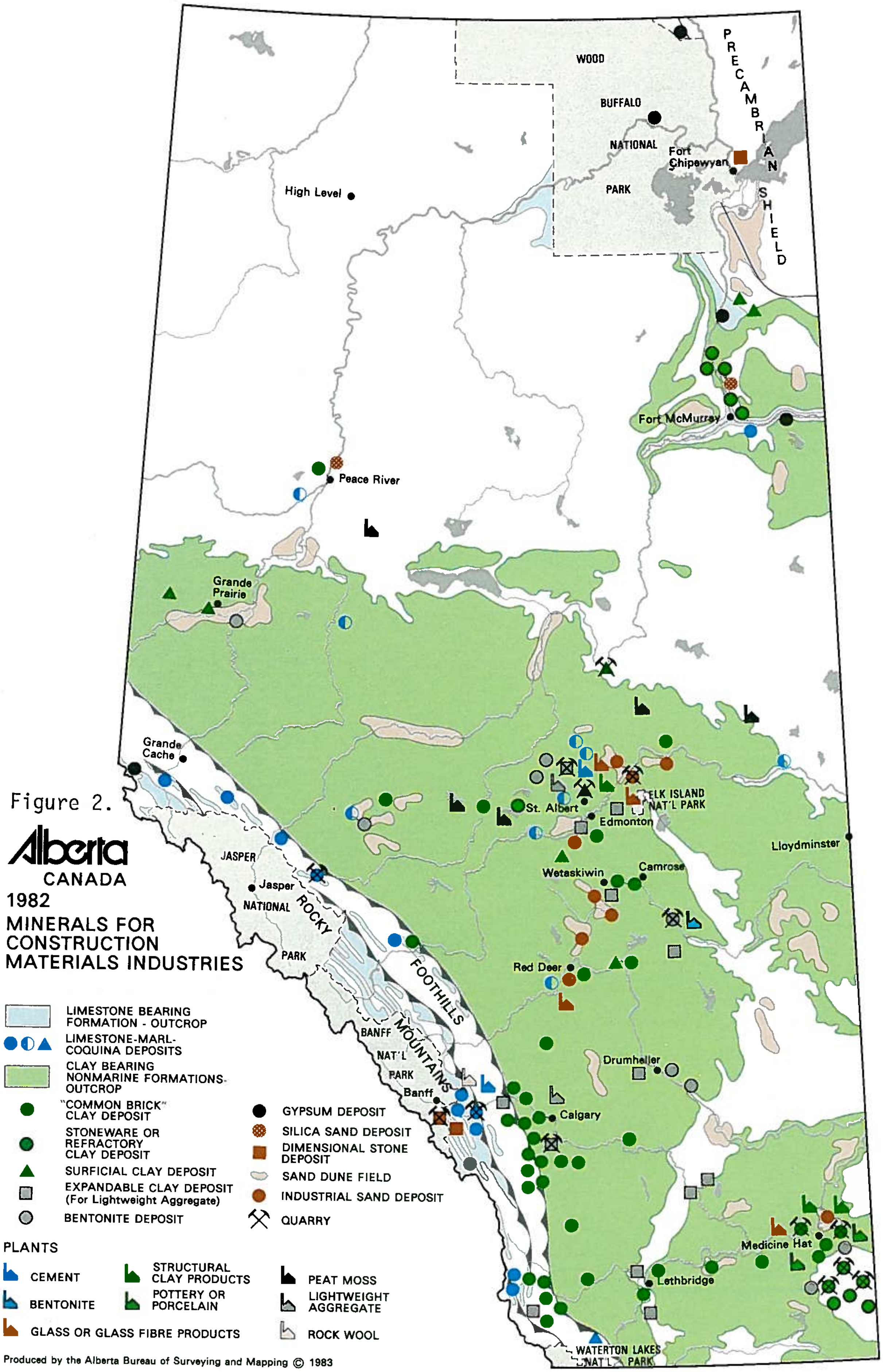
Alberta
CANADA
1982
MINERALS FOR CONSTRUCTION MATERIALS INDUSTRIES
LIMESTONE BEARING FORMATION - OUTCROP
LIMESTONE-MARL-COQUINA DEPOSITS
CLAY BEARING NONMARINE FORMATIONS-OUTCROP
"COMMON BRICK" CLAY DEPOSIT
STONEWARE OR REFRACTORY CLAY DEPOSIT
SURFICIAL CLAY DEPOSIT
EXPANDABLE CLAY DEPOSIT (For Lightweight Aggregate)
BENTONITE DEPOSIT
GYPSUM DEPOSIT
SILICA SAND DEPOSIT
DIMENSIONAL STONE DEPOSIT
SAND DUNE FIELD
INDUSTRIAL SAND DEPOSIT
QUARRY
PLANTS
CEMENT
BENTONITE
GLASS OR GLASS FIBRE PRODUCTS
STRUCTURAL CLAY PRODUCTS
POTTERY OR PORCELAIN
PEAT MOSS
LIGHTWEIGHT AGGREGATE
ROCK WOOL
Produced by the Alberta Bureau of Surveying and Mapping © 1983
WOOD BUFFALO NATIONAL PARK
PRECAMBRIAN SHIELD
Fort Chipewyan
High Level
Fort McMurray
Peace River
Grande Prairie
Grande Cache
JASPER NATIONAL PARK
Jasper
ROCKY MOUNTAINS
FOOTHILLS
BANFF NAT'L PARK
Banff
St. Albert
Edmonton
ELK ISLAND NAT'L PARK
Lloydminster
Wetaskiwin
Camrose
Red Deer
Drumheller
Calgary
Medicine Hat
Lethbridge
WATERTON LAKES NAT'L PARK

Table 1. Limestone/dolostone resources of Alberta; producers: present - √; past - (√); potential - X

	(Miss.) *Livingstone Formation	(U. Dev.) **Waterways Formation	(U. Dev.) Palliser Formation	(L. Camb.) Eldon Formation
Fort McMurray	-	X	-	-
Grande Cache	(X)	-	X	-
Brûlé	?	-	X	-
Cadomin	?	-	√	-
Nordegg	√	-	?	-
Exshaw	√	-	√	(√)
Blairmore	(√)	-	?	-
Crowsnest	√	-	√	-

- Not applicable

* Compositional problems with dolostone and siliceous impurities

(X) Limited potential

** Moderate quality, alumina and siliceous impurities

? No information, basic geologic data are needed the cost/benefits better understood/accepted in the agricultural community.

2. Potential competitors for carbonate rock application in the aglime industry are marl and high-lime content sludges which are produced at hot- water plants for use in oil sands injection-recovery operations.

3. A major well-documented, reconnaissance-scale survey of marl deposits of Alberta (some deposits are discussed in more detail) has recently been completed by the Alberta Research Council (Macdonald, 1982). These deposits tend to be local and relatively small compared to carbonate rock exposures of the Rocky Mountains. Marl is principally seen to be of local and possibly short-term importance as a supply of aglime material. Post-glacial marl deposits are found at surface in the plains region (figure 2). Therefore, it has a possible advantage of being developed much closer to areas of acidic soil than the two prime belts of carbonate rock outcrop (southwest and northeast Alberta).

4. The production of high-lime sludges as a waste product of hot-water generation for oil sands operations is a relatively new development. The high-lime sludges result from the lime/soda ash softening of the produced water. The status and likelihood of using such sludges in the long-term as a soil conditioner/neutralizer is currently undergoing laboratory investigation at the Alberta Research Council (Alberta Research Council, 1985). If the tests prove positive, and the volume of sludge production meets the needs of the agricultural industry, then a useful waste/byproduct disposal will be achieved.

5. As an industrial mineral product, the use of carbonate rock in the traditional lime-cement products area should experience steady growth with population increases. There is essentially an unlimited supply of limestone/dolostone for these uses within Alberta. The Alberta Research Council report by Holter (1976)

presents a useful reconnaissance overview, with some local detail at active or prospective sites. Filling in the data base for the limestone/dolostone resources (see Research Project No. 1) would logically lead to an update and release to the public of a revised version of Holter's overview.

6. Many years ago (mid-1960s) an unsuccessful attempt to utilize marl as a raw material feed for a cement plant was made by Imperial Cement near Clyde. Today, one cement plant (Houg Cement Ltd. at Halfway Lake) uses marl for cement production. However, the natural variability in composition of marl deposits presents a major difficulty in controlling a uniform feed composition to plants. The energy cost in drying moist marl is another key economic factor. Attempts to substitute marl for limestone on a large scale seem unlikely in the near future and the traditional utilization of limestone is expected to continue.

RESEARCH PROJECTS

1. Field investigations and evaluations are appropriate to fill information gaps and to better define the "limited potential" of some formations as displayed in the information matrix of table 1.

2. A more accurate, comprehensive and in-depth appraisal of limestone/dolostone resources could be achieved from a wider search and assessment of the existing relevant literature. The full benefit of the present summary study is unfortunately foreshortened by the limited scope of the current program. Consequently, the report is somewhat superficial in its approach and conclusions. It is recommended that provisions be made to undertake an appropriate research-oriented, broad-ranging study of this important commodity. Of particular relevance would be direct contact with the industry to obtain an update on current trends in technology, product lines and specifications.

3. To maximize the benefits, consideration should be given to aligning

the objectives and results of field studies to the direct needs of a potential industrial user. Better definition of average grade, grade variation, and the pattern of their distribution within the carbonate strata are needed to enable an industrial evaluation of deposits and to quantitatively compare these data with technical specifications for potential industrial applications; for example,

riprap - has no chemical specifications, but boulders of a minimum size are usually specified.

aglime - specifications cover a wide range of chemical composition; a heterogeneous composition is usually not a problem; for example, shale impurities do not present a quality control problem.

quicklime and portland cement - a high-calcium limestone is needed; a uniform composition and quality is important, and acceptable limits on the range of chemical variations are applied.

4. If not already available in the industry, it would be appropriate to produce a handbook or manual that gathers together the technical specifications for the common industrial uses of limestone/dolostone: that is, a manual similar in content to the Alberta Research Council publication on sand; report #71-4 by McLaws, 1971.

5. In the search for building stone, riprap, similar construction/engineering materials, and even in mining (quarry) operations, a knowledge of jointing characteristics is required. Although this feature is of critical significance in these potential industrial uses, most geological/technical field reports largely overlook systematic rock fracture data. Future technical studies of limestone/dolostone resources should address this geological factor in a systematic manner.

6. It would be of help in the course of resource evaluations to be aware of the possible variations in lithology and chemical composition on the scale of a potential quarry site. Does

government monitor active limestone/dolostone quarries in terms of changing geological/mineralogical/chemical characteristics? Does government have access to records of this type that would be routinely compiled for quality control by industry? Otherwise some valuable data are being lost as the quarry face advances.

7. Crushed stone is produced at several industrial plants and operations. However, not all crushed stone has a direct industrial use, and some of it ends up in large waste piles; for example,
(a) sub-grade limestone presently stockpiled at the Inland Cement quarry at Cadomin may eventually find a use as aggregate if the economics ever prove favourable;
(b) blocks smaller than the specified riprap size produced for the Dickson Dam (Red Deer River) have been stockpiled as waste about 65 km southwest of Rocky Mountain House. However, this stockpile may be eventually crushed further for use as aglime.

In general, the accumulation of industrial wastes should be monitored and potential industrial uses reviewed and explored on every possible occasion.

SUMMARY OF DATA GAPS

1. Basic, reconnaissance-level geologic field data are needed for several of the industrially important carbonate formations in the major transportation corridors of the Rocky Mountains.

2. Data are absent for the quarry-scale of investigation. Variations in lithology and composition at the quarry scale of evaluation are available at active quarries.

3. Geological field investigations commonly omit the study of jointing, a feature of importance in some industrial uses and in quarry design and planning.

4. Consolidation of technical specifications for the multiple

industrial uses of limestone/dolostone would facilitate dissemination and access of these key data.

5. The geologic and compositional nature, volumes and rates of accumulation of industrial wastes (especially quarry and industrial plants) should be documented and efforts made to utilize such products.

OUTLINE FOR REFERENCE CLASSIFICATION: RESOURCE INVENTORY

A. Resource (Commodity) Evaluation References
   1. General Overview
   2. Specific Commodity Overview
   3. Exploration - Reconnaissance Scale
   4. Exploration - Site Specific Scale

B. Supporting References
   1. Concepts and Principles
   2. Indirect Exploration - Reconnaissance Scale
   3. Indirect Exploration - Site Specific Scale

C. Background and Miscellaneous References

REFERENCES

A. RESOURCE (COMMODITY) EVALUATION REFERENCES

1. General Overview

Hamilton, W.N. (1976): Industrial Minerals: Alberta's uncelebrated endowment; Proceedings, Eleventh forum on the geology of industrial minerals; Montana Bureau of Mines and Geology Special Publication 74, Alberta Research Council Contribution Series 752.

2. Specific Commodity Overview

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3. Exploration - Reconnaissance Scale

Fox, J.C. (1981): Industrial Minerals of the Canmore Corridor, Tour Information Guidebook, CIM 83rd Annual General Meeting, Calgary, Alberta; Alberta Research Council Contribution Series 1164, 30 pages, 11 maps.

Hamilton, W.N. (1973): Mineral Resource Development in the Kananaskis River Basin; Alberta Research Council Open File Report 1973-26, 3 pages.

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Kopf-Johnson, A.G. and W.N. Hamilton (1982): Limestone Exploitability in the Alberta Rocky Mountains; Alberta Research Council Open File Report 1982-12, 8 pages, 3 maps.

Mellon, G.B. and J.W. Kramers (1972): Geology and Minerals Resources, Northwest-Central Alberta (Hinton to Grande Prairie); Alberta Research Council Economic Minerals File ZZZ-IR-012, 14 pages, 3 maps.

4. Exploration - Site Specific Scale

Canadian Pacific Railway (1949): Limestone, Report on Limestone Deposit East of Exshaw; Alberta Research Council Economic Minerals File LST-IR-01, 4 pages.

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Macdonald, D.E. and Hamilton, W.N. (1979): Limestone Resources of the Grande Cache Area, Alberta; Alberta Research Council Open File Report 82-11, 32 pages, 5 appendixes, 5 plates, 14 figures, 1 table.

Macdonald, D.E. and Hamilton, W.N. (1981): Limestone Prospects in the vicinity of Crowsnest Pass: A Preliminary Assessment; Alberta Research Council Open File Report 1982-10, 45 pages, 2 appendixes, 5 plates, 3 figures, 1 map, 1 table.

Siebert, F.V.: Limestone, Report on Limestone Deposit at Mile 25 Mountain Park Subdivision, Canadian Pacific Railway; Alberta Research Council Economic Minerals File LST-IR-02, 5 pages.

B. SUPPORTING REFERENCES

1. Concepts and Principles

2. Indirect Exploration - Reconnaissance Scale

3. Indirect Exploration - Site Specific Scale

C. BACKGROUND AND MISCELLANEOUS REFERENCES

Alberta Research Council (1985): Scientists study liming potential of thermal plant byproduct; Research and Development at the Alberta Research Council, vol. 3, no. 2, March.

Macdonald, D.E. (1982): Marl resources of Alberta; Earth Sciences Report 82-1, 94 pages.