PLACER - company report

CROSS RIVER. M-10

003570

Property File 82J NW001

BAYMAG PROPERTY

1972

SUMMARY REPORT OF GEOLOGY

D.M. Jenkins

February, 1973

INTRODUCTION

G.B. Leech (1965) reported the occurrence of major quantities of magnesite in an area of Lat. 50 47'N. and Long. 115 40'W. This is near the confluence of Assiniboine Creek with Mitchell River in the East Kootenay area of British Columbia (see Figures 1,2 and 3 also Appendix A).

A claim staking rush ensued due to Leech's report. Baykal Minerals Limited eventually acquired control of 344 claims by a combination of claim staking and agreement with the New Jersey Zinc Exploration Co. (Canada) Ltd. (see Figure 4 and Appendix A). A subsequent agreement with Canadian Exploration Limited gave Canadian Exploration responsibility for exploration and development of this mineral prospect.

This report is a general summary of the proceedings and findings of Canadian Exploration's geological staff with regards to their study of the Baymag magnesite deposit. This study has been predominately field oriented with most of the emphasis being placed on obtaining diamond drill core samples of the magnesite. Geological mapping of a portion of the claim area and chip sampling of promising stratigraphic horizons were also carried out. Laboratory-type investigations of this mineral deposit were oriented either towards completing the mineral inventory for the deposit or towards solving a specific geological problem. Ongoing metallurgical investigations by Canadian Exploration's engineering staff are not herein reported in detail.

SUMMARY

Canadian Exploration Limited continued the magnesite exploration program initiated by Baykal Minerals Limited.

The magnesite occurs in the Cathedral Formation of Middle Cambrian age. It was originally deposited as the hydrous carbonate, hydromagnesite, in lagoons surrounded by supralittoral algal flats.

The deposit lies on the west dipping limb of a broad anitcline. The bed strikes north 30 degrees west and dips southwest at 20 to 40 degrees. Major faulting has not been recognized.

"BQ" size diamond drilling was continued on the Rok claims with a total of 7,287 feet cored. Geological reserves based on this drilling and earlier drilling are 10,413 x 10^3 tons with an average grade of 97.15 percent MgO at 96 percent MgO cut-off.

A bulk sample of this deposit was obtained using diamond drilling equipment which had six inch diameter coring capabilities. Six inch core drilling totaled 1,580 feet which yielded approximately 20 tons of sample.

"BQ" size drilling was also carried out on the VANO claims. This work was to test known magnesite outcrops and to fulfil assessment requirements. The footage drilled was 1,800 feet. High grade magnesite was not penetrated.

In preparation for taking ground to lease, a legal survey was carried out between Mitchell River and Assiniboine Creek. Twenty-three claims and fractions were surveyed into four lots.

GEOGRAPHY

Topography of the region is extremely rugged. Mature dissection of thick relatively undeformed sedimentary rock masses has produced erosion forms of the classic alpine type. Relief ranges from valley floors near 4,000 feet to "Matterhorn" peaks exceeding 8,000 ft. in elevation.

Modification of the fluvial erosion cycle by valley glaciation has produced "U"-shaped valleys with over-steepened walls. Rapid physical erosion of over-steepened valley walls has produced a drape of coarse talus over the junction of the lower valley wall and floor. Modification of glacial land forms and talus cover by fluvial processes is currently in progress.

Drainage of this region is accomplished by the deeply incised water courses of the upper Cross River, the Mitchell River, and Assiniboine Creek. Subsidiary drainage is by numerous small streams which fall from the castleated peaks in a series of cascades.

Exposures of rocks on valley floors are rare and occur only along active water courses. Exposures along lower valley walls are generally masked by talus, but outcrops of massive carbonates do exist. Above the talus cover (the 5,000 foot elevation and up), rock outcrops comprise in excess of 50 percent of the surface and increase gradually to total exposure above 7,000 feet in elevation.

Coniferous trees provide heavy cover on valley floors and on most talus slopes. Above the talus cover, vegetation becomes sparse in distribution being limited in the main by poor soil development. Local enclaves of deciduous bush and trees occur in areas of high soil moisture such as abandoned stream channels and the bases of avalanche scars.

PALEOGEOGRAPHY

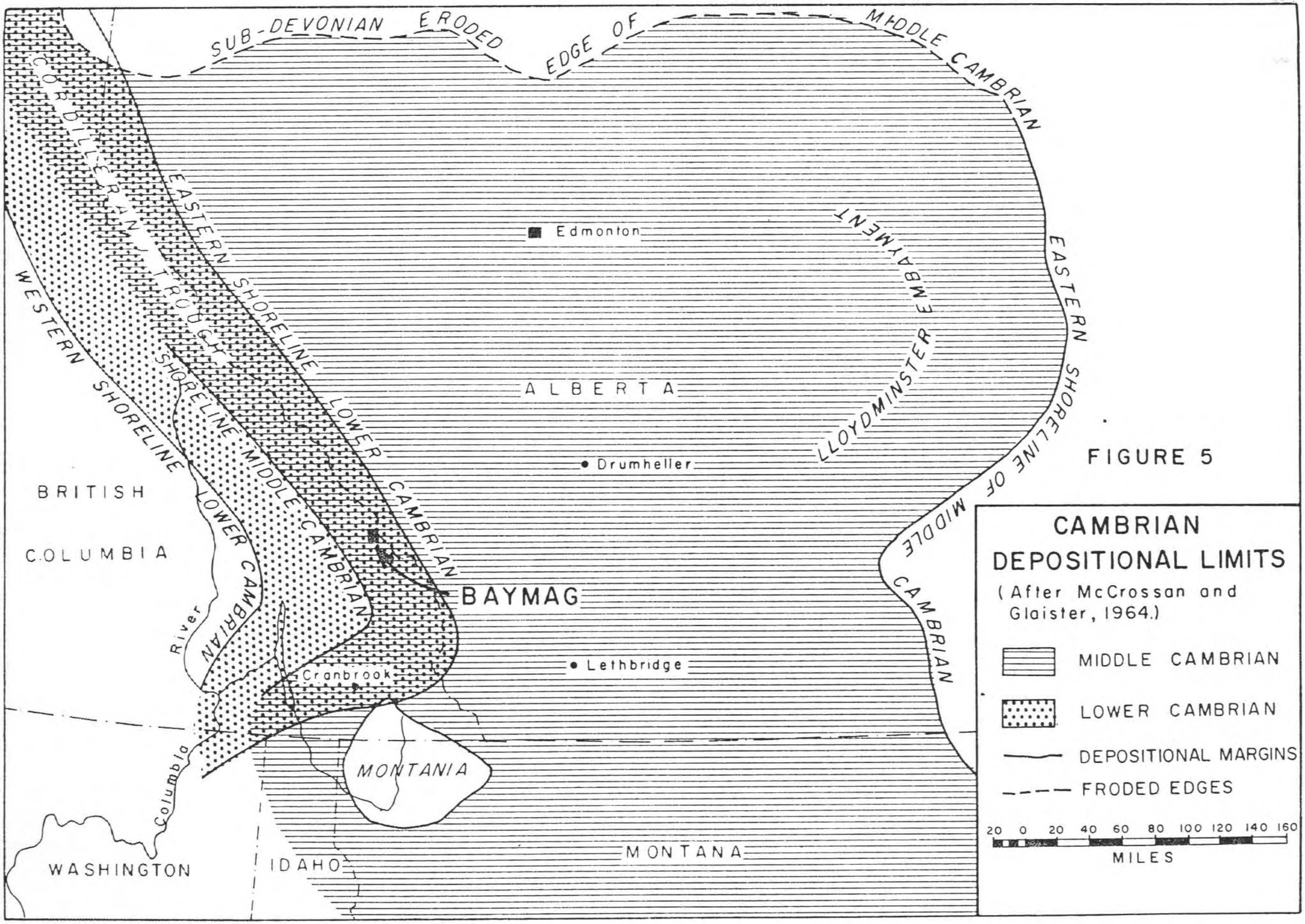
Lower Cambrian sedimentation in southeastern British Columbia and southern Alberta was restricted to the narrow Cordilleran Trough (Figure 5). This was a shallow north west trending marine seaway. It was bounded on both the east and the west by land masses of very low relief.

Gentle downwarping of the eastern land mass began during early Cambrian time and continued intermittently during the Paleozoic. During middle Cambrian time the Lloydminster Embayment came into being as a direct result of this downwarping.

The Lloydminster Embayment was a broad shallow feature. Sedimentation in the eastern half was dominated by clastic sediments derived from the Canadian Shield (Figure 6). A narrow band of similar clastic sediments was deposited adjacent to the western land mass and "Montania" the southern land mass. The central portions of the basin were dominated by a carbonate depositional regime.

The western edge of this carbonate province was a broad intertidal to supertidal algal carbonate platform. The Baymag magnesite occurs in rocks of this facies.

Between the western land mass and the algal carbonates, a shallow shale basin existed. Deposition here was controlled by tidal currents. Maximum water depth was probably never more than a few feet.


SUB-DEVONIAN ERODED EDGE OF MIDDLE CAMBRIAN
CORDILLERAN TROUGH
EASTERN SHORELINE LOWER CAMBRIAN
WESTERN SHORELINE LOWER CAMBRIAN
SHORELINE MIDDLE CAMBRIAN
Edmonton
LLOYDMINSTER EMBAYMENT
EASTERN SHORELINE OF MIDDLE CAMBRIAN
ALBERTA
Drumheller
BRITISH
COLUMBIA
BAYMAG
Columbia River
Cranbrook
Lethbridge
MONTANIA
MONTANA
IDAHO
WASHINGTON
FIGURE 5
CAMBRIAN DEPOSITIONAL LIMITS
(After McCrossan and Glaister, 1964.)
MIDDLE CAMBRIAN
LOWER CAMBRIAN
DEPOSITIONAL MARGINS
FRODED EDGES
20 0 20 40 60 80 100 120 140 160
MILES

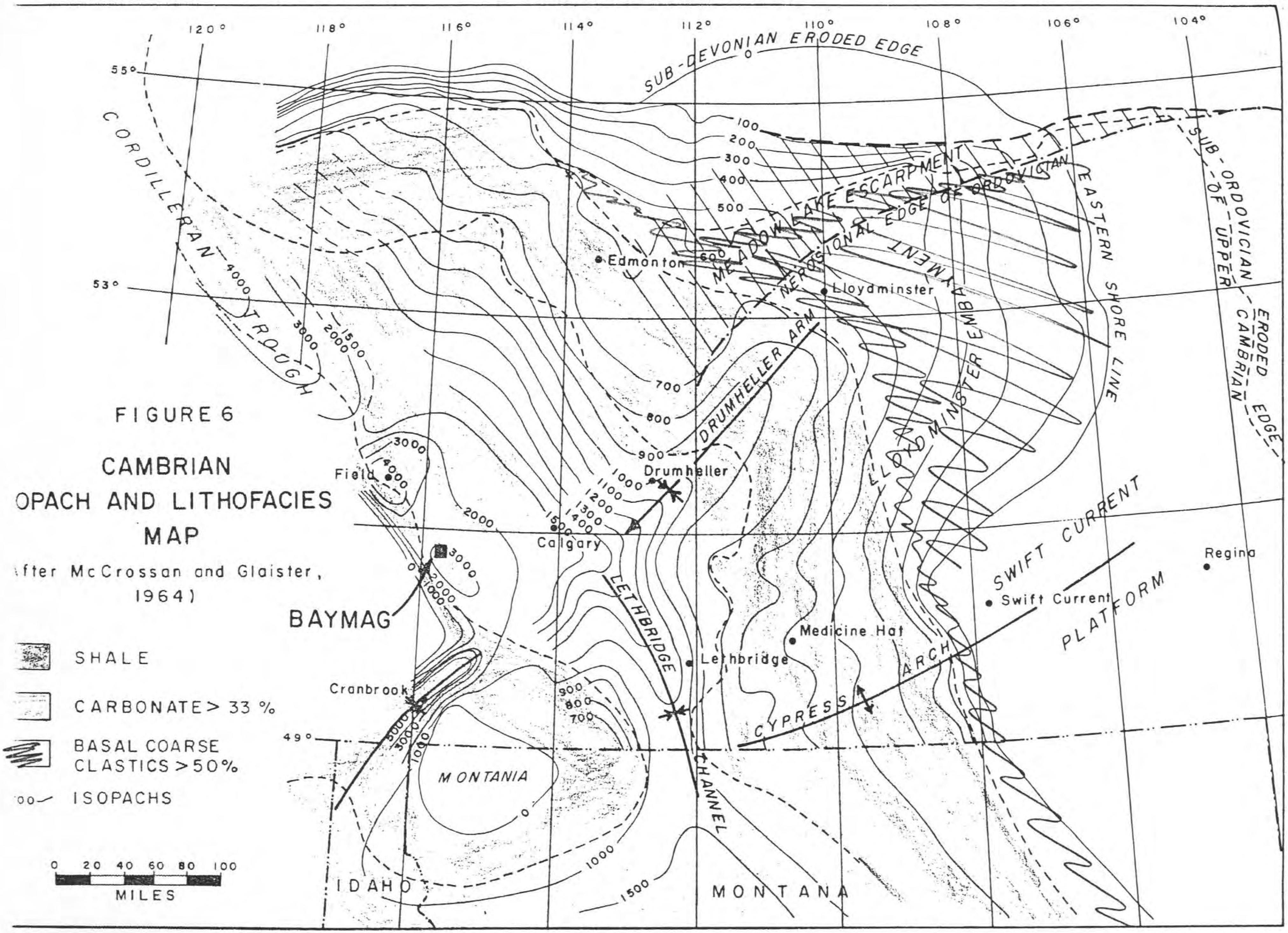


FIGURE 6
CAMBRIAN
OPACH AND LITHOFACIES
MAP
(After McCrossan and Glaister, 1964)
BAYMAG
SHALE
CARBONATE > 33 %
BASAL COARSE CLASTICS > 50%
ISOPACHS
0 20 40 60 80 100
MILES
SUB-DEVONIAN ERODED EDGE
CORDILLERAN TROUGH
MEADOW LAKE ESCARPMENT
NEPOSITIONAL EDGE OF ORDOVICIAN
EASTERN SHORE LINE
SUB-ORDOVICIAN ERODED EDGE OF UPPER CAMBRIAN
LLOYDMINSTER EMBAYMENT
DRUMHELLER ARM
LETHBRIDGE CHANNEL
SWIFT CURRENT PLATFORM
CYPRESS ARCH
MONTANIA
Edmonton
Lloydminster
Field
Drumheller
Calgary
Swift Current
Regina
Medicine Hat
Lethbridge
Cranbrook
IDAHO
MONTANA
120°
118°
116°
114°
112°
110°
108°
106°
104°
55°
53°
49°

STRATIGRAPHY

Rocks of Middle and Upper Cambrian age can in this area be stratigraphically and structurally subdivided into an eastern and a western facies (D.G. Cook, 1970). The facies boundary is sharp with transition taking place within one mile. Structural shortening further accentuates this striking facies differentiation.

The eastern facies is characterised by thick sections of massive carbonate rocks with minor interbeds of pelitic lithotypes. The western facies is the antithesis of the eastern facies. Western facies rocks are typically a monotonous sequence of pelitic lithotypes with minor calcareous and pelitic carbonate interbeds. Table 1, taken from D.G. Cook (1970), is a synthesis of regional stratigraphic data. Figure 7 (ibid.) demonstrates regional stratigraphic correlations.

Detailed geologic mapping on the Baymag property has been restricted to the ridge between Mitchell River and Assiniboine Creek. (Figure 8 and Appendix A). The remainder of the claim group has only been reconnoitered. Therefore the data given below in regards to the property is subject to some revision.

Eastern Facies

Eastern facies rocks exposed within this map area belong to the Gog Group, Mount Whyte Formation, Cathedral Formation, and the Stephen Formation.

Gog Group: The Gog Group is not totally exposed within the confines of the Baymag claim group. A minimum thickness of 500 feet of interbedded quartzose sandstones and shales are exposed in the valley of Assiniboine Creek.

Quartzose members of the group are multistory accumulations of sand to granule sized quartz grains with minor feldspar and ferromagnesian mineral contents. Grey sandstones which weather grey to red occur in beds from two to five feet thick. These beds comprise sandstone bodies with aggregate thicknesses between 20 and 200 feet. Trough and planar cross lamination are well exposed in outcrops of Gog Group sandstones. Infauna burrows reported from other outcrops were not observed at Baymag.

Pelitic sediments in the Gog Group occur as red silty shale lenses 10 to 30 feet thick and several hundred feet wide. Fissility is not evident in most exposures of these pellitic sediments and is at best only moderately well developed.

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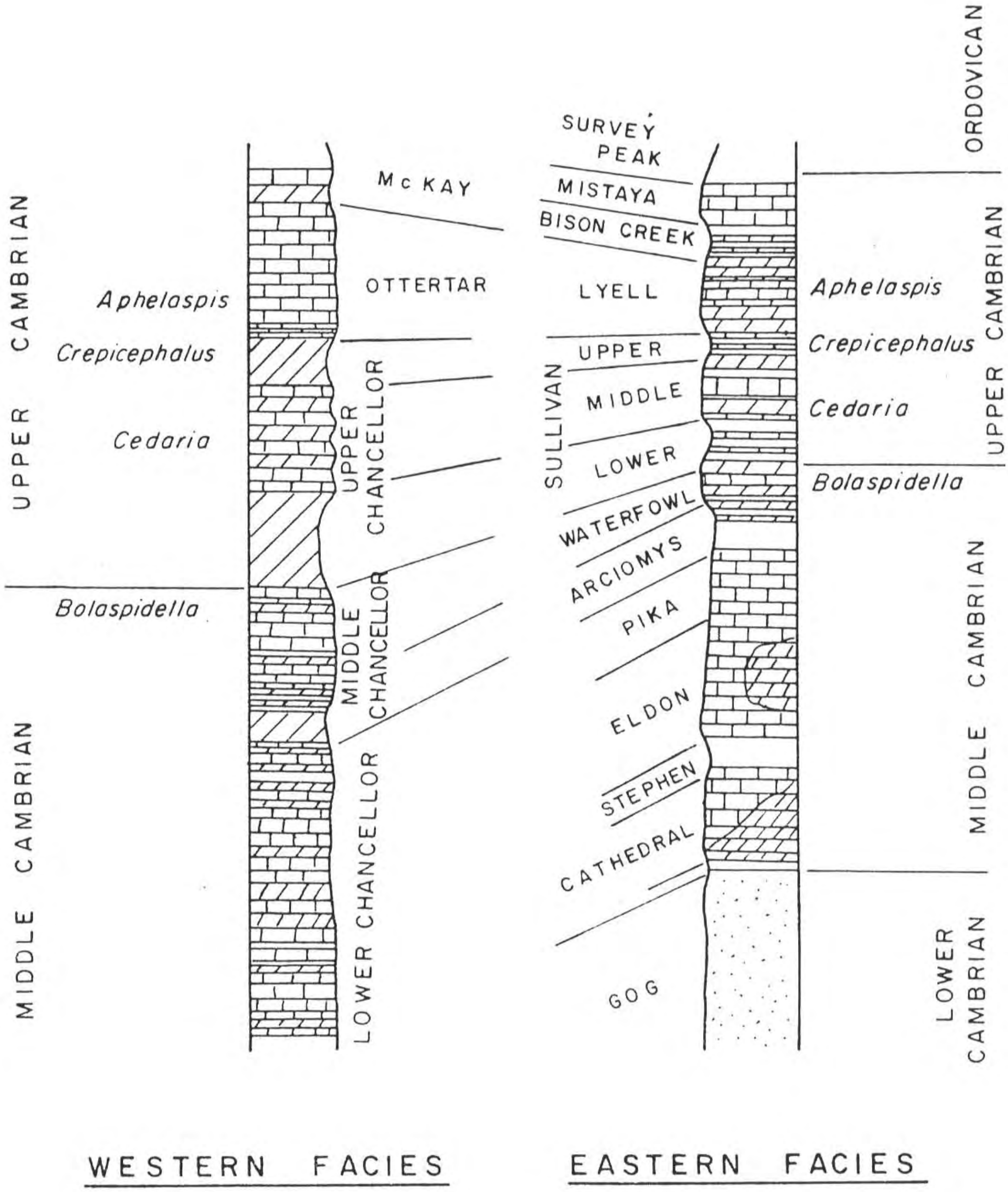
TABLE I: TABLE OF FORMATIONS

Age	Eastern Facies: Formation	Eastern Facies: Description	Western Facies: Formation	Western Facies: Description
LOWER ORDOVICIAN	SURVEY PEAK FM. (Aitken & Norford, 1967)	Top not exposed; 800 feet; pale green shales with silty beds at base, limestone nodules toward top.	McKAY GRP. (Evans, 1933; Aitken & Norford, 1967)	Top not exposed; few hundred feet of greenish grey, soft, calcareous slates; at least one thick-bedded limestone unit.
UPPER CAMBRIAN	MISTAYA FM. (Greggs, 1962; Aitken & Greggs, 1967)	500 feet; thin-bedded, grey weathering limestone with brown weathering, dolomite partings.		
UPPER CAMBRIAN	BISON CREEK FM. (Greggs, 1962; Aitken & Greggs, 1967)	400 feet; brown and grey shale with rusty weathering limestone interbeds.		
UPPER CAMBRIAN	LYELL FM. (Walcott, 1920; Aitken & Greggs, 1967)	1000 feet; thick-bedded limestone and dolomite.	OTTERTAIL FM. (Allan, 1911)	1,500-2,000 feet; thick-bedded limestone. Beds are laminated grey and brown. 350 feet shale and dolomite at base.
UPPER CAMBRIAN	SULLIVAN FM. (Walcott, 1920; Aitken & Greggs, 1967)	U: 300 feet; shale	CHANCELLOR FM (Allan, 1914): upper CHANCELLOR 3,300-4,500 feet	U: slate
		M: 700 feet; limestone and dolomite		M: interbedded slate and limestone
		L: 500 feet; shale with minor limestone, silty at base.		L: Slate with silty beds at base
MIDDLE CAMBRIAN	WATERFOWL FM. (Greggs, 1962; Aitken & Greggs, 1967)	500-700 feet; thick-bedded dolomite, some limestone.	middle CHANCELLOR	about 2,000 feet; southern part: slates and orange-weathering dolomite at base, overlain by cleaved argillaceous limestone. Northern part: alternating 50-100 foot units of thin-bedded grey limestone and rusty slate.
MIDDLE CAMBRIAN	ARCTOMYS FM. (Walcott, 1920; Aitken & Greggs, 1967)	200-500 feet; varicoloured, shale, siltstone, and dolomite. Purple beds near base.		
MIDDLE CAMBRIAN	PIKA FM. (Deiss, 1939)	800 feet; limestone and dolomite, largely flaggy limestone with shaly partings.	lower CHANCELLOR	about 3,500 feet; irregularly interbedded grey, argillaceous limestone, brown and greenish brown shale, and thin-bedded brown argillaceous dolomite.
MIDDLE CAMBRIAN	ELDON FM. (Walcott, 1908; Rasetti, 1951; Aitken & Greggs, 1967)	1,200-1,500 feet; massive dolomite and limestone.		
MIDDLE CAMBRIAN	STEPHEN FM. (Walcott, 1908; Rasetti, 1951; Aitken & Greggs, 1967)	90-350 feet; greenish, siliceous, argillaceous shales, and thin-bedded limestone.		
MIDDLE CAMBRIAN	CATHEDRAL FM. (Walcott, 1908)	800-1,900 feet; massive dolomite and limestone.		
MIDDLE CAMBRIAN	MOUNT WHYTE FM. (Walcott, 1908; Deiss, 1939; Rasetti, 1951)	0-600 feet; alternating greenish silty shales and dark grey limestone; some sandstone.		
LOWER CAMBRIAN	GOG GRP. (Deiss, 1940; Okulitch, 1956; Mountjoy, 1962)	2,000-3,000 feet; thick-bedded, clean quartz sandstone with some shale interbeds. Up to 20 feet rusty limestone at top (Peyto limestone member)	GOG GRP.	not exposed
PRE-CAMBRIAN	MIETTE GRP. (Walcott, 1913; Mountjoy, 1962)	grey and brown slate; some pebble conglomerate; minor limestone.	MIETTE GRP.	not exposed

Cook, 1970



CORRELATION CHART

From Cook (1970)

FIGURE 7

Mount Whyte Formation: Conformably overlying the Gog Group is the Mount Whyte Formation. This formation is well exposed only in the Assiniboine Creek drainage. In the Mitchell River valley, the Mount Whyte is covered by talus.

The sediments comprising this formation are approximately 175 feet thick. The lower most units are light grey weathering calcareous shales. They occur in thin bedded units and typically exhibit only poorly developed fissility. Outcrops with well developed fissility do exist. By gradual increase in the carbonate content, these shales become very fine grained argillacious limstones. Near the top of the section oolites comprise a significant portion of the rock. These oolites have few grain to grain contacts and are best described as floating in a matrix of pelitic carbonate mud. Bedding near the top of this section is intensely deformed in what have been interpreted as structures produced by soft sediment deformation.

Cathedral Formation: Rocks immediately overlying the Mount Whyte Formation are the massive dolomite and magnesite beds of the Cathedral Formation. The nature of the contact between the two formations is obscured first by the soft sediment deformation in the Upper Mount Whyte Formation, secondly by the total recrystalization of most Cathedral carbonates, and thirdly by the strikingly different responses of the two formations to tectonic events. Based on evidence presented by other workers in this Cambrian section, it is assumed that the contact is conformable.

The total thickness of the Cathedral formation at Baymag is not known with any degree of certainty but is estimated to be between 1,200 feet and 1,550 feet.

Megacrystalline dolomite and magnesite comprise in excess of 60 percent of the Cathedral Formation at this locality. The original sediment has been almost totally recrystallized so that the fundamental nature of the sediment has been obscured. The megacrystalline magnesian carbonates occur in two bed-like masses which are separated by 200 to 300 feet of thin bedded dolomites and limestones. Megacrystalline magnesian carbonates occur only along the western boundary of the carbonate facies (Aitken, 1966).

These megacrystalline carbonates are the magnesite hosts and will be discussed in more detail in another section of this report.

Lenses and irregular shaped masses of unrecrystallized dolomite and dolomitic limestone occur infrequently within the magnesite. These are thin to medium bedded, light grey, fine crystalline dolomite or

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limestone. Invariably close inspection of weathered surfaces reveals the presence of organic structures. These structures are of three types: algal laminates, stromataloidal, and stromatactoidal.

Algal laminates are characterized by thin discontinuous laminae of light coloured, micro-vuggy dolomite in a matrix of fine crystalline dolomitic limestone. These are usually found in close association with stromatolite fossils and rocks displaying stromatactoidal structures. Algal laminates are often draped over the convex upper surfaces of stromatolites.

The stromatactoidal structure occurs in thin beds where closely spaced irregular vuggy bands of fine crystalline dolomite meet the bedding planes at an angle of 30 to 60 degrees. Superficially this resembles planar cross lamination. The structure is obvious only on weathered surfaces and, in most cases, even close inspection fails to reveal the structure on fresh broken surfaces.

These lenses and masses of fine crystalline carbonates are relatively small in all dimensions. The lenses are relatively thin with maximum thicknesses of 5 to 20 feet, with most occurrences in the five to eight feet range. Widths range from a few feet to a few tens of feet for those beds that are totally exposed. In a few cases, the thicker beds which are not completely exposed can be traced in outcrop for 200-300 feet. These may be wedge-shaped interbeds with surrounding carbonate facies.

The lower surfaces of these sedimentary masses are usually planar or nearly planar. Where in contact with megacrystalline carbonates, the upper surfaces are not usually distinct, the transformation between lithotypes being gradational in both chemical and textured aspects. The lateral contacts are similar to the upper contacts in the respect that they are gradational; however, distinct interbeds of megacrystalline carbonates are occasionally observed. Bedding surfaces within the fine crystalline carbonates are frequently marked by a double layer of subhedral to euhedral megacrystalline magnesian carbonate grains.

Between the two megacrystalline magnesian carbonate beds and overlying the upper megacrystalline bed are strata of fine crystalline carbonates. These recessive weathering strata are in each case 200 to 300 feet thick.

These strata are thin to medium bedded fine crystalline dolomites and dolomitic limestones. Many of thes carbonates are argillaceous. Relic fossils or organic structures identical to those reported in

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the preceding paragraphs are the most common features to be observed in these rocks.

Stromatolite bioherms 20 feet across and 10 feet thick occur in several outcrops. These are the most striking of the fossils, but are volumetrically relatively unimportant when compared with the algal laminates.

Algal laminates in a matrix of very finely crystalline carbonates comprise the bulk of these strata. The percentage of algal laminate varies from bed to bed. Some beds contain as much as 50 percent visible algal laminae while other beds are virtually devoid of visible algal material.

Local accumulations of flat pebble calcirudite occur in several localities. The clasts are of two types, one being algal laminate flakes and the other carbonate mud flakes. The origin of the algal laminate flakes is obviously the erosion of algal laminate beds near the site of calcirudite deposition. The carbonate mud flakes show little in the way of internal lamination or other structures. These flakes are in some cases greater than 25 cm. in diameter and less than 3 cm. thick. Flakes of this type would rapidly break down during transportation. Their shape, therefore, precludes a remote provenance. These flakes could be algal laminate but if this were the case, at least some of the flakes should show distinct algal laminate structure. As these do not, another origin must be considered. Indistinct polygons were observed on bedding planes at a few localities. These polygons could be either syneresis cracks or dessications cracks. The second origin is favoured by this writer. Such dessication features could easily be the origin of the flat non-laminated clasts found in certain flat pebble calcirudites.

The last important lithotype in the Cathedral Formation at Baymag is the oolite. Oolites are found as minor constituents in many of the fine crystalline beds. In a number of places, oolites were observed to be spread over bedding planes in layers one or two ooliths thick. In certain of these instances, soft sediment deformation was observed only because of the bedding plane trace of oolites. Near the northeastern boundary of the Baymay property, beds of oolite become quantitatively important in the zone between the megacrystalline strata. The oolites ranging in size up to about 6 cm. occur in moderately sorted beds several feet thick. The total thickness of oolite beds is not known but is probably less than 25 feet. These distinctive beds are not exposed either along strike or to the dip. Distribution is therefore assumed to be local.

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Stephen Formation: This is the stratigraphically highest unit that was studied at Baymag. The contact with the underlying Cathedral Formation is gradational. The Cathedral Formation fine crystalline carbonates become thin bedded and argillaceous near the top. Pelitic partings between carbonate laminae become common. Within a few stratigraphic feet of the lowest pelitic parting, there is an abrupt change from dominately carbonate to exclusively pelite deposition. The lower-most shales are maroon to red in colour and are followed stratigraphically by fissile green shales.

No attempt was made to study this formation in detail as it was stratigraphically distant from the important magnesite strata. The distinctive lower shale did serve as a mapping marker horizon during this study.

Western Facies

Chancellor Formation: A single formation belonging to the western facies outcrops in the vicinity of the Baymag property. This is the Chancellor Formation. Only the lower Chancellor outcrops in the area. It contains beds correlative with eastern facies formations previously discussed. Lower Chancellor Formation thickness near Baymag was not determined, but Cook (1970) estimated its thickness to be 3,500 feet in the Mount Stephen-Mount Dennis area. Cook (1970) states "Strata of the Chancellor Formation appear to be at least twice as thick as their correlatives in the eastern facies. Much of this thickening is probably a result of penetrative plastic deformation resulting from horizontal compression". The same is probably true at Baymag.

Chancellor Formation strata are predominately dark grey to black shales. Thin to medium thick beds of black argillaceous dolomite and black dolomitic limestones outcrop at several localities along Mitchell River. At one locality black shales and thin bedded, black, argillaceous stromatactoid dolomites and similar limestones are intimately interbedded through a stratigraphic thickness of several hundred feet. Along strike these lithotypes intergrade one with the other.

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REGIONAL STRUCTURE

Structural features in the vicinity of the Baymag property can be divided into two suites of structures. Each suite is related to the contrasting deformation styles of the two sedimentary facies in response to horizontal compression. In both facies, most structures trend between north 20 degrees and 30 degrees west.

Massive carbonate rocks of the eastern facies lie in broad, northwest trending, concentric folds. These have wave lengths measured in miles but relatively small amplitudes. Neither thrust faults nor transverse faults of large displacement have been definitely identified in rocks of the eastern facies. A zone of complex structure in Cross River valley, south of the Baymag claim group is believed to be associated with a west dipping thrust fault. This fault has not been traced onto the Baymag property.

Horizontal compression of the western facies pelites against the buttress-like eastern facies carbonates has resulted in a narrow zone of intense deformation. This deformation is confined to western facies rocks adjacent to the facies boundary. These rocks have undergone extreme plastic deformation. Stratigraphic thicknesses have apparently been increased by a factor of two and perhaps even more.

Fold style is demonstrably disharmonic. Attitudes of axial planes range from vertical through recumbent, with most being overturned to the east. Trends of axial traces are variable but average between north 20 degrees and 30 degrees west.

Low angle faults of the thrust-type can be identified in cliff faces along Mitchell and Cross rivers. These faults are west dipping, and they cross bedding planes at low angles. Most are known from a single locality. Continuity of faults between outcrops cannot be demonstrated. It is expected that some of these low angle faults cross the east-west facies boundary in shale tongues. This has not been recognized in the field.

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DETAILS OF THE DEPOSIT

Onerous topography precludes mine development at Baymag except in two areas; along the Cross River upstream from its confluence with the Mitchell River and between Mitchell River and Assiniboine Creek.

Along the Cross River suitable grade magnesite has not been found. Therefore, this area is no longer considered promising for mine development.

Between Assiniboine Creek and the Mitchell River, two megacrystalline carbonate beds outcrop. The lower of these two megacrystalline beds has the greatest potential for economically viable development at Baymag. Hence, virtually all study and consideration has been applied to this unit. The following discussion deals specifically with the lower megacrystalline unit; however, the mineralogical information which follows is generally true for the upper megacrystalline bed also.

Geometry

The actual geometry of the lower megacrystalline unit has not been defined due to lack of exposure and incomplete penetration of the unit by diamond drilling. Interpretation of exposures in the Assiniboine Creek drainage indicates a wedge shaped geometry with the thin edge of the wedge to the east of the drill pattern. Calculations based on the thickness of magnesite penetrated by diamond drill hole C-22 and dips taken on limestone beds within the drill pattern indicate a maximum magnesite thickness in excess of 400 feet. Magnesite is not exposed west of the drill pattern. Exposures along Mitchell River, one quarter mile west of the drill pattern, are thin bedded shales and carbonates of the Chancellor Formation. Exact stratigraphic equivalence of the Mitchell River exposures and the magnesite can not be demonstrated. Therefore, the geometry of the western edge of the magnesite is undefined.

Along the strike of the lower megacrystalline carbonate bed, the only exposures of the unit are on Mount Brussilof approximately three-quarters of a mile to the south. Here at the same stratigraphic interval, several lenses of magnesite occur in a thicker section of megacrystalline dolomite. These lenses have maximum exposed thicknesses of 20 to 70 feet. Due to the cliff forming nature of the rock, it is not practical to "walk out" exposures of magnesite. However, interpretation of observations made at intervals along strike indicates that the thicker lenses have a north-south lateral extent of 1,000 to 3,000 feet.

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The above observations compare well with observations made by Aitken (1966). He states "Megacrystalline dolomite is invariably white. It occurs in lensoid masses 3 to 70 feet thick, and rarely more than ten times broader than thick, and consists of crystals ranging up to 5 centimeters and more on the edge."

Deductions based on the above observations would give the Baymag deposit a lens like cross-section with a maximum thickness of approximately 400 feet and lateral extent of one to two miles on the north-south axis and less than one mile on the east-west axis.

Mineralogy

The following paragraphs describe minerals which have been identified at Baymag and their occurrences. Table II is a summary of this data.

Magnesite: Quantitatively, magnesite is the most important mineral in the Baymag deposit. Within each lens, it occurs in discrete masses of irregular shape separated by pyrite rich bands. The shape and grain size of these masses is dependent upon physical conditions at the time of recrystalization.

Grain size varies from mass to mass. It is, in fact, the most easily discernable megascopic difference between two adjacent magnesite masses. Range in grain size is from approximately 1 mm. to 3 cm. Close inspection and staining frequently disclose differences in intergranular dolomite content between masses. Presumably other minerals will also show strong quantitative variations across these boundaries.

Magnesite in all of the masses exhibits granoblastic texture composed of sub-equigranular but unequidimensional crystals. Grain size of magnesite crystals within any one mass shows a narrow to moderately wide distribution about the median for that mass. Median grain sizes range from approximately 1 mm. to 2.5 cm. A statistical analysis of grain size distribution has not been undertaken; however, the most commonly reported grain size lies in the range 0.5 cm. to 1.0 cm.

Microprobe analyses of Baymag magnesite crystals have proven this magnesite to have a narrow compositional range. This compositional variation has a mean of 97.63 percent MgO and a standard deviation

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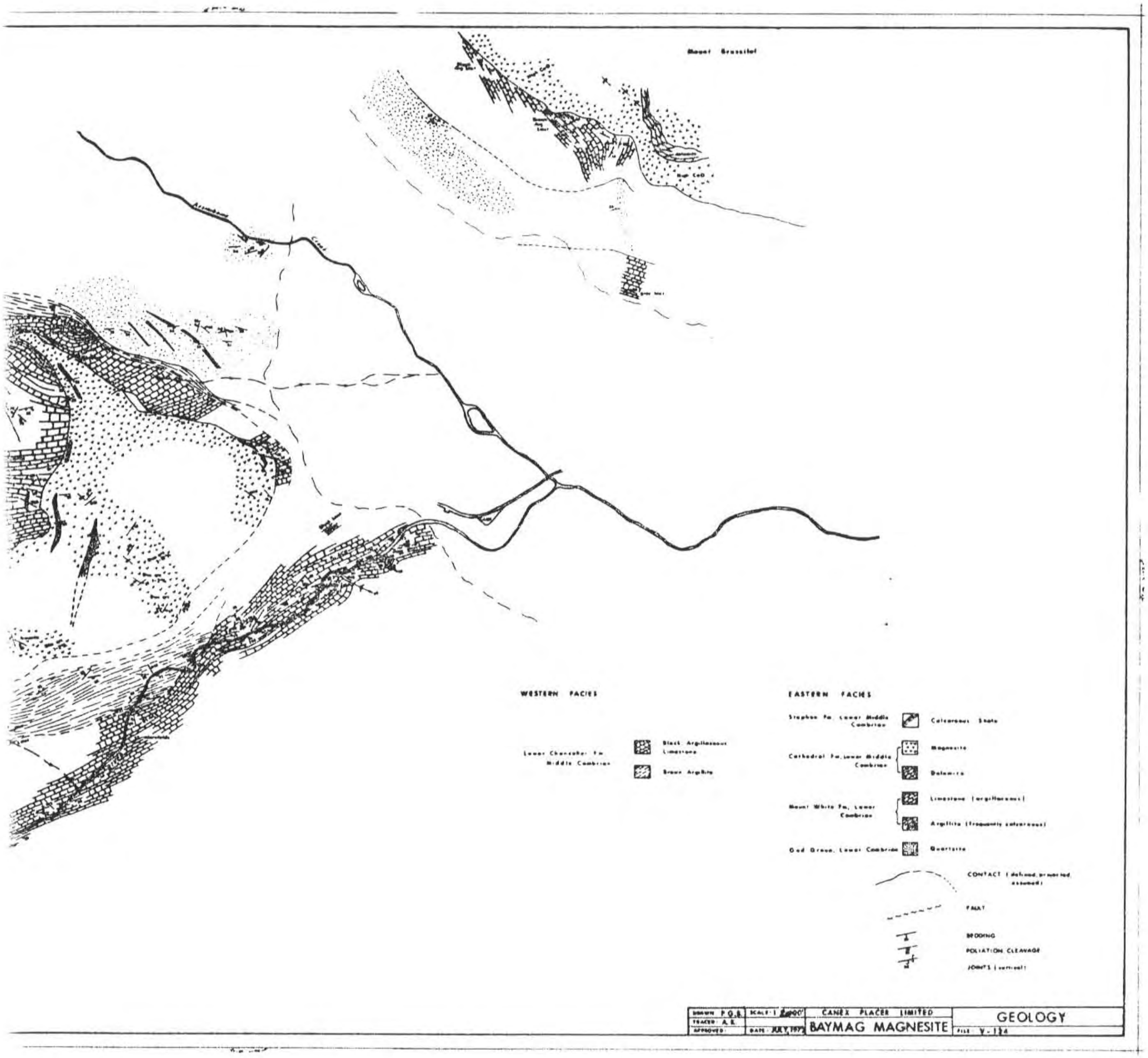
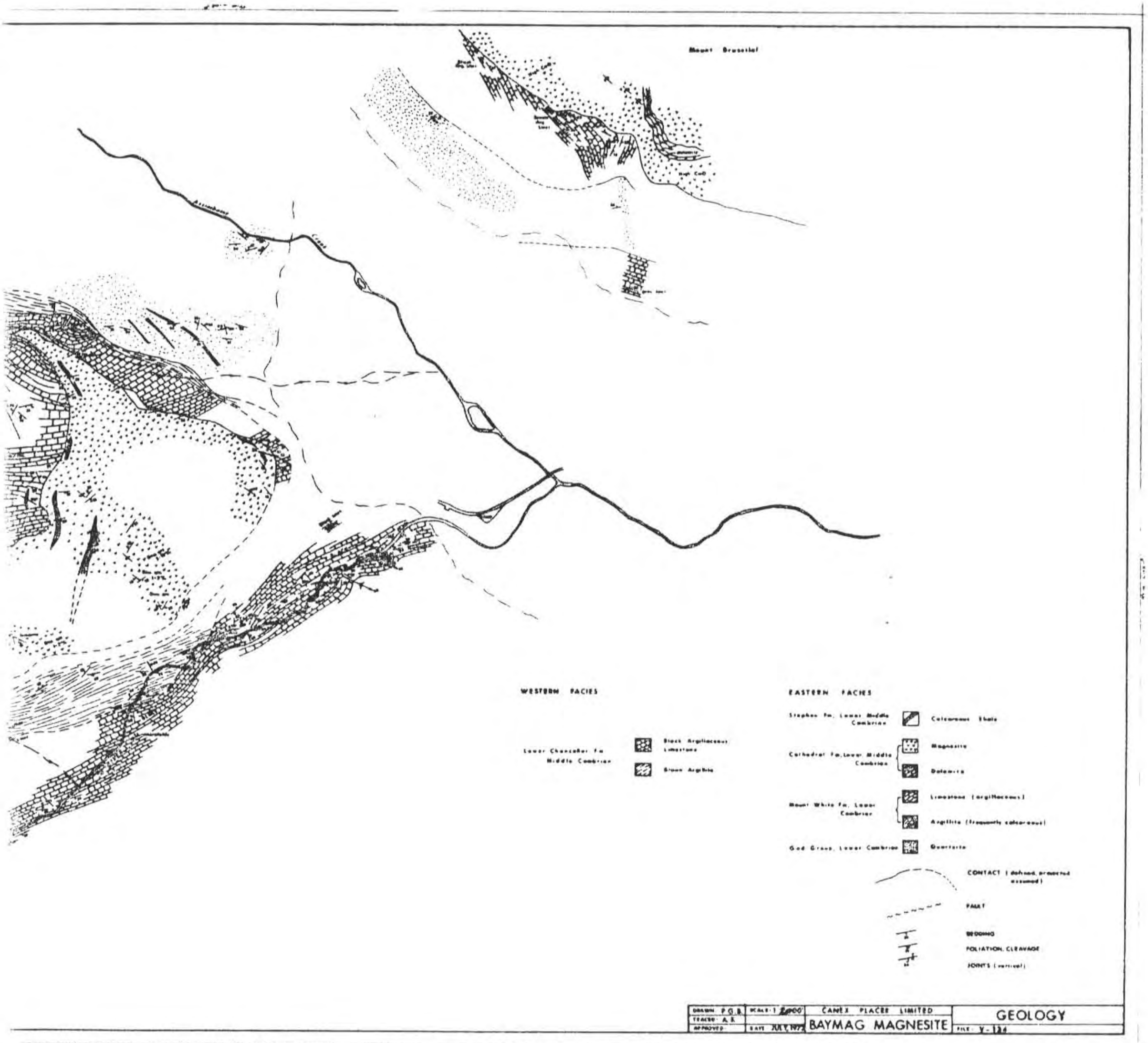

Mount Brussilof
WESTERN FACIES
Lower Chancellor Fm Middle Cambrian
Black Argillaceous Limestone
Brown Argillite
EASTERN FACIES
Stephen Fm, Lower Middle Cambrian
Calcareous Shale
Cathedral Fm, Lower Middle Cambrian
Magnesite
Dolomite
Mount Whyte Fm, Lower Cambrian
Limestone (argillaceous)
Argillite (frequently calcareous)
Gog Group, Lower Cambrian
Quartzite
CONTACT (defined, projected, assumed)
FAULT
BEDDING
FOLIATION CLEAVAGE
JOINTS (vertical)
DRAWN P.O.B.
TRACED A.E.
APPROVED:
DATE JULY 1972
CANEX PLACER LIMITED
BAYMAG MAGNESITE
GEOLOGY
FILE V-124



Mount Brussilof
WESTERN FACIES
Lower Chancellor Fm. Middle Cambrian
Black Argillaceous Limestone
Brown Argillite
EASTERN FACIES
Stephen Fm. Lower Middle Cambrian
Calcareous Shale
Cathedral Fm. Lower Middle Cambrian
Magnesite
Dolomite
Mount Whyte Fm. Lower Cambrian
Limestone (argillaceous)
Argillite (frequently calcareous)
Gog Group, Lower Cambrian
Quartzite
CONTACT (defined, projected assumed)
FAULT
BEDDING
FOLIATION, CLEAVAGE
JOINTS (vertical)
DRAWN P.G.B.
TRACED A.S.
APPROVED
SCALE 1" = 2000'
DATE JULY, 1972
CANEX PLACER LIMITED
BAYMAG MAGNESITE
GEOLOGY
FILE Y-134

of 0.8 percent MgO. Calcium and iron are the major contaminants. Both substitute for magnesium in the crystal lattice. Calcium has a mean microprobe assay value of 0.63 percent CaO. Iron has a mean value of 0.35 percent Fe_2O_3. Manganese in trace amounts was detected in three crystals.

Dolomite: This is quantitatively the second most important mineral in the deposit. It occurs in the deposit as follows:

a) One to five micron sized inclusions within the magnesite crystals;
b) anhedral grains disseminated in a magnesite matrix and similar in size to adjacent magnesite crystals;
c) in very narrow veins (less than 1 cm.);
d) as crystals in vugs and other solution cavities.

The most important occurrences are "a" and "b" above. Micron sized inclusions are disseminated throughout most of the magnesite crystals. Petrographically, they appear as fine dust within the magnesite crystals. Rarely large inclusions occur which exhibit exsolution textures. Megascopically these dolomite inclusions tend to give the magnesite a bright white colour and reduce the translucence of the magnesite grains.

Perhaps the most important occurrence of dolomite within this deposit is as crystals similar in size to the magnesite and disseminated through the magnesite matrix. Variations in calcium oxide assays are most often related to this type of dolomite occurrence.

Calcite: This carbonate has been found only in fractures where it is related to surficial weathering and in solution cavities as anhedral and rarely euhedral crystals. Quantitatively this mineral is a relatively unimportant source of calcium.

Ankerite: This mineral has not been positively identified. A tan carbonate which does not react vigorously with cold 10 percent HCl occurs in very thin veins and in zones of vuggy solution cavities along fractures. Iron oxide stains commonly accompany the second type of occurrence listed above. This mineral occurs so rarely that it could be classified as an exotic mineral.

Huntite: This mineral has not been positively identified. The name has been applied to a white, very fine grained "paste-like" deposit on vertical fractures and in vuggy solution cavities along fractures. This mineral reacted vigorously with cold dilute (10 percent) HCl. While this is not a rare mineral, it comprises far less than one

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percent of the deposit.

Pyrite: This is by far the most common sulphide mineral in the Baymag deposit. It comprises approximately one percent of deposit but locally may provide up to 20 percent of the volume. It is thought to be the most important source of the iron reported in assays. Pyrite is ubiquitous as disseminated, fine grained, euhedral crystals. Most of these crystals have diameters in the range of 1 mm to 3 mm, but the maximum reported diameter is 2.5 cm.

Massive pyrite occurs most commonly as bands on the boundaries of magnesite bodies and rarely as small clots within the magnesite bodies. These bands are known only from diamond drill hole intersections. Contorted "layering" within the bands and the irregularity of their margins preclude accurate determinations of band widths. The bands are thought to vary in width from approximately 2.5 cm. to a meter.

Veins with pyrite were emplaced late in the history of the deposit. In general the veins are less than 2.5 cm. wide and the pyrite is present as a coating on the vein walls. The central portion of the vein is filled with dolomite or rarely calcite. Work sufficient to determine the preferred orientations of the veins has not been carried out.

Pentlandite/Siegenite: One grain of this nickel and cobalt bearing sulphide was identified during microprobe analysis of selected magnesite grains.

Boulangerite/Geocronite: Occurrences of this mineral are very rare in the Baymag magnesite. The principle occurrence is in veinlets which are less than 1 mm wide. Small clusters of needle like boulangerite/geocronite crystals at the interstices of magnestie grains have been observed in diamond drill core from several drill holes. A single example of acicular crystals has been observed in recent solution cavities.

Quartz: This is the most abundant megascopic silicate mineral in the Baymag magnesite deposit. The principle occurrences are as follows:

a) discrete fine grains with irregular boundaries,
b) as isolated grains within massive pyrite bands,

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c) as very fine veinlets of quartz with muscovite,
d) anhedral grains disseminated in magnesite and similar in size to the magnesite grains,
e) clusters of terminated crystals associated with solution cavities.

Occurrence types "a", "b", and "c" are found throughout the area which has been drilled off; however, quartz is only rarely encountered within the drill pattern.

Occurrence types "d" and "e" are important in the vicinity of diamond drill hole D24 and in particular in the area northeast of hole D 24. Locally quartz comprises 20 percent of the rock northeast of drill hole D 24.

Muscovite: The most obvious occurrences of muscovite are in the rare 0.5 cm. wide quartz/muscovite veinlets. Gordin P.E. White has reported muscovite also occurs as felted interstitial masses. White believes that most of the silica and alumina reported in assays are related to fine grained muscovite and leuchtenbergite and this writer concurs.

Leuchtenbergite: (a chlorite mineral species): Comments given under the muscovite heading are equally appropriate for leuchtenbergite with one exception. Veinlets of leuchtenbergite and quartz have not been recognized.

Phlogopite: Clots of massive lavender coloured phlogopite 0.1 m - 0.3 m in diameter have been observed at two localities near the base of the magnesite.

Talc: This silicate is a relatively common but sparsely distributed mineral in the upper stratigraphic levels of the Baymag magnesite lens. Within the drill pattern light green coloured, coarse, anhedral crystals comprise the only known type of occurrence. Locally near drill hole D 42, these crystals are present in quantities which approach 0.5 percent of the rock. Northeast of the drill pattern approximately 3,000 feet, lenses of talcose minerals occur. These have maximum widths measured in a few tens of feet and thicknesses of approximately a foot. Talc is thought to have formed during magnesite recrystalization due to the reaction of carbonated pore fluids with non-aluminous silicates.

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Limonite: This is the most commonly occurring secondary mineral in the deposit. Most occurrences are light stains along fractures which are open to the surface. Infrequently similar stains are seen in solution cavities. Thick incrustations are at times encountered where these water courses encounter pyrite mineralization. Pyrite which is within 20 feet of the surface or adjacent to fractures in the magnesite is always at least partially altered to limonite and is frequently totally altered. Interesting examples of limonite pseudomorphs after pyrite are common in outcrop.

Palygorskite: Films of a white, tough, fiberous mineral occur on recent fractures throughout the magnesite. While these deposits occur only infrequently, occasional mats 10 mm thick have been observed. These mats probably would not grind well, therefore they could accumulate in the grinding circuit. The presence of this mineral should be considered during the designing of the grinding circuit.

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$Mg_3(OH)_2Si_4O_{10}$	Disseminated (C-R) Bedded (R)	
HYDRATED OXIDES		
Limonite $FeO(OH)_nH_2O$		Stains (VC), alteration of pyrite (VC)
CLAY MINERALS		
Palygorskite $(OH_2)_4(OH)_2Mg_5Si_8O_{20}\cdot 4H_2O$		Fracture coating (R-C)
"Mixed" clays		Fracture coating transported from the surface (C)

*Present at completion of magnesite crystalization
** Emplaced following magnesite crystalization
(VC) Very common (R) Rare
(C) Common (VR) Very rare

STRUCTURE OF THE DEPOSIT

Geological structure underlying the area which has been drilled has not been closely defined. The massive magnesite outcrop gives no indication of bedding attitude. Outcrops of associated beds from which attitudes can be taken, occur only in a small area at the south end of the magnesite outcrop (Figure 8 and Appendix A). Complete penetration of the magnesite by drilling has been affected only near the southern edge of the drill pattern.

The magnesite appears to strike approximately north 30 degrees west and dips to the southwest at 20 to 40 degrees.

Major joints occur at intervals of several feet. The best developed is a set of extension joints with a strike of north 60 degrees east and vertical dip. A second set of joints is nearly as well developed. These have an average strike of north 30 degrees west. Their dip is vertical. These are thought to be release joints which are parallel to major fold areas of the region. A third set of joints does exist but is relatively unimportant when compared with the previously listed sets. These are sheeting joints oriented at approximately north 40 degrees west with 35 degree dip to the southwest.

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SAMPLING OF THE DEPOSIT

Sampling of the deposit was accomplished with "BQ" size diamond drill core and with six inch size diamond drill core. The diamond drilling program was designed to measure magnesite outlined by previous drilling, to provide a selected bulk sample with six inch core, and provide assessment work for the VANO claims.

A total of 7,287 feet of BQ sized core was drilled in the area of the 1970 and 1971 drill program. Drill logs and assay data for this drilling are given in Appendix B. Drillhole locations are shown on Figure 9. Computer calculated geological reserves based in part on this data are given in Table III. Manually drawn assay sections comprise Appendix C.

Assessment work on the VANO claims consisted of 1,800 feet of "BQ" diamond drilling. Direct drilling costs were $5.00 per foot. These holes were spotted to intersect beds of megacrystalline carbonate. Important mineralization was not penetrated. Diamond drill hole locations are given in Figure 10. Drill logs and assay are given in Appendix D.

A bulk sample was obtained with diamond coring equipment designed to give six inch diameter core. A total of 1,580 feet of hole was drilled. This gave approximately 20 tons of sample for metallurgical and market testing. Assaying of this core has not been completed.

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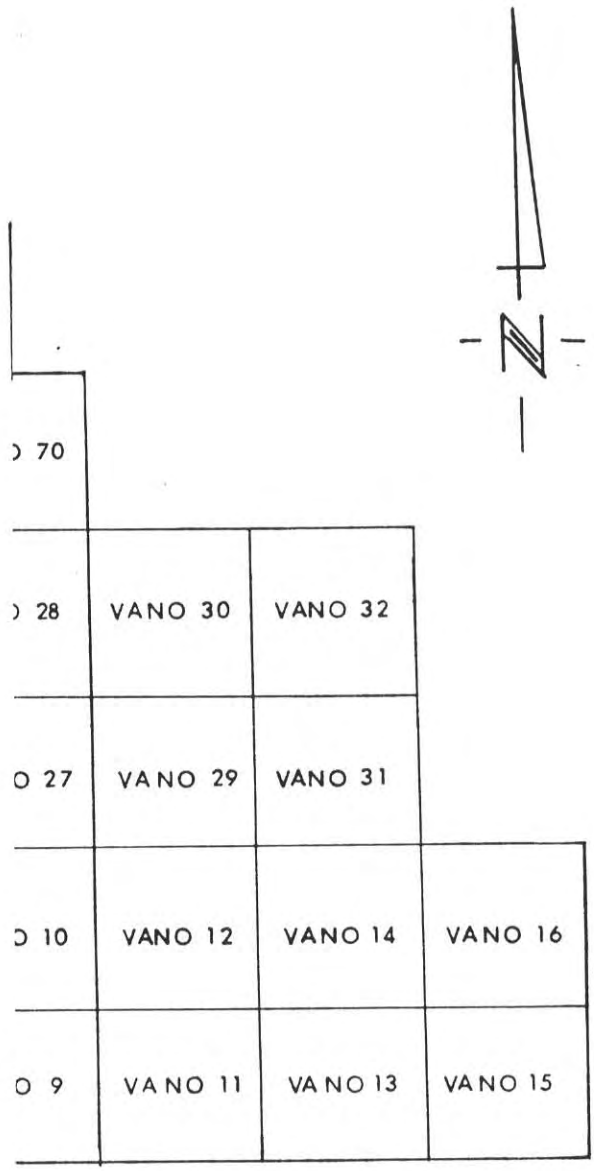

Figure 10.

Location of Baymag
V Series
Diamond Drill Holes

SURVEYING

A topographic base, at 1,000 scale, for the Mitchell River valley near Baymag was produced by Lockwood Survey Corporation Ltd. (Figure 3).

A stadia survey of diamond drill holes was completed. Sufficient surveyed points for good topographic control within the drill pattern and immediate areas were obtained at the same time. These data were plotted on a 40 scale base (Figure 9).

A legal survey of 23 claims and fractions covering the drill pattern and contiguous areas was completed. Four consecutively numbered lots, 3761-3764, were surveyed and boundaries marked. Table IV records the claims assigned to each lot.

TABLE IV

Table of surveyed lots and included claims.

Lot Number	Claims included in Lot	
Lot 3761	ROK 19 ROK 20 ROK 21 ROK 22	
Lot 3762	ROK 17 ROK 15	
Lot 3763	MAG 13 MAG 14 MAG 27 MAG 29	
Lot 3764	MAG 35 MAG 36 JOE 30 JOE 32 JOE 33 JOE 34 JOE 35	JOE 36 JOE 37 JOE 38 JAN 1 Fraction JAN 2 Fraction JAN 3 Fraction

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GENETIC HYPOTHESIS

Megacrystalline magnesian carbonates occurring in the Middle Cambrian deposits of the Lloydminster Embayment do not preserve sedimentary structures or other sedimentary features yielding evidence concerning their genesis. It is therefore necessary to use associated sediments and sedimentary structures to determine the environment of deposition. This information coupled with deductions from mineralogical data and data concerning the geometry of the deposit should allow an adequate definition of the deposits genesis.

Sediments stratigraphically enclosing the megacrystalline carbonates are in almost all cases dolomitic limestones with fossil algae or stromatolites. Sedimentary structures within these rocks are small ripple marks, dessication cracks, and embricated flat pebble conglomerate. Both sedimentary lithotypes and sedimentary structures are shoal water to supratidal assemblages.

These rocks are believed to have been deposited on a carbonate bank. The top of this bank being exposed at low tide, and large portions of it being submerged only during spring tides.

Dolomitization of these beds is irregular. Certain beds are totally dolomitized while others are only mottled with dolomite. The dolomite in these beds is consistently fine grained and contacts with unreplaced rocks are generally gradational.

The megacrystalline carbonates are spatially distributed along the western edge of the bank facies. This fact coupled with the sharp contacts between algal limestones and megacrystalline carbonates and the fine crystalline texture of algal carbonates indicate the megacrystalline carbonates originated in a unique sedimentary environment.

The textural differences between these carbonates indicates that the primary carbonate minerals deposited in the two types of beds were different. The coarse textures developed in the megacrystalline lithotypes points to a metastable primary carbonate.

The work of Alderman (1959) and Alderman and van der Borch (1960, 1961, 1963) in Australia has resulted in an understanding of magnesian carbonate sedimentation. They found mixtures of magnesite with dolomite and aragonite with hydromagnesite ($Mg_4 (OH)_2(CO_3)_3 3H_2O$) being deposited in the shallow hypersaline lagoons of South Australia. Physical parameters of the environment are temperature which range up to 30 degrees C,

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and higher, pH greater than 9 and salinities up to and exceeding 14 percent. Mixtures of hydromagnesite and aragonite are deposited from water which is unique in that it has been altered to an unusually high carbonate-bicarbonate content by perculation through porous carbonate sediments.

The genesis of the Baymag magnesite deposit is intimately related to the initiation of carbonate shoals during late Early Cambrian time. These shoals were produced by winnowing of fine clastics from coarse carbonate debris at depths above wave base and in areas distal from clastic sediment input sites (Figure 11). These carbonate shoals formed barriers which were subsequently occupied by algae. The algae tended to stabilize the barriers.

With the barrier thus established, basinal deposition in the vicinity of the barrier was divided into three regimes:

1. An eastern regime dominated by coarse-grained carbonates including oolites;
2. a western regime characterized by fine-grained clastic detritus;
3. a central area of tidal and supratidal carbonate flats dominated by algal derived carbonate and hydrous chemical precipitates concentrated in hypersaline lagoons.

Figure 12 demonstrates the author's conception of the spatial distribution of facies.

The Sediment

Hydrated carbonates within the lagoons would be magnesium carbonate rich. Contamination, in terms of lowering the magnesium carbonate content, would be by calcium carbonate contribution from the lagoon edges and occasional incursions of water with higher calcium content. In either case, alteration during diagenesis by magnesium rich pore fluids would push the bulk composition of the deposit towards the magnesium end point. Grade of the individual magnesite lenses would be dependent upon the balance between calcium input into the system and the ability of the pore fluid to exchange magnesium for calcium in the sediments.

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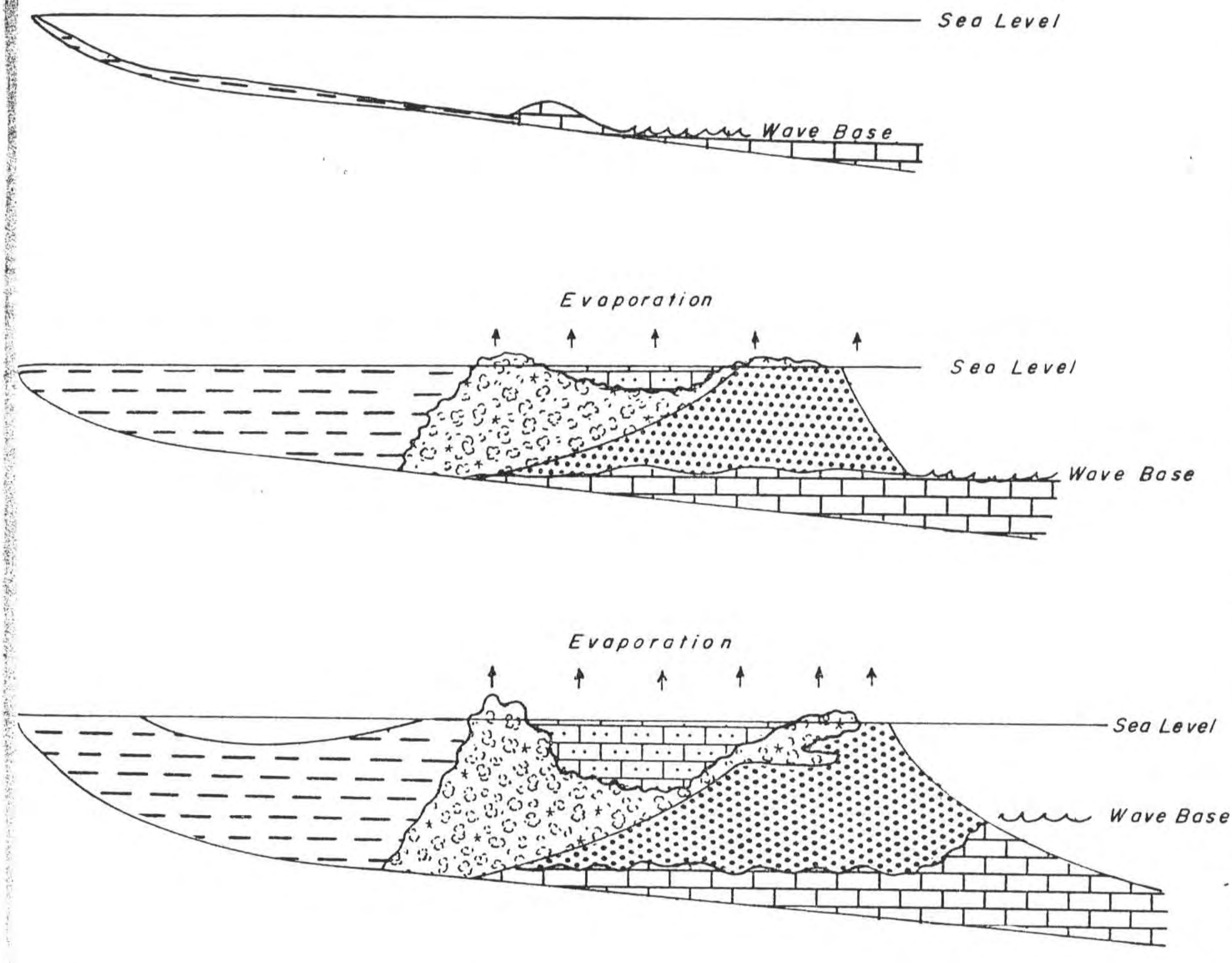
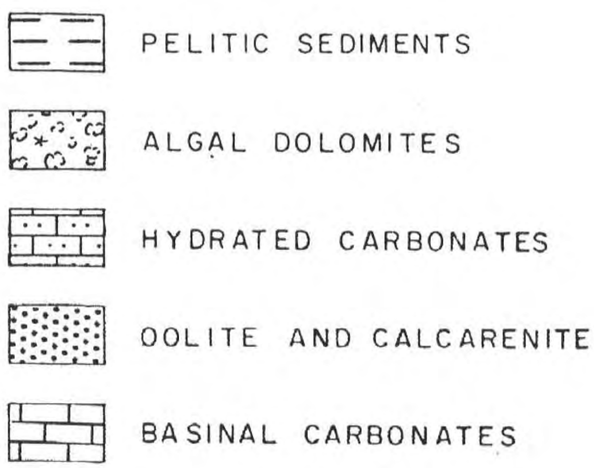
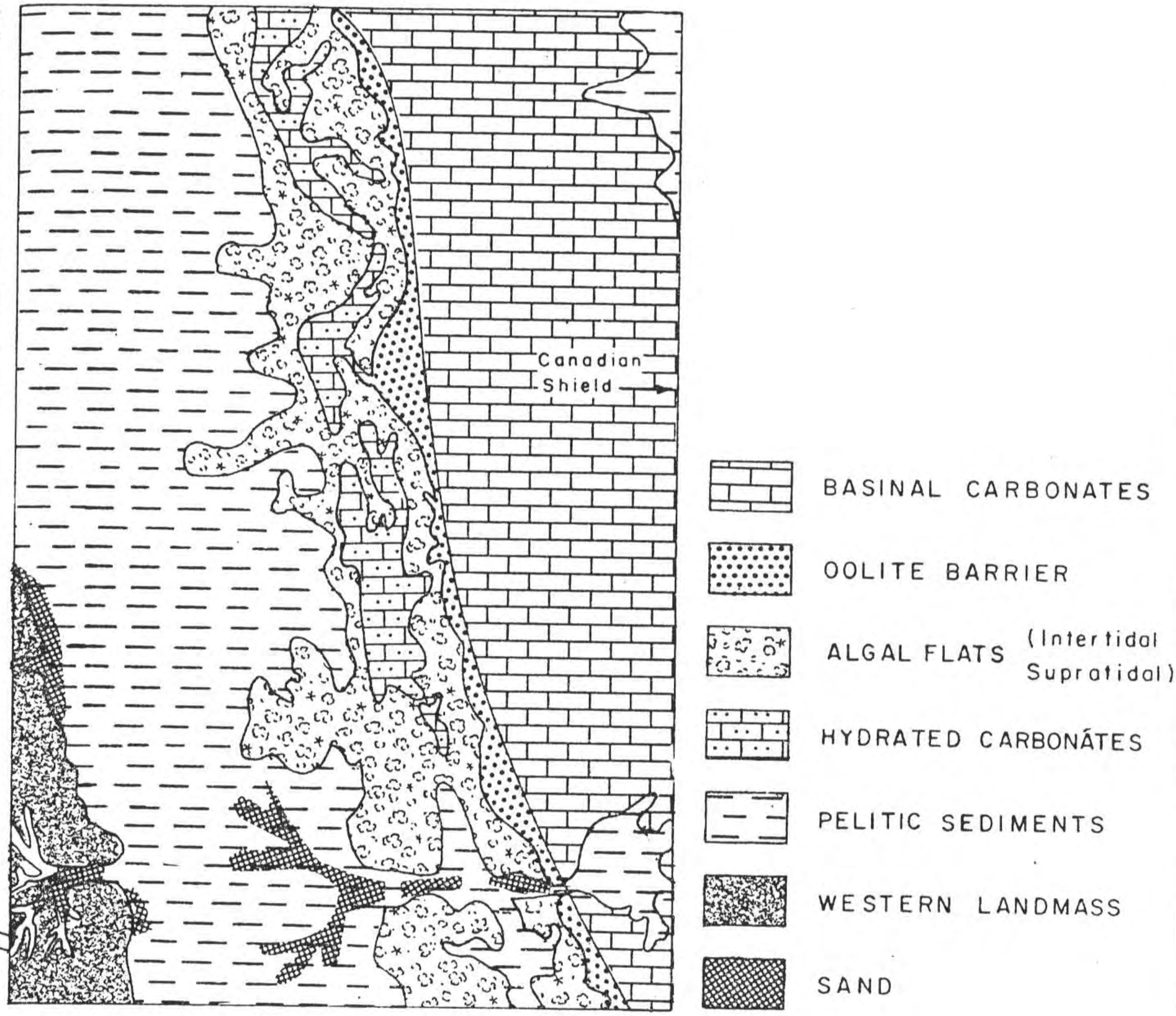




Sections Illustrating Generation of Carbonate Barrier with Hypersaline Lagoons

FIGURE 11.



Diagrammatic Reconstruction of Sedimentary Facies in Plan View

FIGURE 12.

Primary Features

Sedimentary loading and burial with concommitant increase in temperature and pressure would initiate recrystallization and alteration. Loss of molecular water during recrystallization would alter hydromagnesite to magnesite and dolomite. The final product of recrystallization would be a magnesite plus dolomite solid solution in equilibrium with pore fluids and temperature. The higher the temperature the greater the quantity of dolomite that can be accommodated in the solid solution (Harker and Tuttle, 1955).

Under conditions of elevated temperature molecular water in the hydromagnesite would promote development of coarse crystalline textures. Hence coarse crystalline magnesite-dolomite would be the final product.

Textural evidence indicates that silica, alumina, and iron combined with the magnesia rich pore fluid during recrystallization. This resulted in the formation of talc, phlogopite, muscovite, and leuchtenbergite as constituent minerals.

Secondary Features

Folding followed by unloading due to erosion and concomitant lowering of temperature resulted in new equilibrium assemblages of carbonate minerals. As the temperature of the rocks was lowered during uncovering the magnesite-dolomite solid solution was no longer in equilibrium and exsolution of dolomite took place. Exsolution features are well illustrated in the report by White (1972). Silica and alumina rich fluids entered new fractures in the massive rock and quartz along with sericite was deposited in these fractures.

Weathering

Continuation of erosion eventually culminating in exposure of the deposit was accompanied by many changes within the deposit. Oxidizing ground water altered pyrite to limonite in surficial areas. Oxidation of the pyrite resulted in ground water with a low pH. This water produced solution features which later became the sites of dolomite and quartz deposition. At the time of exposure in outcrop, limonite and clay were transported from the surface along open fractures to moderate depths. These minerals were carried as much as 200 feet below the surface. Palygorskite and huntite were locally deposited from surficial water descending along these fractures.

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