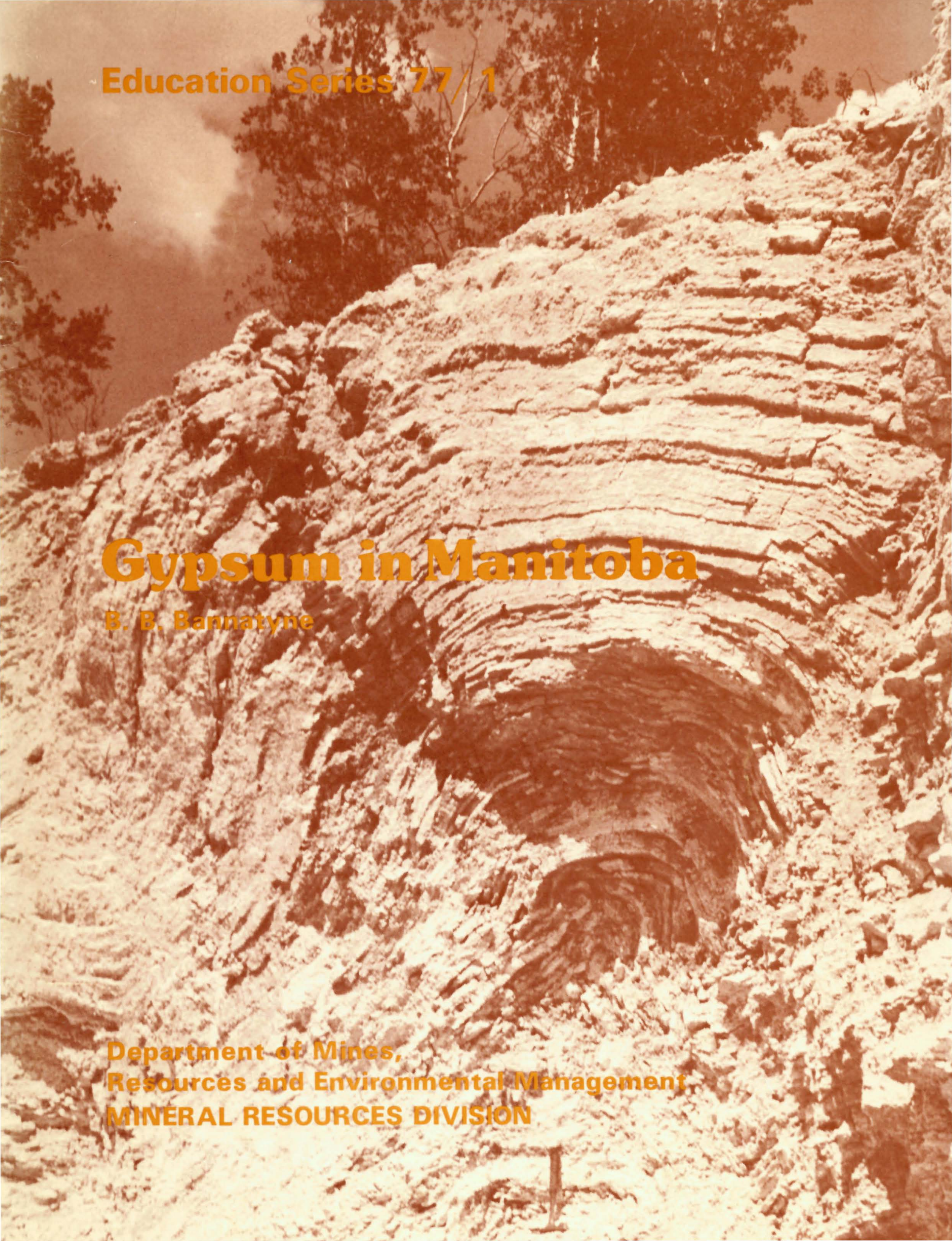
Education Series 77/1

Gypsum in Manitoba

B. B. Bannatyne



Department of Mines,
Resources and Environmental Management
MINERAL RESOURCES DIVISION

GYPSUM IN MANITOBA

B.B. Bannatyne

Gypsum is a soft, white mineral that is used in the construction industry, primarily in gypsum wallboard, in plaster of Paris, and as an additive to Portland cement. Gypsum is a calcium sulphate mineral that is deposited, along with the related mineral anhydrite, from warm sea water in a dry climate. Such conditions existed in Manitoba 175 million years ago, in the Jurassic Period, and gypsum and anhydrite were deposited in a layer 25 to 125 feet thick as part of the Amaranth Formation.

Production of gypsum began in 1901 and in recent years has ranged between 90,000 and 200,000 tons per year. In 1976, the only source was from quarries near Gypsumville. Previously, it has been mined at Amaranth and Silver Plains.

Calcium and sulphate ions are present in sea water, and when their concentration has been increased several times through evaporation of the water in a warm and dry climate, the ions combine to form gypsum ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). These minerals have the following chemical composition:

	Gypsum	Anhydrite
CaO (lime)	32.6%	41.2%
SO_3 (sulphur trioxide)	46.5	58.8
H_2O (combined water)	20.9	0
Total	100.0	100.0

Natural deposits seldom contain 100 per cent of these minerals, but, as in Manitoba, may contain 4 to 20 per cent dolomite ($CaCO_3 \cdot MgCO_3$) and 1 to 5 per cent clay. These impurities occur either intermixed with the gypsum and anhydrite, or as thin layers interbedded with them. When anhydrite is close to the surface, reaction with circulating water will gradually convert it to gypsum, which is the preferred mineral for mining. For a more detailed description of the mineralogy of gypsum and its varieties and classic localities in Manitoba for mineral collectors, the reader is referred to another publication of the Mineral Resources Division, Manitoba, titled "Minerals of Manitoba, Volume 1: Nonmetallic and pegmatitic".

USES

Gypsum has the valuable property of releasing three-quarters of its combined water when heated (calcined) to 160°C (320°F); the resulting plaster of Paris can then be mixed with water, moulded or spread and allowed to set into a solid plaster. Calcined gypsum, mixed with various additives and spread between two sheets of heavy paper, is the main ingredient of wallboard (Figure 1).

Gypsum in its natural state is crushed to a fine powder and mixed with pulverized Portland cement; it acts as a retarder to slow down the setting time of the cement.

Gypsum from Manitoba is used in two wallboard plants in Winnipeg (Westroc Industries Limited and Domtar Construction Materials Limited), in two cement plants in Winnipeg, and at other wallboard plants in Saskatoon, Calgary and Edmonton, and in a cement plant in Regina.

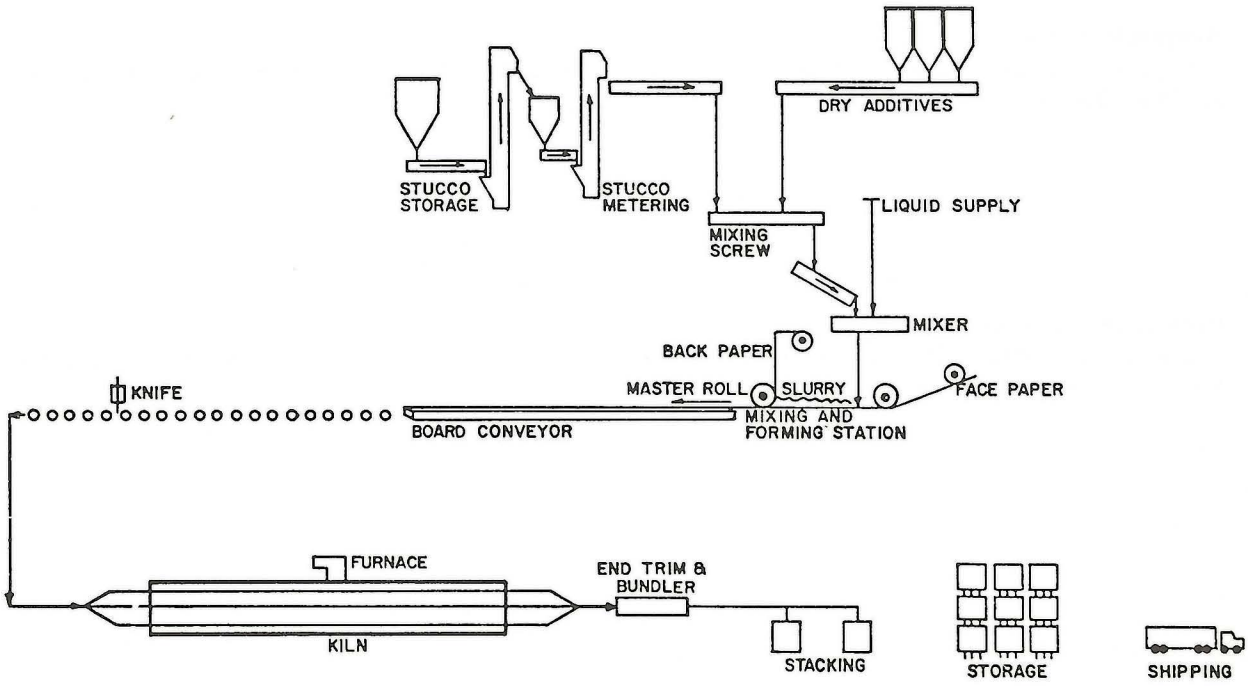


Figure 1. Simplified flow diagram for complete small gypsum plant.

PRODUCTION OF GYPSUM IN MANITOBA

Gypsum has been produced in Manitoba since 1901 from the various locations and by the companies listed in Table 1.

Annual production from 1901 to 1946 fluctuated between 600 and 60,000 tons. From 1946 to 1959 production increased annually to 200,000 tons. In recent years production has averaged 170,000 tons. However, the mine near Silver Plains closed in 1975, and in 1976, the only production was from the Gypsumville deposit; it has been estimated at 91,000 tons (see Figure 2).

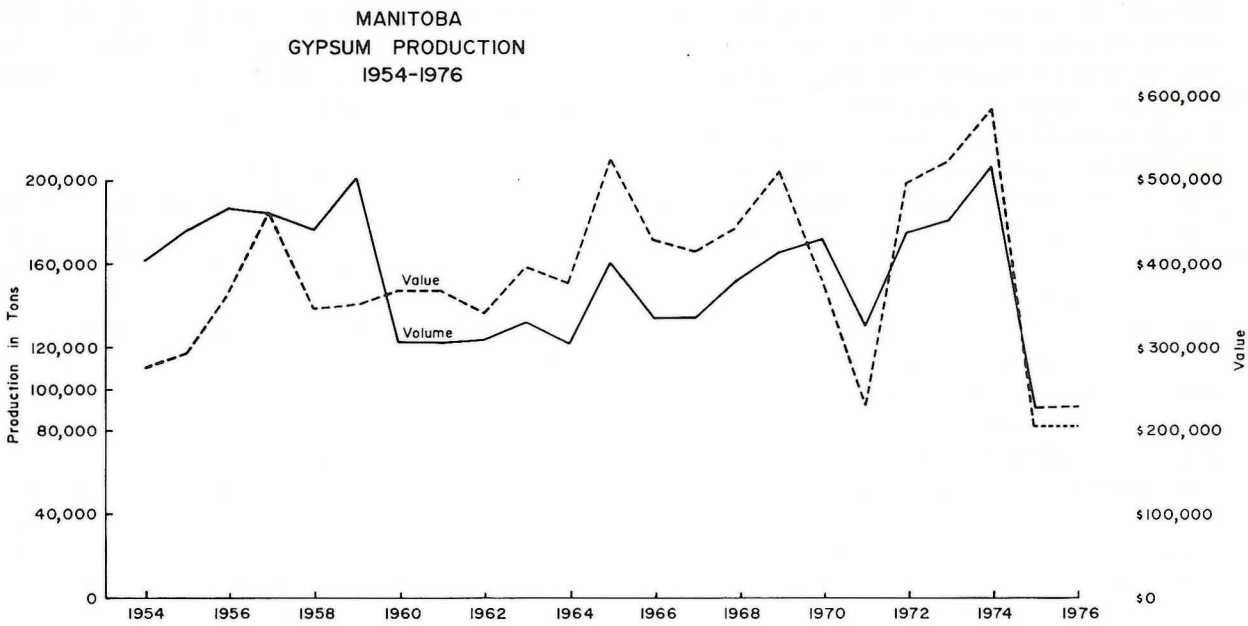


Figure 2.

Acknowledgment

Figure 1 is reproduced with permission from "Industrial Minerals and Rocks," 4th edition, A.I.M.E. (1975).

Note added in press:

Westroc Industries Limited are developing a new gypsum quarry north of Amdrath (See page 6). First production is planned for December, 1977.

GYPSUM OCCURRENCES AND MINING IN MANITOBA

Gypsum deposits in Manitoba occur in the Amaranth Formation of Jurassic Age (175 million years). The formation consists of an upper layer of gypsum and anhydrite and a lower sequence of red shale and sandstone. The strata were deposited on the northeastern flank of Williston Basin which was a sedimentary basin centred in western North Dakota.

The original northern depositional edge of the formation occurred in the area of Dauphin Lake; the thickness increases southward. The original eastward extent is not known but may have been as far east as Lake Winnipeg. present outliers of the formation occur within a crater structure at Gypsumville, and in a local channel in the Headingley-Charleswood area. The formation occurs also in a lagoonal extension of the Williston Basin in an area east of the Red River. It was named the Dominion City Embayment by Lambo (1964) (Figure 3).

In the outcrop belt extending southeastward from Dauphin Lake to the International Boundary, the gypsum deposits form a more or less continuous layer, except where possibly removed by glaciation. The gypsum layer has been intersected in many exploratory oil wells, water wells, and industrial minerals test holes.

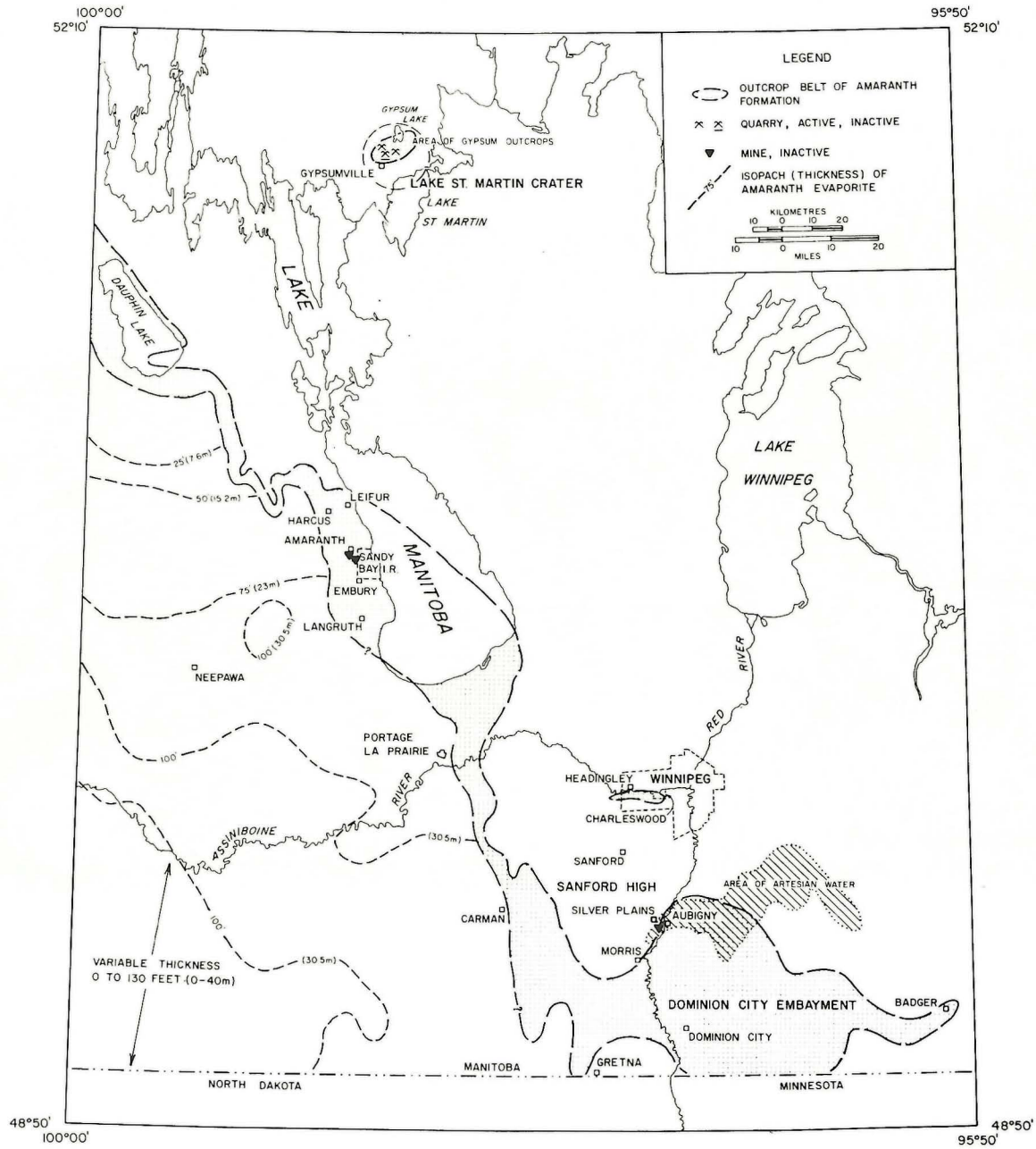


Figure 3. Gypsum deposits in the Amaranth Formation of Jurassic Age in Manitoba

Table 1: Gypsum Operations in Manitoba

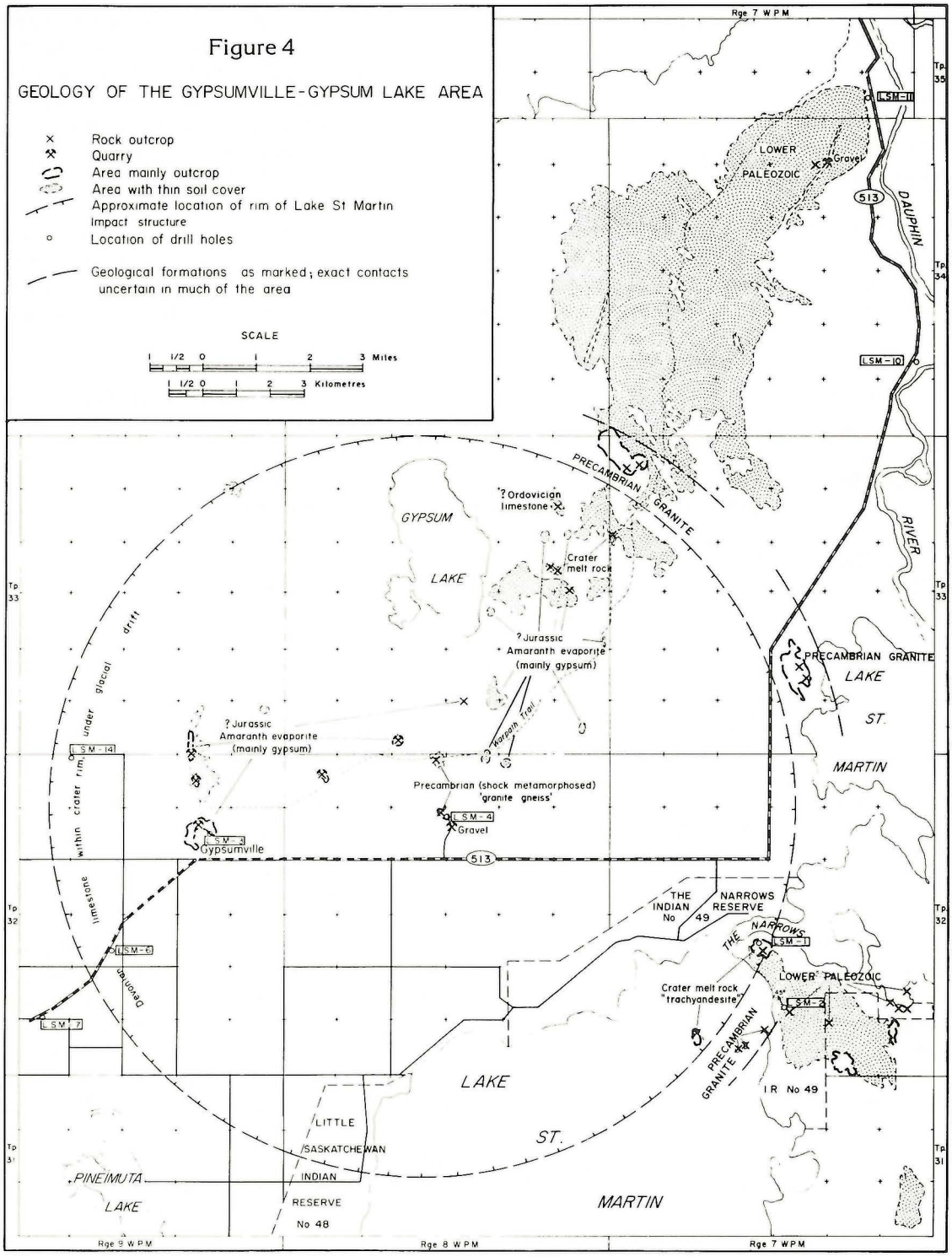
Gypsumville	Q*	1901-1904	Manitoba Union Mining Company
	Q	1904-1928	Manitoba Gypsum Company
	Q	1928-1959	Gypsum, Lime and Alabastine, Canada, Limited
	Q	1959-1977	Domtar Construction Materials Limited
Amaranth	M*	1929-1963	Western Gypsum Products Limited
	M	1967-1970	B.A.C.M. Industries Limited
Silver Plains	M	1964-1975	Westroc Industries Limited (formerly Western Gypsum Products Limited)

*Q: quarry; M: underground mine

Gypsumville

The evaporite deposits at Gypsumville are unusual in several respects. They occur as ridges as much as 50 feet higher than the surrounding plains and swamplands that are underlain in places by thick glacial deposits. The gypsum beds have been contorted in many places into folds of several types (anticlinal, overthrust, and complex interference types) ascribed to ice-thrusting by glaciation (Wardlaw et al, 1969).

The ridges outcrop within an area 10 miles long and 8 miles wide, extending northeastward from Gypsumville to east of Gypsum Lake. This area is entirely within the almost perfectly circular Lake St. Martin impact structure, 14 miles in diameter and centred 5 miles ENE of Gypsumville. The details of this structure, probably formed by meteorite impact, have been described by McCabe and Bannatyne (1970). The gypsum deposits are confined to the northern half of the crater. At Gypsumville, a facies change from 138 feet of gypsum/anhydrite/minor glauberite and 51 feet of red beds, to a thickness of 175 feet of red beds, occurs within a distance of less than one-half mile. In the southern half of the crater, equivalent deposits, if they were present, have been eroded and the area is the site of thick glacial deposits, probably laid down in a pre-glacial valley (Figure 4).



The deposit at Gypsumville consists generally of an upper layer of gypsum in thin beds separated by laminae of grey clay, and a lower, thicker layer of anhydrite. Analyses of samples reported to be less pure than the average run of mine ore indicated: gypsum 90.05 to 95.00%; magnesium carbonate 3.00 to 7.10%; and clay 0.75 to 2.90%. Thus the workable part of the deposit is of good quality. Examination of drill core and of quarry exposures indicates that a sharp change to anhydrite occurs below the floor level of the quarries. This means that gypsum reserves are limited mainly to the ridges. Reserves of gypsum in the area are considered to be many millions of tons, although precise figures have not been published.

In the Elephant Hill deposit, 4 miles east of the main quarries north of Gypsumville, a pure white alabaster is quarried. Large plates of selenite (a crystalline form of gypsum), as much as 2 feet across, occur in that deposit. Layers of glauberite, $Na_2SO_4 \cdot CaSO_4$, several feet thick, occur within the anhydrite about 90 feet below the floor of the old quarry one-half mile north of Gypsumville.

Amaranth-Portage la Prairie area

The outcrop belt of the Amaranth Formation extends southeastward from Dauphin Lake to Harcus, southward to Amaranth and Langruth, and southeastward to Portage la Prairie (Figure 3). The gypsum is covered by 10 to 200 feet or more of glacial drift.

In the area east of Harcus, sinkholes occur in section 22, township 20, range 10WPM. Exploration drilling has indicated 10 to 28 feet of good quality gypsum is present below 10 to 26 feet of glacial drift. Anhydrite is not present, and clay content is low, but the gypsum layer contains 8 to 10% dolomite. The possibility exists that a quarry could be operated there.

Gypsum was mined at locations one and two miles south of Amaranth, between 1929 and 1970. The companies are listed in Table 1. The general geological section is as follows:

DEPTH FEET	LITHOLOGY	THICKNESSS FEET
0-90	Glacial drift of clay and hard, buff till; impervious.	90
90-107	Gypsum, translucent to crystalline white; minor dolomite fragments and a one-foot bed of dolomite at 104-105 feet.	17
107-108.5	Green clay, cut by satinspar stringers.	1.5
108.5-117	Gypsum, translucent pinkish to finely crystalline white; minor dolomite fragments, satinspar, and clay.	8.5
117-120	Anhydrite, bluish, with dolomite fragments; thickness variable from 0 to 12 feet.	3
120-131	Gypsum, translucent to crystalline white; two thin dolomite beds near base; minor green clay and satinspar.	11
131-174	Amaranth red beds: red, brown and green shale, satinspar stringers; some sandstone and breccia at base.	43

A section measured in the mine operated by Western Gypsum Products Limited is illustrated in Figure 5. Nodules or concretions of quartz and chert occur sporadically within the gypsum.

At the Western Gypsum mine, the interval between 96 and 131 feet was removed using room and pillar method, with the anhydrite layer being left as a layer of broken rock on the floor of the mine. Vertical shafts were used as access. At the B.A.C.M. Limited mine, where access was by a sloped decline, mining was confined to the gypsum above the anhydrite layer, and a section averaging 15 feet was removed. A tunnel was excavated under Highway 50 to give access to that part of the deposit west of the highway. The gypsum was crushed underground and taken by conveyor belt to loading bins above a railway spur line.

The first shaft sunk by Western Gypsum,

before the Amaranth location was chosen, was located near Embury, 8 miles southeast of Amaranth. The gypsum was reported to be 25 to 35 feet thick, under a 40-foot layer of glacial drift (Brownell, 1931).

The Amaranth Formation forms the bedrock surface north and east from Portage la Prairie. The glacial drift is from 112 to 190 feet thick. The gypsum bed, intersected in 5 exploration holes, ranged from 93% gypsum over 14 feet, to 85% gypsum over 50 feet. In one cored hole, 5 miles north of Portage la Prairie, a small flow of gas was encountered in the red beds below the gypsum. An analysis of the gas indicated a helium content of 1.19%.

The gypsum extends southeastward to the Carman and Gretna areas. Drill holes near Carman indicate a grade estimated at 80% gypsum over a thickness of about 20 feet at a depth of 300 feet.

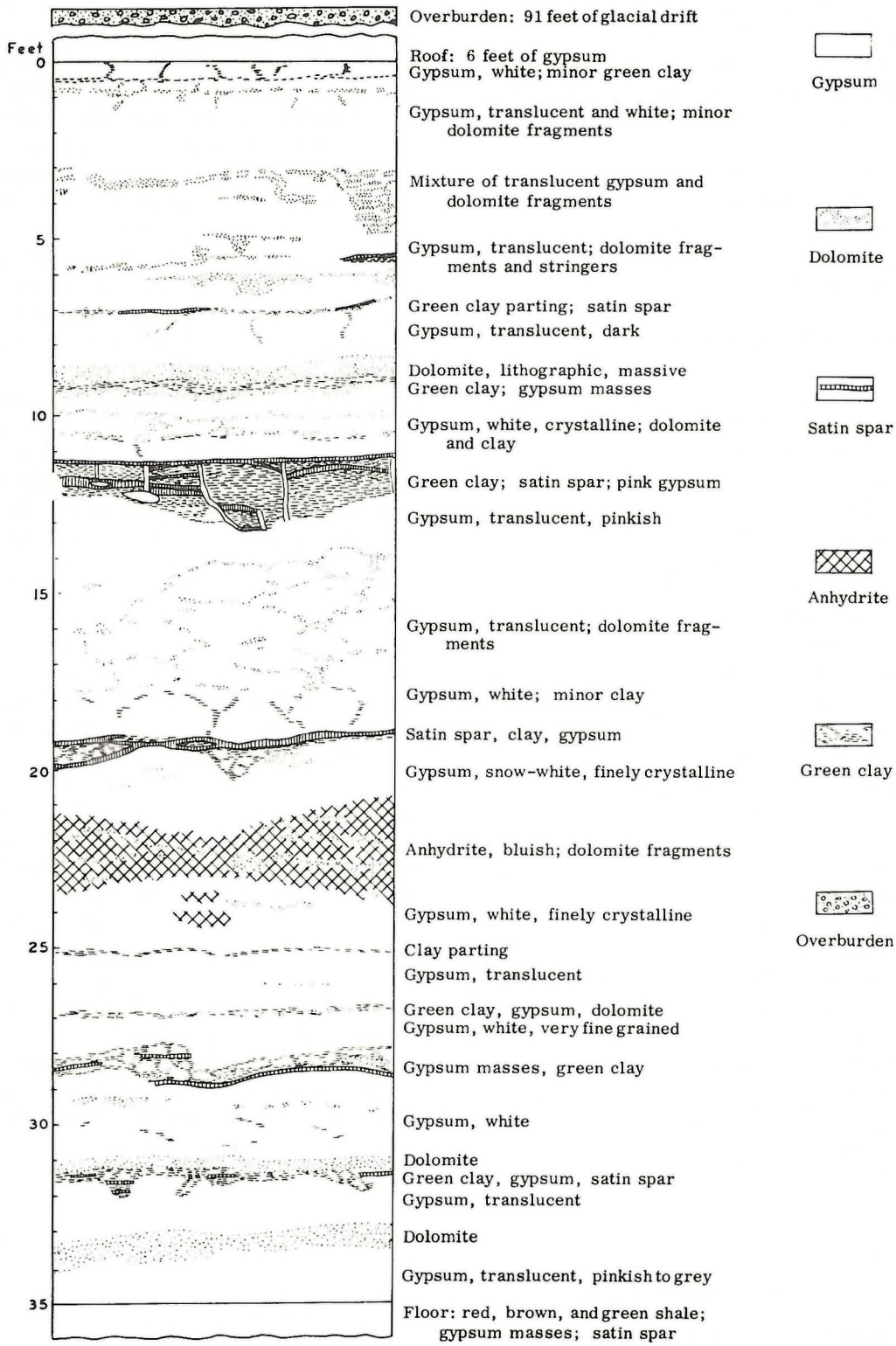


Figure 5. Amaranth Mine Section

Headingley-Charleswood area

An outlier of the Amaranth Formation occurs in the western part of the Winnipeg area and has attracted sporadic interest over the past 60 years because of its favourable location with regard to the wallboard plants in Winnipeg.

Early work in the 1920s suggested the gypsum occurred as rounded masses within red beds in the Charleswood area. This was confirmed in a shaft sunk in 1930, where masses of white gypsum embedded in red shale and glacial till occurred at a depth from 20 to 29 feet, underlain by red beds. In the 1960s, drill holes near Headingley cored a section of interbedded gypsum and red shale 15.0 to 18.5 feet thick, overlying red beds as much as 40 feet thick.

The results suggest a channel-type deposit one to two miles wide and 11 miles long. The western continuity to the outcrop belt has not been encountered as yet, and may have been removed during glaciation.

Dominion City Embayment, including Silver Plains

Jurassic strata, including red beds, gypsum and anhydrite of the Amaranth Formation and, in places, dolomite of the overlying Reston Formation, occur 30 to 65 miles south and southeast from Winnipeg in the Dominion City Embayment (Lambo, 1964). Deposition of the beds was controlled by the paleotopography of the pre-Jurassic erosion surface. In excess of 300 feet of Jurasssic strata was deposited in the southern part of the embayment, tapering off to the north and south. The embayment was connected to the Williston Basin by a seaway 12 miles wide between the Sanford paleotopographic high (Figure 3) in Manitoba and two similar highs immediately south of the International Boundary in North Dakota.

Beds of gypsum were intersected in 1911 in exploration holes 17 miles east of Dominion City, and gypsum has been reported in numerous water wells in the area. Exploration drilling in the early 1960s by Western Gypsum Products Limited resulted in the outlining of a large gypsum deposit near Silver Plains, which was brought into production in 1964. The overburden consists of 105 feet of glacial lake clay and till. Lithology is variable, but a section in the mine area showed an upper 15 foot layer of interbedded green and brown shale and gypsum, a 6 foot layer of white, almost pure gypsum, and 55 feet of gypsum with minor anhydrite, abundant dolomite patches in a penemosaic arrangement, and thin interbeds of red shale and dolomite. Buff to red clayey dolomite and sandstone, and a basal breccia (fragmental) zone, make up the underlying Amaranth red beds, as much as 60 feet thick. The sandstone portion is an aquifer containing artesian water. Following 10 years of mining, the artesian water broke through the floor of one section of the mine, and efforts to control the flow were unsuccessful. The mine flooded in June, 1975 and has been abandoned. The company drilled an area east of Red River near Aubigny in 1976 in an attempt to outline a deposit for a new mine.

The dolomite patches and fragments scattered through the gypsum and anhydrite give the rock a penemosaic texture, and suggest that the deposit was formed near the shoreline of a shallow inland sea (Bannatyne, 1972). Deposits with a similar texture are formed along the shoreline of part of the Persian Gulf, in low-lying areas that are called "sabkhas". Both gypsum and anhydrite are deposited from evaporation of sea water in an arid climate; the minerals displace and cause fragmentation of soft lime mud in the sabkhas.

In the northwestern part of the Dominion City Embayment, circulating groundwater has reacted with much of the original anhydrite to to form gypsum (Lambo, 1964). Lambo noted also evidence of replacement of dolomite by anhydrite in the microscopic study of thin sections. In a few drill holes near the mine as much as 10 feet of dolomite, probably part of the Reston Formation, was intersected above the Amaranth evaporite.

The Silver Plains mine yielded 70,000 to more than 150,000 tons of gypsum annually, recovered by the room and pillar method. A 14-foot layer was removed in most places, and a second, lower 14-foot layer was recovered from one quadrant of the mine. The gypsum was crushed underground, transported by conveyor belt up an incline to loading bins, and trucked to markets in Winnipeg, primarily a wallboard plant and two cement plants. Some gypsum was shipped to wallboard plants in Saskatchewan and Alberta, and to a cement plant in Saskatchewan.

REFERENCES

Bannatyne, B. B.

1959: Gypsum-anhydrite deposits of Manitoba; Manitoba Mines Branch publication 58-2, 46 p.

1972: In: Field Excursion C-23, industrial & non-metallic minerals of Manitoba and Saskatchewan (central Plains), XXIV International Geological Congress Guidebook, p. 5-8.

Brownell, G. M.

1931: The Amaranth gypsum deposit; C.I.M. Bulletin, vol 34, no. 233, p. 1048-1068.

Lambo, W. A.

1964: Geology of the Silver Plains gypsum deposit; Unpublished M.Sc. thesis, University of Manitoba, 91 p.

McCabe, H. R. and Bannatyne, B. B.

1970: Lake St. Martin cryptoexplosion crater and geology of the surrounding area; Man. Mines Br., Geol. Paper 3 / 70, 79 p.

Wardlaw, N. C., Stauffer, M. R., and Hoque, M.

1969: Striations, giant grooves, and superposed drag folds, Interlake area, Manitoba; Can. J. Earth Sciences, vol. 6, no. 4, p. 577-593.