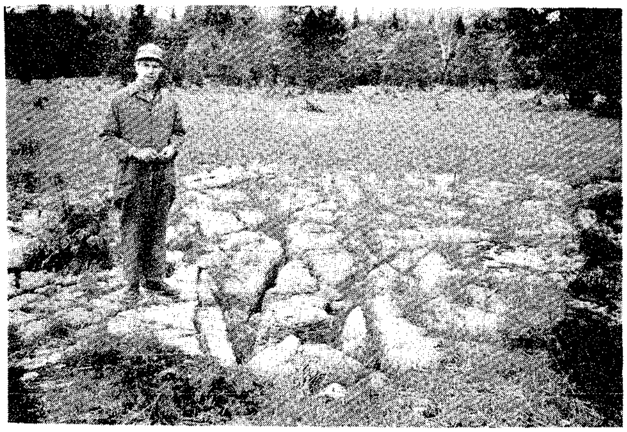
# DRILL CORE INVESTIGATION OF THE FIBORN LIMESTONE MEMBER IN SCHOOLCRAFT, MACKINAC, AND CHIPPEWA COUNTIES, MICHIGAN



MICHIGAN
DEPARTMENT OF
NATURAL RESOURCES

GEOLOGICAL
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REPORT OF
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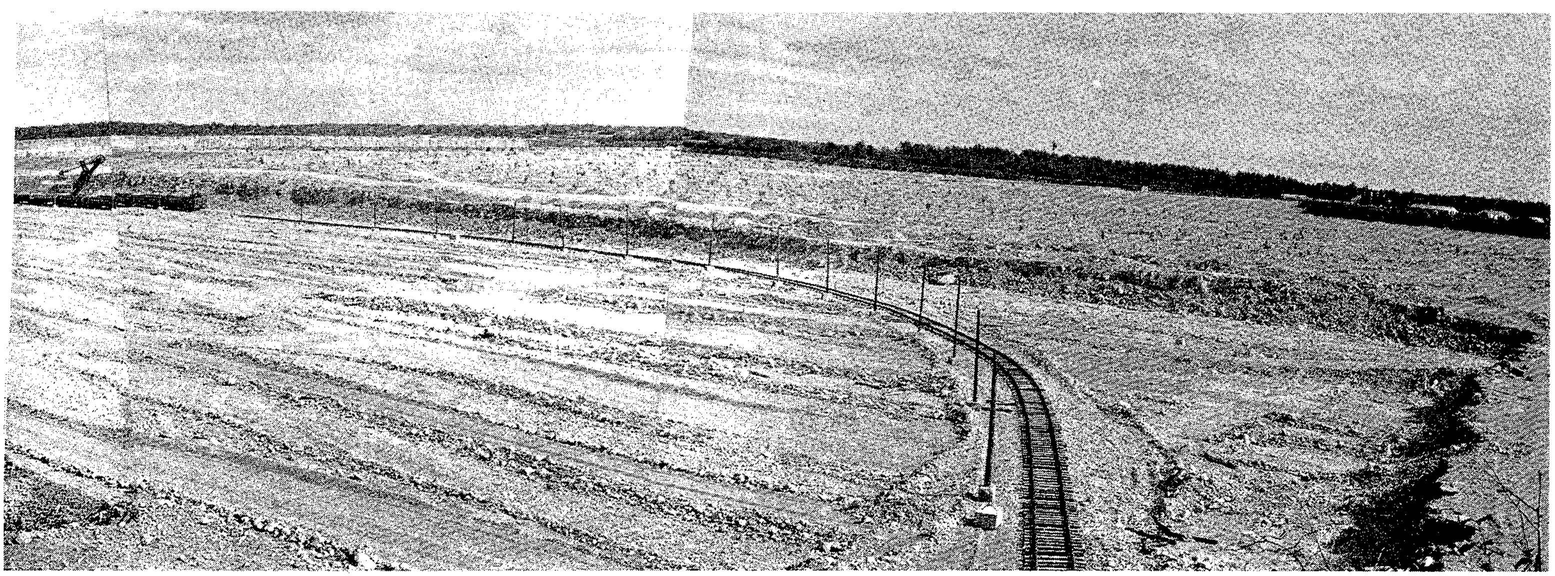

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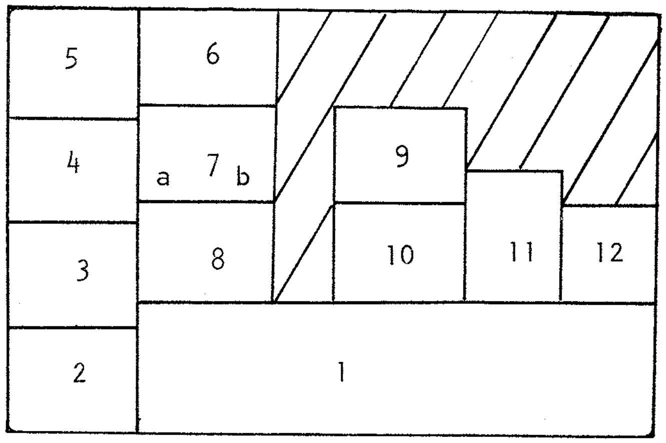


back cover front cover

1. Composite panorama of Inland Lime and Stone Quarry located near Gulliver, Mackinac County (See text Figure 4).

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Geological Survey Division

Report of Investigation 18

# DRILL CORE INVESTIGATION OF THE FIBORN LIMESTONE MEMBER IN SCHOOLCRAFT COUNTY, MACKINAC AND CHIPPEWA COUNTIES, MICHIGAN

by

Allan Johnson and Harry Sorensen

Lansing, Michigan
1978

STATE OF MICHIGAN
William G. Milliken, *Governor*

DEPARTMENT OF NATURAL RESOURCES
Howard A. Tanner, *Director*

GEOLOGICAL SURVEY DIVISION
Arthur E. Slaughter, *Chief*
and *State Geologist*



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## PREFACE

Since late 1973 an evaluation of limestone resources in the State of Michigan has been underway. The work is being done jointly by the Michigan Geological Survey Division of the Department of Natural Resources (DNR) and the Institute of Mineral Research (IMR), Michigan Technological University. Initial efforts are being concentrated on high-purity limestone and dolostone. Three carbonates are presently under investigation: 1) The Fiborn member of the Hendricks Formation, Burnt Bluff Group in the Northern Peninsula of Michigan, a high-calcium limestone; 2) The Engadine dolostone, also in the eastern Northern Peninsula, for low silica, high-purity dolomite; and 3) the Traverse Group limestones of the Afton-Onaway region of the Southern Peninsula, for industrial limestones.

High priority was attached to the project because of land-use considerations and the economic significance of these resources. The limestones being studied underlie land of high recreational value and constitute an important present and future source of flux stone for the steel industry. High-purity reserves should be defined so they are not lost or their utilization impaired through improper land-use decisions. Present knowledge is not adequate to define reserves; the most recent comprehensive work was done prior to 1915 by R. A. Smith, the State Geologist at that time.

The program involves review of available information, geological field reconnaissance, the selection of drilling sites, core drilling, study of the core followed by chemical analysis and reporting the results. The first work was done on Fiborn limestone; field reconnaissance began in the fall of 1973, followed by core drilling in the summer of 1974 and core study and analysis in late 1974 and 1975.

At the end of the 1974 summer field season plans were laid for investigation of the Engadine dolostone outcrop belt in Mackinac and Chippewa counties. Sixteen cores were diamond drilled during the 1975 season and three supplemental core tests were drilled in the spring of 1977. The 1976 season resulted in four core tests in the Traverse Group of the Afton area and during the forthcoming season, field work including drilling will continue on the evaluation of the Traverse Limestone. This report exclusively covers the Fiborn limestone investigation. A report covering the Engadine dolostone resources is in preparation and one for the Traverse Group limestones will follow soon after final field core testing has been completed.

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## ILLUSTRATIONS


Figure 1. An index map of the study area.

*Abstract*

*Progress on evaluation of high-purity, high-calcium limestones of the Middle Silurian Fiborn member of the Hendricks Formation, Burnt Bluff Group in the eastern portion of the Northern Peninsula is presented. During the 1974 field season, nine cores were diamond drilled from outcrop exposures of the Hendricks Formation along a strike length of about 110 miles in Schoolcraft, Mackinac and Chippewa Counties. Careful selection of drilling sites required only shallow coring depths to sample the nearly flat-lying strata (regional dip is southerly 50 feet per mile) which form part of the northern rim of the Michigan Basin. Core logging and chemical analysis of the core intervals revealed the greatest thickness of high-purity, high-calcium Fiborn limestone to be present from the eastern margin of Schoolcraft County eastward through Mackinac County to the western area of Chippewa County in the vicinity of the Village of Trout Lake. To the west, from the approximate vicinity of Gulliver in eastern Schoolcraft County and through the Garden Peninsula in Delta County, the Fiborn member is not present as high-calcium limestone - it has been completely dolomitized. To the east beginning somewhere between Trout Lake and Scott Quarry the Fiborn member consists of interbeds of high-calcium limestone and dolostone.*

*Maximum thicknesses of high-calcium limestone from the nine coring locations were found at the Gould City and Trout Lake locations. The upper 20 feet of strata in the Gould City core averaged 93.3 percent calcite and the upper 49 feet of the Trout Lake core averaged 92 percent calcite. Dolomite contents were 5.3 and 6.7 percent, respectively (1.2 and 1.5 percent MgO). Combined impurities $SiO_2$, $Fe_2O_3$ and $Al_2O_3$ were 1.46 and 1.34 percent, respectively. Silica was the most abundant impurity.*

*No anomalous indications of zinc mineralization were found in the upper Hendricks strata.*

## INTRODUCTION

While limestones as a class are abundant and widely distributed, high-purity stone which meets rigid chemical and physical specifications for industrial use is limited in its occurrence. Economic deposits are even less abundant. To be economic, high-purity limestone must be present in sufficient quantity, be situated for ease of mining, and must have access to cheap transportation if it is not located close to the market area.

Michigan is blessed with large limestone resources occurring within easy access of Great Lakes shipping. As a result, Michigan is a major producer and supplies large quanities of industrial limestones for metallurgical, chemical, cement, aggregate, agricultural and other uses. The demands of the steel industry for this resource are particularly large. In 1976 Michigan produced 40.6 million tons of limestone valued at $77.5 million. Of this production, 29.1 million tons was high-calcium stone valued at $52.6 million. This figure represents the basic F.O.B. cost of stone at the quarry, with no value added for shipping or refining. High-calcium stone for the manufacture of cement and lime accounted for 16.7 million tons and values reported for these products were $142.8 million and $39.1 million, respectively. In 1976 limestone and limestone products totaled $259.4 million, nearly one-fifth of the $1.5 billion value reported for Michigan's mineral production. Thus, the need for high-purity limestone and its importance to the State's and nation's economies present strong arguments for developing knowledge of this resource.

### Project Goals and Scope

The purpose of this work is to define the distribution, quality and quantity of limestone resources in Michigan. Initial emphasis has been to work on strata of known potential for high-purity stone. This report deals with the first work done on the high-calcium Fiborn member of the Burnt Bluff Group in the Northern Peninsula of Michigan. Other occurrences under investigation include the Engadine dolostone (Northern Peninsula) and Traverse Group limestones (northern part of the Southern Peninsula). The work is being done as a cooperative project by the Michigan Geological Survey Division of the Department of Natural Resources and the Institute of Mineral Research (IMR) of Michigan Technological University. No outside funding has been made available for the work; funding is from the regular operating budgets of these two agencies.

The program consists of: reconnaissance geological field work to determine where drill cores of strata are needed; selection of sites suitable for drilling; diamond coring of rock strata; and the study and analysis of these cores. The purpose is not to "block out" quarries or mines, but rather to define promising areas which can be investigated more closely by follow-up work. Therefore, such cores are usually drilled at widely spaced intervals spanning many miles of strata.

Information on the limestone resources of Michigan obtained from this program will obviously be useful to the mineral industry; but it will also provide direct benefit to the State and its people. Mineral production provides jobs and tax dollars while producing an essential raw material.

Reconnaissance work on the Fiborn limestone began in the fall of 1973. Drilling was accomplished during the 1974 field season, and the cores were examined and analyzed in late 1974 and 1975. See Figure 1, an index map of the study area.


## Acknowledgements

A great many people have been involved in this project in one way or another. Without their help and cooperation, the work could not have been completed and this report would not have been possible.

The authors would like to thank: John Moffat (deceased), Dino Pirola, Frederic Cayia, and James Mallock of Inland Lime and Stone Company and Ivan Mueller and Gerald Gabel of Drummond Dolomite Corporation for their advice and help during implementation of the program; Fisheries Division, Department of Natural Resources (DNR) personnel at the Thompson Fish Hatchery, including Keith Pratt, George Chvala, John Potvin and Martin Miller for arranging for the use of DNR facilities and equipment, which materially aided our investigation; United States Forest Service personnel Richard Ruppenthal and William Smith for their extra efforts in securing permission to drill on Federal lands; William Howe of Mead Corporation for permission to drill on company lands and Stanley Watkins, Pickford, for permission to drill on his land; Michigan Geological Survey Division, Department of Natural Resources personnel R. Thomas Segall, Jerry D. Lewis, Richard Lilienthal, D. Michael Bricker, Kenneth Childs and Jack VanAlstine for assistance in drilling, geological field work and core logging; and John Jostock, Lawrence MacDonald and Arthur Johnson of the Institute of Mineral Research for field assistance and for keeping the drilling operation running smoothly. Editing skills of Beverly L. Champion, Michigan Geological Survey, were essential to bring the manuscript to publication. Steven E. Wilson, also with the Survey, is credited with the general layout and graphics coordination. Thanks are also extended to Donald E. Raymond for drafting the figures and to Lois J. DeClaire for typing the manuscript.


## Previous Work

The earliest comprehensive work on the Fiborn limestone was done by R. A. Smith, State Geologist, in the years preceding 1915. Although both the Hendricks and Fiborn quarries were operating in the Fiborn limestone at this time, Smith first described the occurrence of this high-purity limestone and named it after strata exposed in the Fiborn Quarry. Smith's work on the Fiborn limestone was only a small part of his total contribution to knowledge of the mineral resources of Michigan. His "Limestones of Michigan" published in 1916 by the Michigan Geological and Biological Survey remains to this date the most complete and comprehensive assessment of industrial limestone resources in Michigan.

Two other "giants" in the way of contributions to knowledge of the Silurian rocks of the Northern Peninsula are the late Dr. George Marion Ehlers and Dr. Robert V. Kesling, both at the University of Michigan. Dr. Ehlers began his studies of the Silurian strata of the Northern Peninsula prior to 1920; the results of this work led to his doctoral dissertation. Dr. Ehlers continued his Silurian studies for nearly 60 years, as a Professor at the University of Michigan and during retirement, along with the added responsibility of serving as Curator of the Museum of Paleontology. The most complete results of his work on the Silurian of Michigan were printed in *Papers on Paleontology* No. 3, "Stratigraphy of the Niagaran Series of the Northern Peninsula of Michigan" in 1973 by the University of Michigan Museum of Paleontology. Dr. Robert Kesling, present Curator of the Museum, deserves credit for bringing this lifetime work into publication. The document contains valuable information on the stratigraphy, lithology and paleontology of Silurian strata in the Northern Peninsula. Another very valuable contribution by Dr. Ehlers and Dr. Kesling is the 1957 field guide book, "Silurian Rocks of the Northern Peninsula of Michigan" published by the Michigan Geological Society.[1]

## GEOLOGY

### Regional Setting

The eastern arm of the Northern Peninsula of Michigan is largely underlain by Paleozoic sedimentary limestones, dolostones, shales and sandstones. These beds comprise a segment of the northern rim of the Michigan Basin, a major geologic feature in North America. Resistant Silurian strata, particularly the Middle Silurian carbonates - the 'Niagaran reef' - can be traced to the south and east of Drummond Island across Cockburn and Manitoulin islands and thence across southern Ontario into western New York. From there the strata continue through Niagara Falls and along the south shore of Lake Ontario into the foothills of the Appalachian Mountains. The same resistant strata are found at Big Bay de Noc in Delta County. From there they continue southward and westward under Lake Michigan, exposed here and there as small islands, and eventually emerge to form the Door Peninsula in Wisconsin. The strata can be traced further south through eastern Wisconsin, easterly through northeastern Illinois and on into northern Indiana.

In the Northern Peninsula Silurian rocks are the youngest Paleozoic strata. They crop out in a wide arcuate belt bordering the northern shores of Lake Michigan and Huron and extend some 10 to 20 miles inland (Figure 2). The gentle regional dip of 40 to 50 feet per mile to the south plus slight topographic variations expose these relatively thin strata as rather wide belts to form an arcuate pattern. Middle Silurian strata range from a minimum of 640 feet in thickness to a maximum of 1120 feet, depending on where the measurements are taken (Ehlers and Kesling, 1957). In like fashion the total Silurian section ranges from 1400 feet minimum to 2000 feet maximum thickness.

Silurian rocks in northern Michigan have been divided, from youngest to oldest, into the Cayugan, Niagaran and Alexandrian Series. It is the Middle Silurian or Niagaran section that is pertinent to this report. The relationship between formations comprising the Niagaran Series and their relative thicknesses are listed in Table 1. A geologic plan map with a cross-sectional view is shown in Figure 2.

| SERIES | GROUP | FORMATION | THICKNESS (Feet) |
|---|---|---|---|
| NIAGARAN | | Engadine Dolomite | 250-300 |
| | Manistique | Cordell Dolomite | 135-150 |
| | | Schoolcraft Dolomite | 40-60 |
| | Burnt Bluff | Hendricks Dolomite<br>(Fiborn Member) | 60-120<br>(18-50) |
| | | Byron Dolomite | 80-155 |
| | | Lime Island Dolomite | 15-35 |

Table 1. Niagaran Series formations and their relative thicknesses.

### Fiborn Limestone

The Fiborn limestone was first named by R. A. Smith in 1915 when he divided the Niagaran limestone into four distinct units which he provisionally named, from the top, Engadine dolomite, Manistique Series, Fiborn limestone and Hendricks Series. Smith (1915) pp. 153-4 reported the Fiborn limestone to be ".... exposed at many places in several areas of considerable size in an arcuate belt which extends ..." from eastern Schoolcraft County across Drummond Island. Smith (1915) pp. 154-5 described the Fiborn limestone in the following manner:

> The Fiborn limestone beds are buff to grayish buff dense grained to lithographic limestone generally containing small disseminated crystals of calcite...
>
> The stone is mainly massive though locally it is markedly laminated and well bedded. The joint systems are very irregular and poorly developed. The stone is brittle and breaks with a perfect conchoidal fracture, forming fragments with sharp points and edges. The lithographic texture, numerous small calcite crystals, and perfect conchoidal fracture are features which make field identification of the Fiborn beds easy and unmistakable. Moreover, the stone calcines easily and, whereever forest fires have passed over it, the surfaces of the exposures and field boulders are pure white in contrast to the grayish or yellowish white of partially burned stone from other beds.

[1] Current name of the organization is Michigan Basin Geological Society.

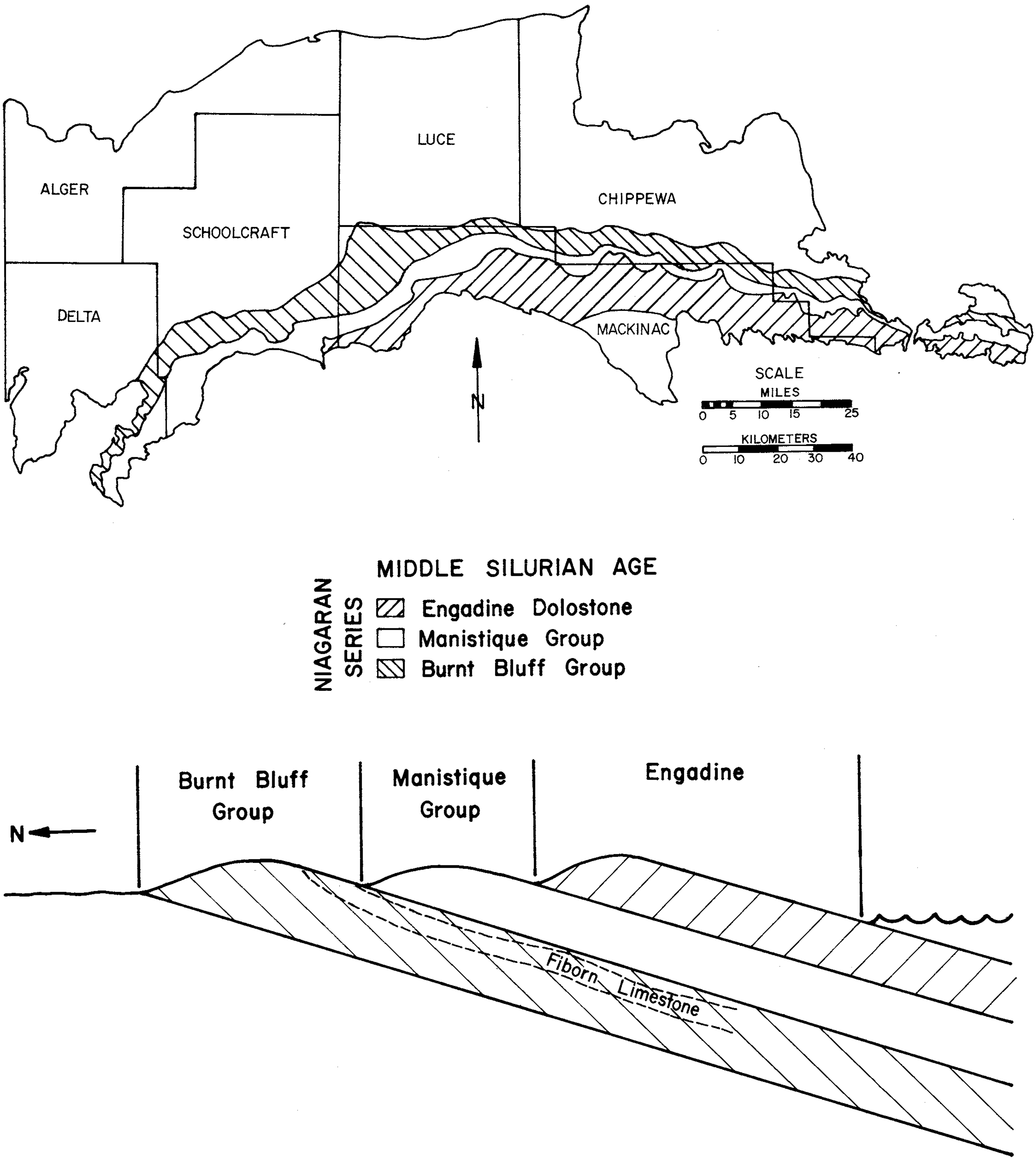



Figure 2. Geologic plan map with a generalized cross-sectional view.

Smith noted that the Fiborn bed existed as a lens of variable thickness in the Niagaran strata, which would restrict its occurrence largely to the limits of the Northern Peninsula. He also indicated that following further studies the Fiborn limestone may be found to be a part of the underlying Hendricks strata.

On the basis of fossil evidence, Ehlers (1973) p. 20 assigned the Fiborn to the Hendricks Dolomite Formation as a member. He noted (p. 20) that the Fiborn limestone

> ... has a thickness ranging from 18 to 34 feet. Although this limestone is the thickest single bed of nearly pure calcium carbonate in the Niagaran Series, it seems unwise to recognize it by name as a distinct unit, because the limestone may easily be confused with several lower and thinner beds having similar chemical and lithological composition.

Ehlers placed the top of the Fiborn limestone member near the upper contact of the Hendricks Formation below the overlying Schoolcraft Formation of the Manistique Group. Ehlers (1973) p. 17-18 states:

> The disconformity between the Burnt Bluff and Manistique strata is indicated chiefly by a faunal break, which is best shown at localities where the uppermost strata of the Burnt Bluff are limestones. At these localities, the Burnt Bluff limestones contain a few diagnostic fossils ..., and are overlain by a thick-bedded, coarsely crystalline, yellowish-gray to buff dolomite of the Manistique Formation containing numerous molds of the shells of the brachiopod *Pentamerus*. At most localities, however, the disconformity is very poorly indicated by a faunal difference... As a matter of fact, the exact position of the disconformity seems practically impossible to determine at a few places, because the uppermost Burnt Bluff strata lack fossils and are indistinguishable lithologically from the lowest Manistique strata which locally contain very few remains of *Pentamerus*. Although frequently obscured, the disconformity without doubt occupies a position at or a very short distance below the base of the thickbedded buff, *Pentamerus* bearing dolomite.

Ehlers and Kesling (1957) observed that *Pentamerus* (a Silurian brachiopod) are present in three separate units of the lower Schoolcraft Formation. These units are quite similar, each being a coarsely crystalline buff to gray dolostone crowded with molds of *Pentamerus*. They note how remarkable it is that these three *Pentamerus* units have such great linear extent in the belt of Middle Silurian rocks in the Northern Peninsula. These marker horizons were a great help to our investigation for locating the gradational contact between the Schoolcraft and Hendricks formations. A good example of a *Pentamerus*-bearing bed from the Schoolcraft Formation is shown in Figure 3.

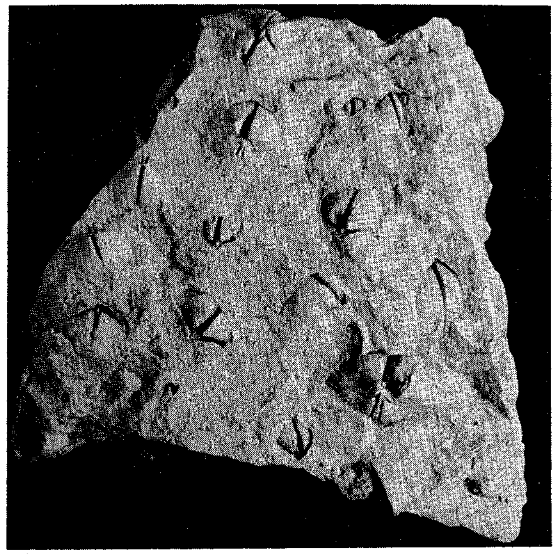
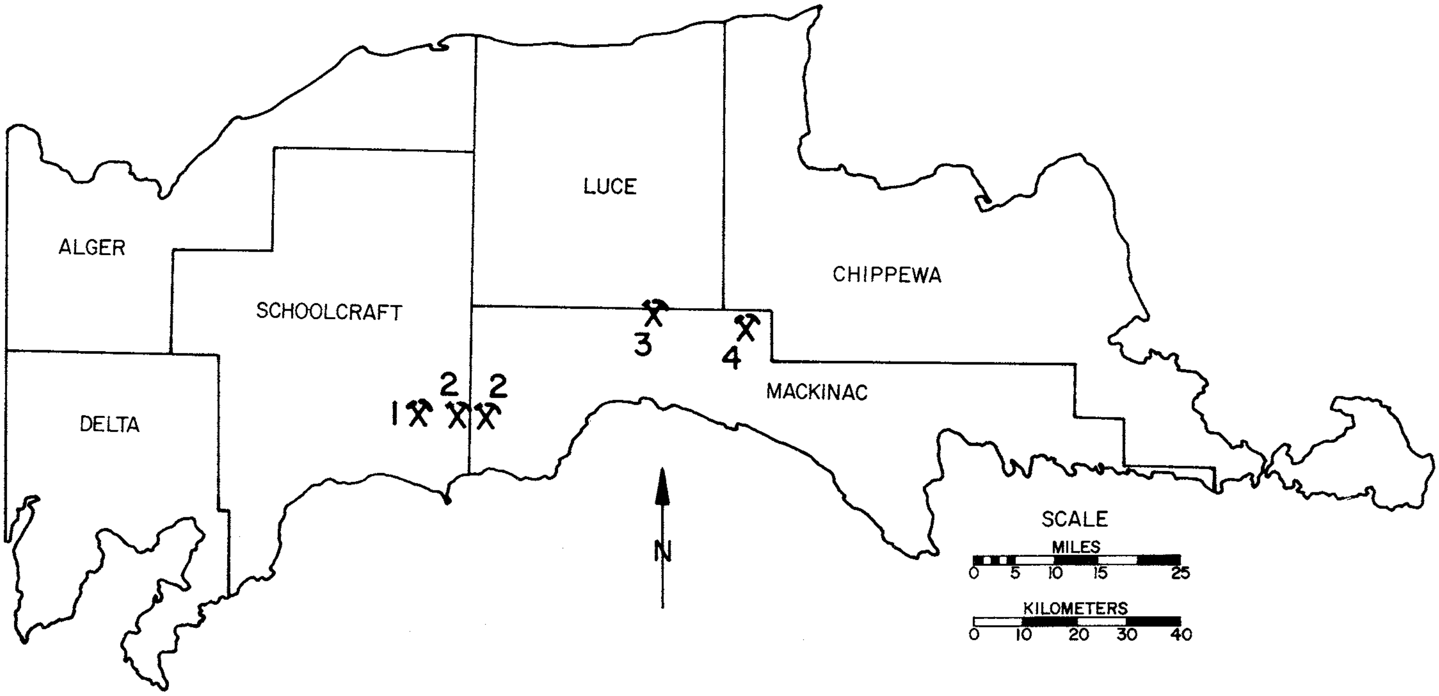


Figure 3. The brachiopod *Pentamerus* sp. from the Schoolcraft Formation. Specimen is about 4 inches (10.0 cm) long.

## DEVELOPMENT

### Historical Review

Historically, three quarries have produced Fiborn limestone: Blaney or Nicholsonville Quarry, Hendricks Quarry, and Fiborn Quarry. All were abandoned prior to 1935 with exception of some incidental quarrying for local aggregate material in both the Hendricks and Fiborn quarries. The only presently active quarry in the Fiborn limestone is that of Inland Lime & Stone Company at Gulliver. The first shipment of stone from this quarry was made in 1930 from Port Inland on Lake Michigan. Locations of Fiborn limestone quarries, both active and abandoned, are shown in Figure 4 and are described as follows:




**1. Blaney or Nicholsonville Quarry**

**2. Inland Lime and Stone Company Quarry**

**3. Hendricks Quarry**

**4. Fiborn Quarry**

Figure 4. Map showing the location of quarries in study area.

Inland Lime and Stone Company Quarry

Inland Lime and Stone Company, a subsidiary of Inland Steel Company, owns and operates two adjacent quarries in the Fiborn limestone in western Mackinac County and eastern Schoolcraft County. A panorama of the eastern quarry is reproduced as Cover Illustration 1. Stone is quarried from three bench levels in open pits which are 50 to 60 feet deep. The stone is loaded with electric shovels and hauled southward 7 miles by electric rail to the dock at Port Inland on Lake Michigan. Here the stone is crushed, washed, sized and stockpiled awaiting lake shipment. The company also produces a smaller quantity of dolostone from a quarry in the Engadine Formation near its plant site.

Blaney or Nicholsonville Quarry

The site of the abandoned Blaney Quarry is in Section 3, T42N, R13W, Schoolcraft County, west of the present Inland Lime and Stone Quarry. R. A. Smith (1915) reported this area to be the largest extent of Fiborn limestone under thin drift cover. Old Department of Conservation maps label the now-flooded quarry as Calspar Quarry Pool. The quarry occupies approximately 40 acres and is located near the south central part of Section 3, approximately ¼ mile north of River Road (County Highway 433). The land is owned by Inland Lime and Stone Company.

Analysis of a composite sample of Fiborn limestone from the Blaney Quarry contained 95.87 percent $CaCO_3$, 3.76 percent $MgCO_3$ with 1.68 percent combined silica, iron and alumina (Smith, 1916, analysis 680). Kesling (1975) reported that 44 feet of Hendricks Formation, mostly Fiborn limestone was once exposed in the quarry.

Hendricks Quarry

The abandoned Hendricks Quarry is located in the western part of Mackinac County close to the southern boundary of Luce County. The quarry is about 11 miles southeast of Newberry, in Section 6, T44N, R8W. Cover Illustration 11 shows the author Harry Sorensen standing near an exposure of Fiborn strata in the northwest wall of the Hendricks Quarry.

When R. A. Smith visited the quarry prior to 1915 he reported it to be 1/8 mile long and from 8 to 25 feet deep. Smith noted that the high-purity calcium stone was 18 feet thick. Analyses of samples collected by Smith show that the high-calcium stone ranges from 89 to 99+ percent $CaCO_3$ (analyses 400 - 409, p. 296-97). Aside from $MgCO_3$, impurities (iron, silica, alumina) range from 0.67 to 1.34 percent. Most of the stone produced from the Hendricks Quarry was shipped by rail to the Union Carbide Company plant in Sault Ste. Marie, Michigan, for the production of calcium carbide.

Fiborn Quarry.

The abandoned Fiborn Quarry is situated 11 miles north of Epoufette in Section 16, T44N, R7W, Mackinac County. According to Smith (1915) p. 235 the quarry was originally called the Osborn Quarry and was the first to be opened in the Fiborn limestone. Smith named the Fiborn limestone from strata exposed in the Fiborn Quarry. His description of the exposed Fiborn beds is as follows (p. 236):

> The beds in the quarry are, on the whole, gray to buff gray, lithographic to dense grained, high calcium limestone, very brittle and breaking with a smooth conchoidal fracture and generally containing small disseminated calcite crystals. Locally the stone is finely banded and free from calcite crystals.

The maximum thickness of Fiborn limestone in the quarry is about 30 feet. Typically, marketable high-purity stone from the Fiborn Quarry averaged 95 percent $CaCO_3$, 2 to 3 percent $MgCO_3$ and 1 to 2 percent combined oxides of iron, alumina and silica.

## LIMESTONE EVALUATION PROGRAM

Field Reconnaissance

Reconnaissance field work over known Fiborn limestone occurrences was done in October, 1973 by the authors accompanied by R. Thomas Segall of the Michigan Geological Survey. Restrictions imposed by available equipment limited drilling sites to areas of outcrop. Furthermore, it was necessary to select stratigraphic intervals as close to the upper contact of the Hendricks Formation as possible because of depth limitations imposed by the small drilling rig.

An early decision was made not to reject a drilling site because of ownership. Consequently the drilling sites included Federal, State and private property. Nine sites were selected for core drilling. They spanned the area from near the Village of Cooks in Schoolcraft County on the western end to near Stalwart in Chippewa County on the extreme eastern end of the Northern Peninsula, a distance of nearly 110 miles (Figure 5).

During the winter of 1973-74 drilling plans were made, permission to drill on privately owned land was sought, drilling permits were secured and the necessary supplies purchased.

Core Drilling

Drilling equipment consisted of a portable GW-4 Winkie drill and a Robbins-Meyers water pump. The drill was capable of coring to a depth of approximately 100 feet using small diameter E-size rod. A 1-inch diameter core was produced from a 1½-inch diameter hole using IEX-size diamond bits.

The first hole was cored near Cooks in May, 1974. The hole was completed to a depth of 81.5 feet with core recovery slightly above 92 percent. A series of three two-week drilling periods was needed to complete the drilling program. The drilling was done in June, July and September. The holes penetrated strata either directly above the contact of the Fiborn Member or were drilled directly on pavement outcrops of Fiborn limestone. A total of 657 feet of core was drilled from the nine locations. Hole depths ranged from 52 to 86 feet, the average depth being 73 feet. Core recovery was good, ranging from 91.6 to 98.1 percent and averaging 93.5 percent. The locations of the drilling sites are shown in Figure 5 and locations and depths are listed in Table 2.

The light equipment performed admirably well, and except for drilling engine problems, which temporarily halted progress and delayed drilling from July until September, no major difficulties were encountered. The dense, finely crystalline to lithographic texture of the Fiborn limestone makes it very brittle. This characteristic made splitting of the small diameter core and wedging in the core barrel a common occurrence. When wedging occurred it was necessary to pull the drill stem and clear the core from the core barrel before continuing the drilling. Cover illustrations show the drilling equipment and crews in operation at several of the sites.

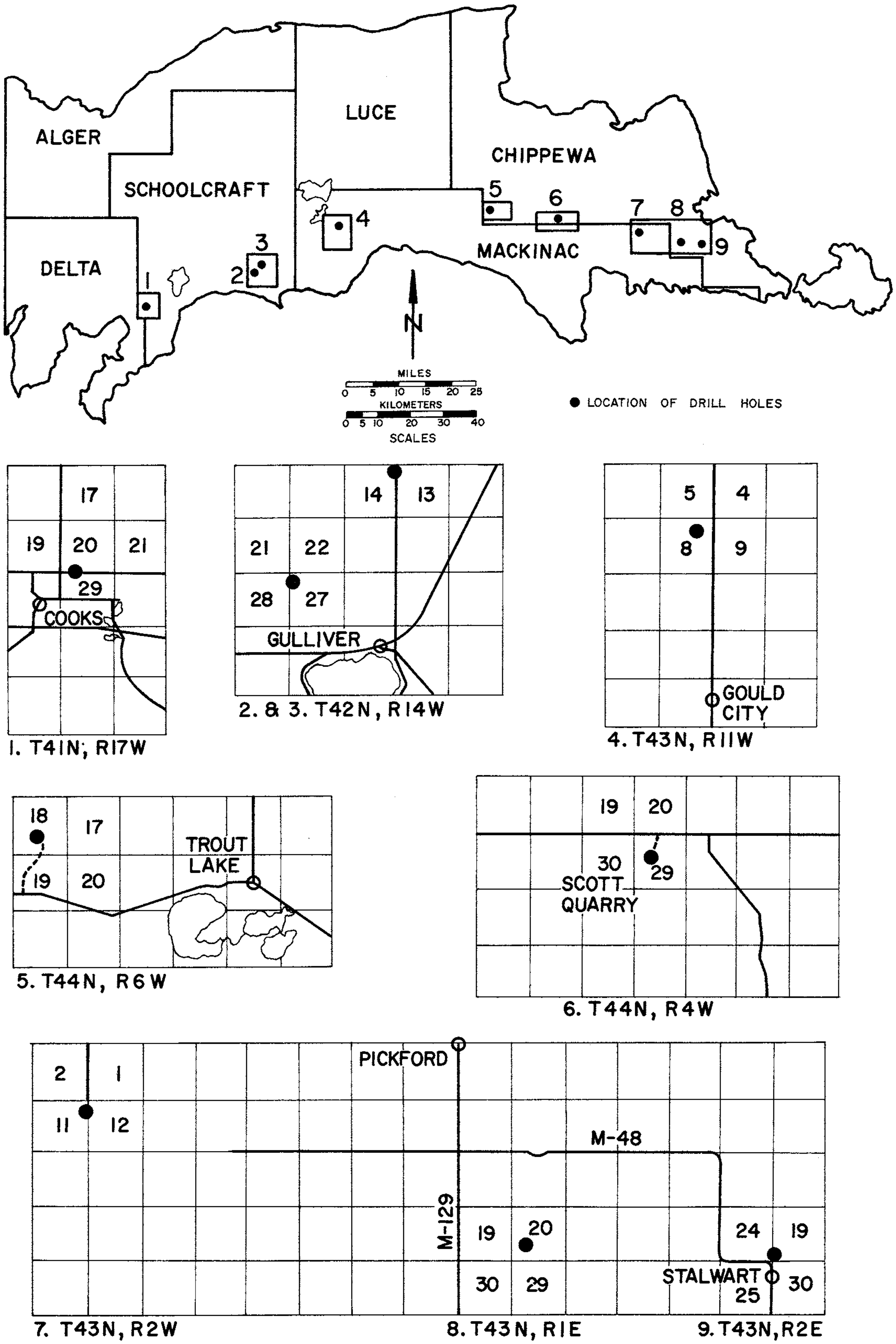



Figure 5. Map showing the drill site locations.

| CORE # | NAME | COUNTY | GENERAL LOCATION | PLAT LOCATION | DEPTH (FEET) |
|---|---|---|---|---|---|
| 1 | Cooks | Schoolcraft | 0.5 Mi N & 0.5 Mi E of Cooks | SE¼ SW¼ Sec. 20 T41N R17W | 81.5 |
| 2 | Gulliver #1 | Schoolcraft | 2 Mi W & 1.3 Mi N of Gulliver | NW¼ NW¼ Sec. 27 T42N R14W | 86.1 |
| 3 | Gulliver #2 | Schoolcraft | 3.2 Mi N of Gulliver on Cty Rd P-432 | NE¼ NE¼ Sec. 14 T42N R14W | 52.2 |
| 4 | Gould City | Mackinac | 3.25 Mi N & 0.3 Mi W of Gould City | NW¼ NE¼ Sec. 8 T43N R11W | 57.0 |
| 5 | Trout Lake | Chippewa | 4.25 Mi W & 0.75 Mi N of Trout Lake | NE¼ SW¼ Sec. 18 T44N R6W | 80.8 |
| 6 | Scott Quarry | Chippewa | 9 Mi E and 0.4 Mi S of Trout Lake | SE¼ NW¼ Sec. 29 T44N R4W | 83.8 |
| 7 | Pickford | Mackinac | 7 Mi W & 1.25 Mi S of Pickford on Fish Rd | NE¼ NE¼ Sec. 11 T43N R2W | 76.0 |
| 8 | Northwoods Camp | Chippewa | 7.25 Mi N and 1.25 Mi E of Cedarville | SE¼ SW¼ Sec. 20 T43N R1E | 70.3 |
| 9 | Stalwart | Chippewa | 0.3 Mi N of Stalwart | SW¼ SW¼ Sec. 19 T43N R2E | 67.9 |

Table 2. Fiborn limestone drill site locations and depths.

## Core Logging

Cores were boxed and returned to IMR until they could be logged in greater detail. Following the 1974 field season the authors, assisted by Jack VanAlstine, DNR Region I Geologist (Northern Peninsula) with the Michigan Geological Survey, convened at IMR to log cores. Discernible features were described. These features include mineralogy, color, texture, structure, lithology and identifiable fossils. In addition, the entire length of each core was tested with a 10% hydrochloric acid solution to differentiate between high-calcium and dolomitic zones. The descriptive core logs are in Appendix I.

Using the core log descriptions as a guide, each core was subdivided into approximately 10-foot intervals of similar lithology for analytical purposes prior to splitting. An effort was made to separate zones which would show high impurities upon analysis; specifically, these were chert zones high in silica, and dolomitic zones high in magnesium. Sixty-two core splits were made from the 657 feet of core and are listed in Appendix II. The cores were split longitudinally, one side of the split-core pieces were bagged to process for analysis and the other half retained in the core boxes in the eventuality of future needs. These split cores are available for examination at IMR on the campus of Michigan Technological University in Houghton, Michigan.

## Sample Preparation

The core halves which were bagged for processing were run through a jaw crusher to minus ¼-inch size. Roll crushing further reduced the size to minus 10-mesh. From the minus 10-mesh product a 100-gram sample was cut and pulverized to pass 100-mesh. The minus 100-mesh product was submitted for chemical analysis. The remaining minus 10-mesh material was bagged and is stored at IMR. The core processing steps are depicted schematically in Figure 6.

## Chemical Analysis

Chemical analyses were run on each of the 62 core intervals to quantify both major components and impurities. Analyses for calcium, magnesium and L.O.I. (loss-on-ignition) provide the basis for calculating the total carbonates, calcite and dolomite, present. Loss-on-ignition is the percentage of weight lost at high temperatures. In the limestone samples it is essentially the loss of $CO_2$ by calcining. Both calcium and magnesium content were determined by wet chemical means using the oxalate method.

The core intervals were also analyzed for silica, alumina, iron oxide and sulfur, which are considered to be impurities. Presence of silica was determined by a standard wet chemical gravimetric method. Total iron and aluminum content were measured by atomic absorption spectrophotometry, and tests for sulfur were run by an oxidation-idiometric device.

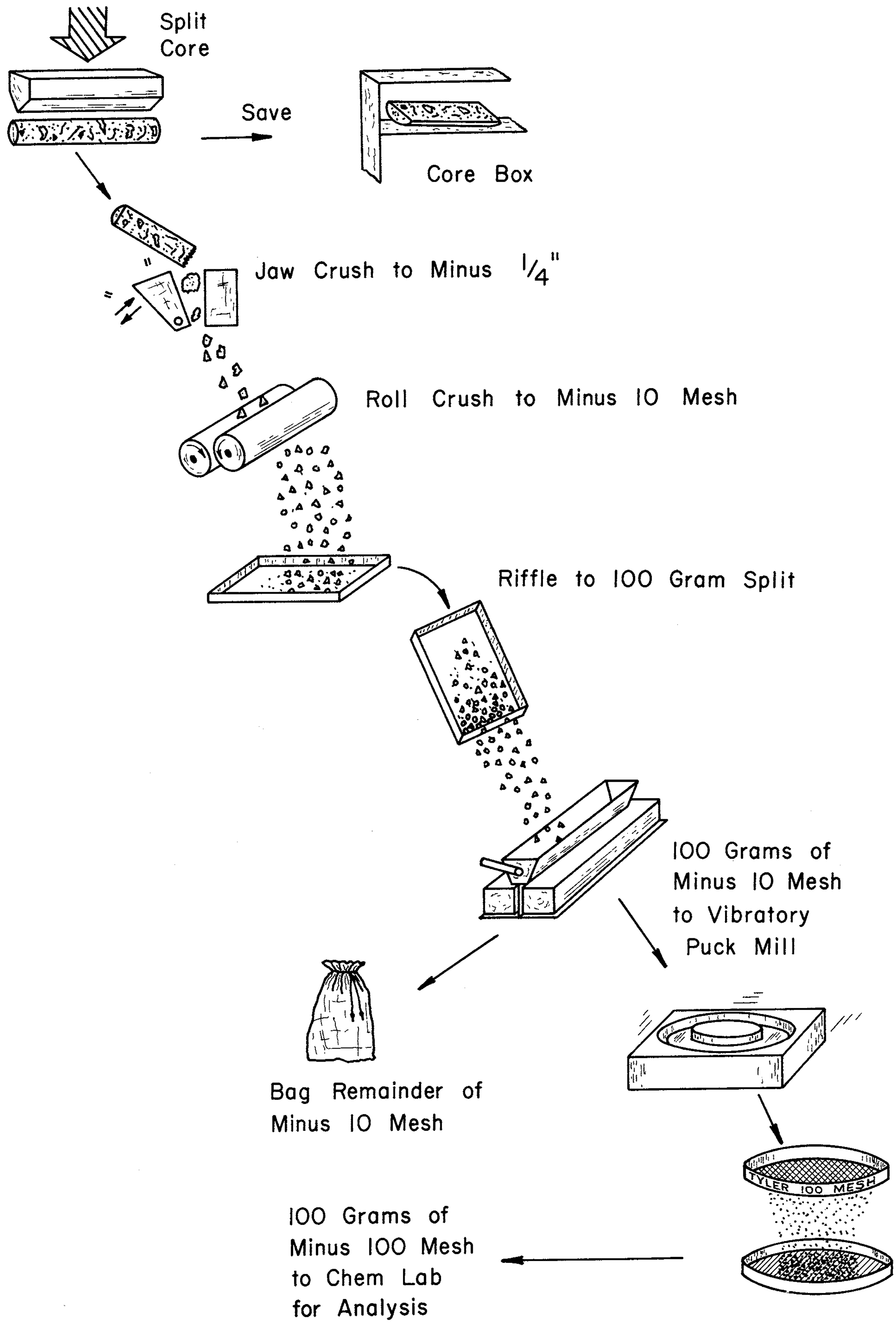



Figure 6. Schematic of core processing system for chemical analyses.

Zinc was routinely checked as its presence could indicate potential zinc mineralization. Zinc analyses were run by the atomic absorption method.

## RESULTS

### Core Evaluation

Of the nine cores logged and analyzed, two showed relatively great thicknesses of high-calcium stone, four had interbedded limestones and dolostones and three were completely dolomitized. The two cores having considerable thickness of high-purity limestone were those from the Gould City and Trout Lake locations (Figures 5 & 7). Four cores having thinner beds of high-calcium limestone interspersed with dolomitic limestone and dolostone were from the easternmost area; locations, from west to east, were Scott Quarry, Pickford, Northwoods Camp and Stalwart. The three dolomitized cores were from the far west area and included Gulliver #1, Gulliver #2 and the Cooks core (Figures 5 & 7).

Acid testing with a 10% hydrochloric acid solution proved to be an effective technique to distinguish high-calcium limestones from dolostones. High-purity limestones reacted with the acid solution, rapidly forming large and small bubbles and spattering. One observation made during this testing was that the high-calcium zones were extremely finely crystalline with a lithographic or micritic texture. This observation was born out by subsequent chemical analyses. Dolomitic limestones and dolostones were generally more coarsely crystalline. Reaction of the dolomitic limestones with 10% HCl was subdued and no apparent reaction (i.e. no effervescence of $CO_2$) occurred with dolostone (essentially pure dolomite).

In only one case was the lithology different from that indicated by acid testing. Normative analysis (conversion of chemical content to mineralogical content) of the Cooks core revealed a dolostone containing 95 percent dolomite and only 2 to 3 percent calcite. Considerable reaction to acid during testing led to the conclusion that it was much higher in calcite content. However, the calcite was secondary, being present largely as vug, pore and fracture fillings. These openings in the rock exposed the calcite to the acid, thus accounting for the intensity of reaction.

### Chemical Analyses

Results of chemical analyses for each of the cores are presented in Table 3. The calculated amount of calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) and the impurities $SiO_2$, $Al_2O_3$ and $Fe_2O_3$ for the intervals of each core are listed. Strip logs showing the collar elevations and the calcite content of each sample interval are shown in Figure 7. A complete

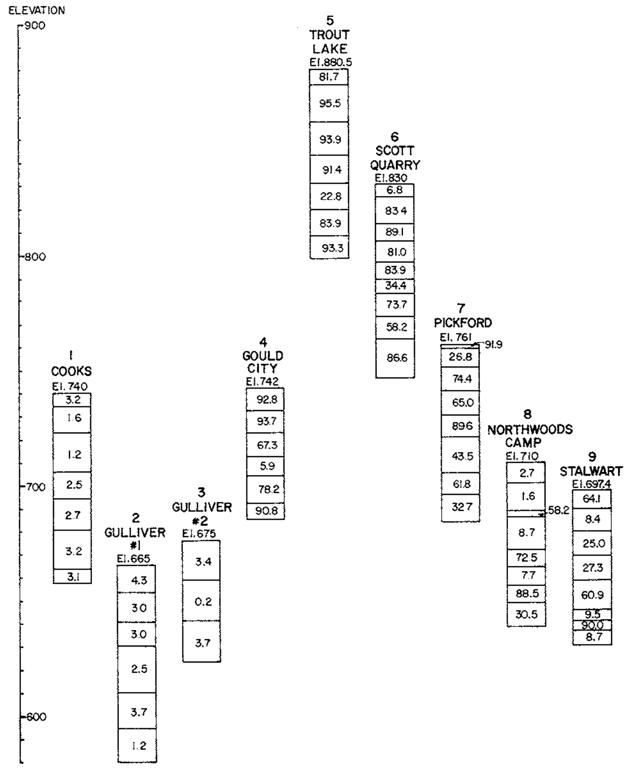



Figure 7. Strip logs showing elevation and calcite content for each sample interval.

tabulation of chemical analyses is included in Appendix II.

Results of chemical analyses, as shown in Table 3, show that the Cooks, Gulliver #1 and Gulliver #2 cores are extremely low in calcite, with average values of 2.4 percent, 2.9 percent, and 2.5 percent, respectively. In the same cores dolomite content averaged 95.9 percent, 93.5 percent and 95.3 percent.

The four cores taken from Gould City eastward to near Pickford contained more calcite than dolomite. These cores are Gould City, Trout Lake, Scott Quarry and Pickford. Average calcite contents in decreasing percentages in these cores, as shown in Table 3, are: Trout Lake 81.0 percent; Gould City 72.8 percent; Scott Quarry 71.7 percent and Pickford 56.1 percent.

East of the Pickford location dolomite content again predominates over calcite. Average calcite contents of the easternmost cores at Northwoods Camp and Stalwart locations are 27.1 percent and 33.8 percent, respectively. Corresponding dolomite contents are 69.5 percent and 61.4 percent.

## Major Impurities

Examination of Table 3 shows that among the major impurities $SiO_2$, $Fe_2O_3$ and $Al_2O_3$, silica is the most abundant, ranging from 79 to 89 percent of the total impurities. Apparently the silica is present primarily as chert. During core logging chert was observed to be present as porous, white, chalky nodules and lenses. No clastic quartz grains were observed, however no thin sections were prepared for petrographic microscope examination which would have provided more conclusive information on the silica morphology. Iron as $Fe_2O_3$ accounts for 5 to 10 percent of the impurities ranging from actual values of 0.12 to 0.30 percent in the cores. Iron is present as oxide coatings and occasionally as pyrite; it may also be tied up in the carbonate crystal lattice. Alumina accounted for the remaining 6 to 14 percent of total impurities in the nine cores.

The Cooks core contained the least amount of impurities, averaging 1.62 percent; the core from Stalwart contained the most with 4.57 percent (Table 3). Impurities found in the two high-calcium cores, Gould City and Trout Lake, amounted to 2.48 percent and 1.73 percent, respectively.

| Location | Depth (Ft.) | No. of Splits | CALCITE (%) | | DOLOMITE (%) | | TOTAL[3] IMPURITIES (%) | | IMPURITIES AVG. (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Range[1] | Avg.[2] | Range[1] | Avg.[2] | Range[1] | Avg.[2] | $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ |
| Cooks | 81.5 | 7 | 1.2 - 3.2 | 2.4 | 90.6 - 97.4 | 95.9 | 0.74 - 6.25 | 1.62 | 1.28 | 0.12 | 0.22 |
| Gulliver #1 | 86.1 | 6 | 1.2 - 4.3 | 2.9 | 90.6 - 96.5 | 93.5 | 1.74 - 5.44 | 3.59 | 3.06 | 0.19 | 0.34 |
| Gulliver #2 | 52.3 | 3 | 0.2 - 3.7 | 2.5 | 94.2 - 97.0 | 95.3 | 1.88 - 2.74 | 2.25 | 1.92 | 0.13 | 0.20 |
| Gould City | 57.0 | 6 | 5.9 - 93.7 | 72.8 | 5.0 - 91.5 | 24.7 | 1.21 - 5.86 | 2.48 | 2.11 | 0.23 | 0.14 |
| Trout Lake | 80.8 | 7 | 22.8 - 95.5 | 81.0 | 3.3 - 74.6 | 17.2 | 0.89 - 2.67 | 1.73 | 1.40 | 0.13 | 0.20 |
| Scott Quarry | 83.8 | 9 | 6.8 - 89.1 | 71.7 | 8.0 - 90.6 | 27.8 | 1.58 - 6.85 | 2.85 | 2.53 | 0.13 | 0.19 |
| Pickford | 77.7 | 8 | 26.8 - 91.9 | 56.1 | 6.4 - 70.4 | 40.2 | 1.69 - 5.78 | 3.61 | 3.16 | 0.17 | 0.28 |
| Northwoods Camp | 70.3 | 8 | 1.6 - 88.5 | 27.1 | 10.5 - 95.1 | 69.5 | 1.03 - 5.96 | 3.38 | 2.94 | 0.19 | 0.25 |
| Stalwart | 67.9 | 8 | 8.4 - 90.0 | 33.8 | 6.1 - 87.8 | 61.4 | 2.96 - 7.06 | 4.57 | 3.99 | 0.30 | 0.28 |

1 Ranges are percentages in separate core intervals.
2 Averages are weighted averages calculated as percentage of total core.
3 Total impurities are sum of $SiO_2$, $Fe_2O_3$ and $Al_2O_3$.

Table 3. Summary of the results of chemical analyses of cores.

## Minor Impurities

Sulfur analyses revealed generally low values with many less than 0.01 percent. Low sulfur content is characteristic of the Fiborn limestone; however, analyses of intervals from three separate cores disclosed values above 0.1 percent sulfur. These higher values were from: 1) Gulliver #1 core, (from 12.6 to 24.3 feet) 0.163 percent; 2) Stalwart core, (from 57.9 to 60.5 feet) 0.104 percent; and 3) Northwoods Camp core, (from 46.3 to 52.6 feet) 0.110 percent. Although small amounts of pyrite had been identified in some of the cores, none was observed during logging any of the above core intervals. It is possible that the sulfur is present as calcium sulfate minerals, either gypsum or anhydrite. Sulfur analyses for each core interval are listed in the detailed chemical analyses in Appendix II.

Zinc analyses were run on the carbonate samples as a matter of course so that potential zinc mineralization would be detected if present. Carbonate strata overlying Precambrian basement rocks near the edges of Paleozoic basins are recognized as favorable loci for zinc and lead mineralization of the Mississippi Valley type (Ohle, 1959). Sphalerite (ZnS) has been reported from Silurian rocks which are correlative to Northern Peninsula strata in the Bruce Peninsula of Ontario, Canada (Sangster and Liberty, 1971). The sphalerite occurs in concretions but is difficult to distinguish by color from the dolostone host rock.

Zinc concentrations were low. Individual values ranged from a lower level of detection at 10 ppm (parts per million) to a high of 80 ppm from one core interval (Stalwart core). The arithmetic average of zinc concentrates for all cores was 36 ppm.

## Calcium Limestones

Two cores, Gould City and Trout Lake, contained intervals of high-calcium limestone which may be suitable for industrial use. In the Gould City core two intervals in the upper 20 feet contained 92.8 and 93.7 percent calcite, or an average of 93.3 percent. Dolomite in this 20 feet of core averaged 5.25 percent which is equivalent to 1.15 percent magnesia (MgO). Impurities totaled 1.46 percent with silica amounting to 1.04 percent, iron oxide 0.27 percent and alumina 0.15 percent. Underlying strata are more dolomitic, but the bottom 6-foot interval is limestone containing 90.8 percent $CaCO_3$.

At the Trout Lake location the upper 49.1 feet of core was composed of four intervals averaging 92 percent $CaCO_3$; from top to bottom the separate intervals consisted of 7.9 feet of 81.7 percent $CaCO_3$, 15.1 feet of 95.5 percent $CaCO_3$, 15.3 feet of 93.9 percent $CaCO_3$ and 10.8 feet of 91.4 percent $CaCO_3$. The average dolomite content for the entire interval was 6.7 percent which is equivalent to 1.46 per cent magnesia. Impurities averaged 1.34 percent, the composition being 1.03 percent silica, 0.13 percent iron oxide and 0.18 percent alumina. The next lower interval, from 49.1 to 60.6 feet, was a limy dolostone containing 22.8 percent calcite and 74.6 percent dolomite. From 60.6 feet to the bottom of the hole at 80.8 feet the strata are limestones again, containing 12 feet of 83.9 percent $CaCO_3$ followed by 8.2 feet of 93.3 percent $CaCO_3$.

R. A. Smith described similar thin layers of higher purity limestones interspersed with more magnesium-rich beds from a 145-foot deep core drilled at the Hendricks Quarry (Smith 1915, p. 238).

Scott Quarry location, approximately 10 miles east of the Village of Trout Lake, does not have beds of high calcium limestone (95 percent or more $CaCO_3$); however, four core splits from the interval 6.8 to 40.7 feet contained 81.0 to 89.1 percent $CaCO_3$. The corresponding normative dolomite contents ranged from 8.0 to 14.5 percent dolomite (1.74 to 3.18 percent MgO). Although this stone contains too much magnesium for chemical uses, it apparently meets specifications for metallurgical stone and for the manufacture of cement.

Farther east at the Pickford, Northwoods Camp and Stalwart locations, the magnesium content is too variable between beds for the stone to be of interest for high-purity uses. Calcite contents of the Pickford core ranged from 26.8 to 91.9 percent with a weighted average of 56.1 percent calcite. Analyses from the Northwoods Camp core revealed an even more dolomitic composition with calcite ranging from 1.6 to 88.5 percent and having an average value of 27.1 percent. The Stalwart core analyzed similarly with calcite contents ranging between 8.4 and 90.0 percent and averaging 33.8 percent.

The Fiborn limestone member was absent from the three cores taken from the western area of the Hendricks Formation. These three cores, Cooks, Gulliver #1 and Gulliver #2 were extremely low in calcite, the greatest percentage in any interval being 4.3 percent. In fact, they are nearly pure dolostones with average dolomite percentages ranging from 93.5 to 95.9 percent. Their potential for use as flux stone is discussed in the next section.

## Economic Considerations

If our interpolations between drill holes are correct, economic thicknesses (20 feet or greater) of high-purity, high-calcium limestone are present from the location of the active quarry of Inland Lime and Stone Company in western Mackinac County and eastern Schoolcraft County to at least the vicinity of Trout Lake. It appears from both core analyses and field reconnaissance that the Trout Lake location is especially promising. Not only is the thickness of high-purity stone encouraging (nearly 50 feet) but also bedrock exposures are known over an area of several hundred acres in this vicinity. It is of interest to note that R. A. Smith had similar thoughts in 1923. Several letters attesting to this from the files of the Michigan Geological Survey Division of the DNR are included in Appendix III.

Excellent possibilities exist for development of high-purity limestones north of the Gould City area; however, according to the drill hole information the extractable thickness of high-purity stone is only about 20 feet. Fiborn limestone crops out in an area south and west of Gould City where Bethlehem Mines Corporation has been active in evaluating the land. In addition, prospects are good for obtaining high-purity limestone at the abandoned Fiborn and Hendricks quarries.

Metallurgical grade stone suitable for steel industry use may be available from the Fiborn member in the area east of Trout Lake. Here the magnesium level in the stone is higher than in the area further to the west; but according to analyses from the Scott Quarry core, the content may be within specifications for present blast furnace use. Core analyses from the interval 6.8 to 40.7 feet show an average near 85 percent $CaCO_3$. In a personal communication in 1973 with John Moffat*, General Manager and Vice President of Inland Lime and Stone Company, he confirmed that stone containing up to 3 percent MgO (13 percent dolomite) was acceptable for use as blast furnace flux. He also said that older specifications for open hearth high-calcium stone required a minimum of 96 percent $CaCO_3$; but this was no longer of great importance because the open hearth process is being replaced by the basic oxygen furnace. He also indicated that consistent chemistry was more important than rigid specifications with regard to CaO/MgO ratios.

* Deceased

Greater variability of CaO/MgO contents in strata further to the east, beyond the Scott Quarry location, makes it unlikely that adequate thicknesses of either high-purity limestone or suitable metallurgical stone will be found there.

West of Gulliver massive dolomitization of "Fiborn interval" strata rule out the presence of any high-calcium stone; however, these strata might some day be useful as dolomite stone. The presence of silica would be of major concern here, although the amount of silica appears to lessen with depth, especially in the Cooks drill core. This dolomite is generally more finely crystalline than much of the Engadine dolomite.

Fine crystallinity is desirable in metallurgical stone. The high surface area of the more finely crystalline stone reacts more rapidly and completely than coarsely crystalline stone in high temperature metallurgical reactions. The stone may also be suitable for use as aggregate.

## Depositional Model

Although the primary goal of the project was to develop economic information on the Fiborn limestone member, valuable scientific data also resulted from the study. Observations made in the field, during core logging and from examination of the chemical analyses provide clues to the geologic history of the Fiborn limestone. These clues promote a better understanding of the depositional environment of the limestone and of the subsequent diagenetic changes it underwent.

Carbonate sediments are for the most part deposited in shallow, warm tropical seas. They originate from an accumulation of the carbonate hard parts of a variety of marine organisms, from the breakdown of lime-secreting plants and perhaps, under proper conditions, from the inorganic precipitation of calcium carbonate from calcium-saturated waters.

Recent work has demonstrated quite conclusively that carbonate sediments are deposited originally as the calcium carbonate minerals, aragonite and calcite. The calcite often has varying magnesium content. Sedimentary dolomite is not normally a primary mineral. It forms later through the interaction of magnesium-rich brines with aragonite and metastable (magnesium) calcites.

Dolomitizing brines are most commonly formed by evaporation of normal sea water in shallow, restricted shelf areas as in back-reef, intertidal areas. A dry, hot climate favors brine formation. Dolomite forms from metastable calcium carbonates by reaction of magnesium-rich brines as follows:

$$2\ CaCO_3 \quad + \quad Mg^{++} \rightarrow CaMg(CO_3)_2 \quad + \quad Ca^{++}$$

| Calcium carbonates (Aragonite, calcites) | Magnesium ion | Dolomite | Calcium ion |
|---|---|---|---|

Several interesting observations can be made concerning the Fiborn limestone member: 1) it is the only non-dolomitized limestone in the Silurian section of rocks in northern Michigan; 2) the western extension of what would be the Fiborn limestone is completely dolomitized (approximately from Gulliver west and southwest through the Garden Peninsula); and 3) on the east, the Fiborn limestone is present as a series of thin limestone beds interspersed with dolostone layers.

The preservation of the relatively thick high-calcium Fiborn limestone lens (60') in the otherwise completely dolomitized Silurian section of rocks is of interest. Obviously the original finely crystalline carbonate mud did not come in contact with dolomitizing brines. It is quite likely that the muds were deposited in a near-normal saline environment similar to the lime mud deposits that are presently forming in the back-reef area of Florida Bay in the vicinity of Key Largo, Florida. Later dolomitization by the penetration of magnesium brines may have been inhibited by the very low permeability of the lime mud bed.

Massive dolomitization of the Fiborn interval of upper Hendricks strata from the area near Gulliver and to the west and southwest indicates that depositional conditions allowed brine interaction with the carbonate sediments. It is possible that in this area, the carbonate sediments were subjected to intermittent tidal flooding and exposure to the sun. Evaporation of the sea water by solar radiation concentrates magnesium and raises the temperature of the resulting brine making it an effective dolomitizing solution. Dolomitization under these conditions is presently taking place along the west shore of the Persian Gulf in Kuwait.

Intermittent dolomitization of carbonate strata to produce interlayers of limestone and dolostone depicts the conditions of deposition in the eastern area of the Fiborn member from about the village of Trout Lake eastward. These interbeds probably represent depositional conditions varying from a normal marine environment in which fine lime mud was deposited to more restricted intertidal conditions. Minor fluctuations in the relative level of the sediment-water interface probably best explain these variations.

An observation during core logging was that wherever the core had the typical Fiborn appearance, i.e., lithographic, conchoidal fracture and calcite-filled angular vugs, it is a high-calcium limestone of high purity. On the other hand, dolomitized zones have a more variable texture, are generally coarser grained and are often much more porous. These observations also suggest that the high-calcium Fiborn member has formed from a lime mud probably originally aragonitic, and that it has undergone only minor diagenetic changes. Obviously, except for the filling of the vugs with calcite crystals, there was not a great coarsening of the calcium carbonate when the aragonite altered to more stable calcite.

## SUMMARY AND CONCLUSIONS

Nine widely spaced core holes spanning approximately 110 miles of strike length of Upper Burnt Bluff Group strata were drilled in the eastern Northern Peninsula of Michigan. The cores were taken to obtain information on the economic potential of the Fiborn limestone member, a relatively thick lens of high-calcium limestone (60 feet maximum) found near the upper part of the Hendricks dolostone formation.

Core logging and chemical analysis indicated that the greatest thickness of the Fiborn limestone is present between the eastern margin of Schoolcraft County and the western edge of Chippewa County in the vicinity of the Village of Trout Lake. To the west, the Fiborn member is absent from the approximate vicinity of Gulliver in eastern Schoolcraft County into the Garden Peninsula in Delta County. The interval where the Fiborn could be expected to occur is completely dolomitized. To the east beginning near the vicinity of Trout Lake the Fiborn member consists of interbeds of high-calcium limestone and dolostone or dolomitic limestone.

Maximum thicknesses of high-calcium limestone from the nine locations were found at the Gould City and Trout Lake locations. The top 20 feet of the Gould City core average 93.3 percent calcite, 5.25 percent dolomite (1.15 percent MgO) and 1.46 percent combined impurities. The upper 49.1 feet of core from the Trout Lake location contained 92 percent calcite, 6.7 percent dolomite (1.46 percent MgO) and 1.34 percent impurities. These areas have the greatest potential for the production of high-calcium limestone. The Trout Lake area is especially promising because of the greater thickness of high-purity limestone.

Evidence suggests that the Fiborn limestone member was deposited originally as a fine lime mud in a back-reef environment. It is apparent that conditions were such that the lime sediments were not subjected to magnesium-rich dolomitizing brines during deposition. The very low permeability of the lime mud sediment may have further reduced the likelihood of later dolomitization. All other Silurian strata are completely dolomitized.

Chemical analysis has confirmed that wherever the Fiborn limestone is present as a lithographic, grey rock having a conchoidal fracture and containing angular vugs with calcite infilling, it is a high-calcium limestone of high purity.

Zinc analyses run on separate core intervals showed low concentrations and do not indicate the presence of zinc mineralization in any of the drilled locations.

## RECOMMENDATIONS

Because the intent of this work has been to define generally the distribution of high-purity stone, more detailed work is recommended. Probably the most productive work that could be done would be to confirm the continuity of high-calcium stone through Mackinac County. Information should be acquired on overburden thicknesses in this generally drift-covered area. Since the area is sparsely populated, there is a lack of water well information on thickness of the overburden. Geophysical techniques combined with limited augering is suggested as a means of obtaining this information. Several more drill holes are also warranted. Ideally one core hole could be drilled centrally between the Fiborn and Hendricks quarries. Two or three drill holes are warranted in the three townships separating the coring location north of Gould City and the Hendricks Quarry to the northeast.

Although the Fiborn limestone member is not expected to continue far into the Michigan Basin, as a high-purity stone, it may be present at depth beneath the area of T43N, R5 to 13W, along the northern shore of Lake Michigan between Epoufette or possibly Brevort and Port Inland. A drill hole near the shore of Lake Michigan deep enough to penetrate into the Burnt Bluff Group would rapidly prove or disprove this speculation. If a sufficient thickness of Fiborn limestone is present, an underground, near-dockside limestone mine might be considered as a future possibility. Advantages offsetting higher costs for an underground mine include less disturbance to the surface for environmental protection and nearness to cheap lake transportation. Year-round operation would also be possible.

Apparently much of the Fiborn limestone meets Portland Cement specifications. It is possible that one or more cement plants could be established in the Northern Peninsula. Nearby sources of shale would be needed. The Point Aux Chenes shale, lying stratigraphically above the Engadine dolostone, might supply this source. It crops out in southern Mackinac County. A drilling and analysis project is warranted to ascertain the availability and suitability of this shale for cement manufacture.

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Appendix I: DESCRIPTIVE CORE LOGS

| | |
|---|---|
| LOCATION: | Approximately 1 mile northeast of Cooks in $SE\frac{1}{4}$ $SW\frac{1}{4}$, Section 20, T41N-R17W, Schoolcraft County 1800' east of SW corner and approximately 35' north of county road in pavement exposure of outcrop. |
| DATE DRILLED: | May 7-9, 1974 |
| DRILLED BY: | Allan Johnson and Arthur Johnson, IMR, Michigan Technological University and Jerry Lewis, Michigan Geological Survey. |
| ELEVATION: | 740' (Topographic map and hand level) |
| DEPTH CORED: | 81.5' (24.8 m) IEX (1" Core, $1\frac{1}{2}$" hole) |
| LOGGED BY: | Harry Sorensen and Allan Johnson, July and December, 1974. |

LOCATION 1

CORE DESCRIPTION

HENDRICKS DOLOMITE

COOKS LOCALITY

SCHOOLCRAFT COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 13 | Dolostone; limy, brown, fine to very finely crystalline, dark gray zones 10 to 40 mm thick; occasional large vug with drusy calcite crystals; dense, breaks parallel to bedding. (Core recovery 6.5' or 1.98 m) | 6.5 | (2.0) | 6.5 | (2.00) |
| 12 | Dolostone; limy, light brown to buff and gray; medium crystallinity, small drusy vugs near top and central part of section, larger at bottom with dolomite crystals lining; fractures at 45°. (Core recovery 10.3' or 3.15 m) | 12.0 | (3.66) | 18.5 | (5.66) |
| 11 | Dolostone; limy, gray-brown to light brown; medium to coarsely crystalline, much recrystallization, irregularly nodular with yellow-brown rust stains around nodules; few medium vugs, drusy with calcite, becomes less nodular, more dense at base. (Core recovery 2.1' or 0.63 m) | 2.1 | (.64) | 20.6 | (6.30) |
| 10 | Dolostone; limy, more limy towards base; gray to dark gray and brown mottled zone, medium to coarsely crystalline, recrystallized from 20.6' to 24.2'; at 23.0' a 0.1' zone of light brown coarse gray dolostone (recrystallized); drusy vugs, calcite; from 24.2' to 26.7', light brown dolostone, medium to coarsely crystalline, recrystallized; few drusy small vugs, calcite; from 26.7' to 34.3' a brown to gray and buff dolostone becoming more limy at base, mottled coarse to medium gray, recrystallized, abundant small to large drusy vugs with calcite lining, denser with few vugs at base. (Core recovery 11.6' or 3.53 m) | 13.7 | (4.18) | 34.3 | (10.48) |
| 9 | Dolostone; limy, brown grading to light brown with depth and then with gray mottling (faint) near base; medium to coarsely crystalline, alternating coarse and medium zones from 37.8' to 39.0', coarse grained, porous, recrystallized zones 5 to 10 mm thick, not continuous through core but parallel to subparallel to | | | | |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 9 (cont.) | bedding; large vugs, drusy, dolomite in bottom .2 m, same, but with calcite in top 0.6 m, faint coral fossils at top, also has nodular appearance to 38', corals coarsely recrystallized; dense below center to vuggy zone at base. (Core recovery 10.7' or 3.28 m) | 12.5 | (3.81) | 46.8 | (14.26) |
| 8 | Dolostone; porous with zone of small vugs, gray, finely crystalline irregular shapes 3 mm to 5 mm thick in brown, recrystallized dolomite matrix; disturbed zone; light green stains at top (0.8 m thick). (Core recovery 0.2' or .08 m) | .3 | (0.09) | 47.1 | (14.35) |
| 7 | Dolostone; limy, finely crystalline, dense, gray-brown at top to gray at base, faint lighter brown laminae at top, coarser dark gray laminae zones at bottom. (Core recovery 2.3' or 0.71 m) | 2.3 | (0.70) | 49.4 | (15.06) |
| 6 | Dolostone; limy, brown grading to light gray in center of section and then brown again at base, finely crystalline dense, massive in center. (Core recovery 4.8' or 1.47 m) | 4.8 | (1.46) | 54.2 | (16.52) |
| 5 | Dolostone; limy, brown with minor gray mottling, medium grained; thin, black irregular wavy lines parallel to subparallel to bedding are where parting takes place; large calcite lined vugs; has appearance of nodular zone, becoming less distinct and more coarsely crystalline in bottom two feet of section. (Core recovery 4.8' or 1.47 m) | 5.0 | (1.52) | 59.2 | (18.04) |
| 4 | Dolostone; limy, buff to brown becoming grayish in center of section and then more brown at base; fine to medium crystallinity in upper section, dense, becoming coarsely crystalline in lower 0.43 m (porous, recrystallized); most prominent structure is hash-like zone of thin (2 mm) platelets coarsely recrystallized to dolomite in 0.2 m zone beginning 1.3' from bottom. (Core recovery 7.0' to 2.13 m) | 7.0 | (2.13) | 66.2 | (20.17) |
| 3 | Dolostone; limy, more so near base, brown, coarsely crystalline and porous in upper nodular zone to 72', grading into mottled medium crystalline brown and gray zone, becoming fine grained and dense in lower 3.5'; black, thin, wavy seams serve as partings in upper nodular zone, coarsely recrystallized dolomite rhombs; coral fossils; few medium drusy vugs about 2/3 down in section with calcite and dolomite crystal linings. (Core recovery 10.7' or 3.28 m) | 11.1 | (3.38) | 77.3 | (23.56) |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 2 | Dolostone; buff grading rapidly to brown and light grayish-brown, passing from dense, finely crystalline to porous, coarsely crystalline, recrystallized dolomite rhombs; few small vugs. (Core recovery 1.7' or 0.53 m) | 1.8 | (0.55) | 79.1 | (24.11) |
| 1 | Dolostone; buff to brown nodular zone with occasional gray nodule; medium to coarsely crystalline with very coarse, porous recrystallized coral zones; fine wavy black seams serve as partings subparallel to bedding; some small vugs. (Core recovery 2.3' or 0.71 m) | 2.4 | (0.73) | 81.5 | (24.84) |
| | Total | 81.5 | (24.84) | 81.5 | (24.84) |

(Total core recovery 75.3' or 92.4%)

Note: Core in 4 core boxes at IMR, Michigan Technological University.

Box #1, 0' to 27.5'; Box #2, 27.5'-53.5'; Box #3, 53.5' to 80.2'; Box #4, 80.2' to 81.5'

"Edgewise Conglomerate" at approximate depth of 45'.

Hole plugged to depth of 5' with concrete.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 2 miles west and 0.1 mile north of Gulliver in pavement outcrop on east shoulder of road in clearing. NW¼ NW¼, Section 27, T42N-R14W, Schoolcraft County. |
| DATE DRILLED: | June 4-5, 1974. |
| DRILLED BY: | Allan Johnson and John Jostock, IMR, Michigan Technological University and Harry Sorensen, Jerry Lewis and Kenneth Childs, Michigan Geological Survey. |
| ELEVATION: | 665' (topographic map and hand level) |
| DEPTH CORED: | 86.1' (26.2 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Harry Sorensen and Allan Johnson, July and December, 1974. |

LOCATION 2

CORE DESCRIPTION

HENDRICKS DOLOMITE

GULLIVER NO. 1 LOCALITY

SCHOOLCRAFT COUNTY

| Unit No. | Lithology | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 15 | Dolostone; limy, dense, grayish brown and finely crystalline with occasional thin gray zones 5 mm to 40 mm thick beginning at about 3.0' to 5.7', then becoming predominantly a darker gray with subordinate brown zones; some brown and gray mottling in lower half of section, also dark seams and several thin conglomeratic zones (10 mm) more massive in lower half and very finely crystalline. (Core recovery 12.6' or 3.84 m) | 12.6 | (3.8) | 12.6 | (3.8) |
| 14 | Dolostone; brown with gray (light and dark) mottling, black wavy seams, nodular structure and irregular parting on these subparallel to bedding features, finely crystalline, large, drusy, calcite-lined vugs at base. (Core recovery 4.7' or 1.45 m) | 4.7 | (1.5) | 17.3 | (5.3) |
| 13 | Dolostone; bluish-gray, with irregular spheroidal to lenticular brown and gray mottling, most conspicuous in top 0.25 m and in 0.15 m zone 2.2' above base, mottling ranges from 2 mm to 20 mm in size, rock is dense, massive, fine to very finely crystalline. (Core recovery 6.9' or 2.11 m) | 6.9 | (2.1) | 24.2 | (7.4) |
| 12 | Dolostone; brown to buff, nodular coral zone, gray to black uneven wavy partings and seams subparallel to bedding, medium to finely crystalline, medium to large vugs, drusy, lined with calcite. (Core recovery 4.9' or 1.5 m) | 4.9 | (1.5) | 29.1 | (8.9) |
| 11 | Dolostone; bluish-gray, subdued nodular structure in upper 0.33 m with black wavy seams grading to spot mottled interval in center of section, fine to very finely crystalline, dense; lower 1.51 m is more brown with blue-gray mottled markings, fine to medium crystallinity; wavy dark gray to black seams; two disturbed zones with fine | | | | |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 11 (cont.) | hash appearance, 20 mm thick beginning at 35.1' and 0.14 m thick at 35.5', dense. (Core recovery 7.3' or 2.24 m) | 7.5 | (2.3) | 36.6 | (11.2) |
| 10 | Dolostone; strongly mottled at large scale, brown, with light brown and gray to bluish-gray mottling, occasional small to medium vugs with drusy calcite near top, massive (long unbroken pieces of core and no marked bedding), grading into nearly structureless buff-brown dolostone at 47.5', coral at 40'; medium crystallinity at 48.5'; dolostone is brown with gray markings as seams and wavy lines subparallel to bedding; these structures become less prevalent towards base where last 0.3 m is buff-brown with occasional dark brown wavy line subparallel to bedding; whole bottom section is dense, medium to finely crystalline with occasional large and small calcite-lined vugs, also some vertical fractures cemented with clear calcite. (Core recovery 20.4' or 6.22 m) | 20.3 | (6.2) | 56.9 | (17.3) |
| 9 | Dolostone; brown with dark brown wavy laminae subparallel to bedding in 10-20 mm zones separated at 20-100 mm intervals with brown and gray indistinctly mottled dolostone, fine to medium crystallinity, dense; 40 mm zone of chert at 57.1'. (Core recovery 1.2' or 0.38 m) | 1.3 | (0.4) | 58.2 | (17.7) |
| 8 | Dolostone; brown strongly mottled gray and light brown in top 0.15 m with large drusy (calcite) vugs, grading into brown denser dolostone towards base, 0.14 m interval below 59.7' is nodular with dark brown wavy partings, medium crystallinity. (Core recovery 2.7' or 0.81 m) | 2.8 | (0.9) | 61.0 | (18.6) |
| 7 | Dolostone; gray grading to light gray, dark gray and then to brown at base, all with dark wavy laminae parallel or subparallel to bedding, a 0.16 m structureless brown-buff zone below 62.6' medium to coarsely crystalline; medium to large vugs, drusy, calcite-lined, and vertical fractures, calcite lining in bottom 0.57 m, also mottling in this zone. (Core recovery 7.8' or 2.39 m) | 7.8 | (2.4) | 68.8 | (21.0) |
| 6 | Dolostone; brown-gray, nodular with dark wavy laminae as partings, fine to medium crystallinity, white chert nodules abundant. (Core recovery 1.8' or 0.56 m) | 2.2 | (0.7) | 71.0 | (21.7) |
| 5 | Dolostone; brown, medium to coarsely crystalline, occasional dark wavy laminae, dense. (Core recovery 1.4' or 0.43 m) | 1.4 | (0.4) | 72.4 | (22.1) |
| 4 | Dolostone; brown with darker brown zone with chert in top 0.1 m (vuggy, drusy, calcite fossils), occasional dark wavy laminae in bottom and dense. (Core recovery 1.7' or 0.51 m) | 1.7 | (0.5) | 74.1 | (22.6) |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 3 | Dolostone; gray at top, light brown zone 0.1 m in center, brownish gray at base, very fine to medium crystallinity, dense, vertical calcite-healed fractures. (Core recovery 1.7' or 0.51 m) | 1.7 | (0.5) | 75.8 | (23.1) |
| 2 | Dolostone; brown with gray mottling, with nodular zone starting at 77.2' (0.21 m); 82.2' (0.75 m). In bottom 0.2 m brown with numerous dark wavy laminae parallel to sub-parallel to bedding, drusy, calcite-lined vertical fractures in upper 0.5 m of core, dense throughout, fine to medium crystal-linity. (Core recovery 9.5' or 2.9 m) | 10.2 | (3.1) | 86.0 | (26.2) |
| 1 | Dolostone; gray with buff mottling, fine to medium crystallinity. (Core recovery 0.1' or 0.03 m) | 0.1 | (0.03) | 86.1 | (26.2) |
| | Total | 86.1 | (26.2) | 86.1 | (26.2) |

(Total core recovery 84.4' or 98.1%)

Note: Core stored in 4 boxes at IMR, Michigan Technological University

Box #1, 0' to 24.5'; Box #2, 24.5' to 48.5'; Box #3, 48.5' to 74.0'; Box #4, 74.0' to 86.1'

Hole plugged with 5' of concrete.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 3.2 miles directly north of Gulliver on County Road P-432; at power pole No. 980 which is situated just east of a dilapidated shed by an abandoned farm house in the NE¼ NE¼, Section 14, T42N-R14W, Schoolcraft County. |
| DATE DRILLED: | June 7, 1974 |
| DRILLED BY: | Allan Johnson and Larry MacDonald, IMR, Michigan Technological University and Harry Sorensen and Jerry Lewis, Michigan Geological Survey. |
| ELEVATION: | 675' approx. (from 7½-minute topographic map) |
| DEPTH CORED: | 52.3' (15.9 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 3, 1974. |

LOCATION 3

CORE DESCRIPTION

HENDRICKS DOLOMITE

GULLIVER NO. 2 LOCALITY

SCHOOLCRAFT COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 4 | Dolostone; gray to light brown, mottled, medium to fine grained, vuggy with drusy vugs, minor white chert, porous, many indistinct corals. (Core recovery 5.7' or 1.73 m) | 6.1 | (1.9) | 6.1 | (1.9) |
| 3 | Dolostone; light gray, light brown in lower one foot, fine to medium crystallinity, dense, gray irregular wavy lines, sparse small vugs. (Core recovery 10.3' or 3.15 m) | 11.4 | (3.4) | 17.5 | (5.3) |
| 2 | Dolostone; gray to dark gray, predominantly medium crystallinity with some fine and coarsely crystalline zones, top 0.8' nodular, coarse recrystallized dolomite from 20.1' to 21.1', chert zones with crystallized dolomite, drusy vugs, coral fossils. (Core recovery 16.1' or 4.9 m) | 17.1 | (5.2) | 34.6 | (10.5) |
| 1 | Dolostone; light gray grading to brown and light brown toward bottom, very fine to finely crystalline at top grading to coarsely crystalline at bottom, dark gray wavy irregular lines produce light mottling, limy zone darker gray from 45.7' to 46.6', very few small vugs near bottom, upper portion of section dense, coral fossil at 43'. (Core recovery 17.7' or 5.38 m) | 17.7 | (5.4) | 52.3 | (15.9) |
| | Total | 52.3 | (15.9) | 52.3 | (15.9) |

(Total core recovery 49.8' or 95.2%)

Note: Core stored in two wooden boxes at IMR, Michigan Technological University.

Box #1, 0' to 27.4'; Box #2, 27.4' to 52.3'

Hole plugged with concrete to depth of 5'

| | |
|---|---|
| LOCATION: | Approximately 3.25 miles north and 0.3 mile west of Gould City in NW¼ NW¼ Section 8, T43N-R11W, Mackinac County. |
| DATE DRILLED: | June 6, 1974 |
| DRILLED BY: | Allan Johnson and John Jostock, IMR, Michigan Technological University and Harry Sorensen, Jerry Lewis and Kenneth Childs, Michigan Geological Survey. |
| ELEVATION: | 742' (Gould City NW Quadrangle) |
| DEPTH CORED: | 57.0'(17.4 m) IEX (1" core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 5, 1974. |

LOCATION 4

CORE DESCRIPTION

HENDRICKS DOLOMITE

GOULD CITY LOCALITY

MACKINAC COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 8 | Limestone; light gray, lithographic, dense, sparse small vugs near top, drusy and filled vugs near bottom with clear calcite. (Core recovery 5' or 1.52 m) | 5.2 | (1.6) | 5.2 | (1.6) |
| 7 | Limestone; brown in upper half to gray in lower half, lithographic to very finely crystalline at bottom, mostly massive, dense, mottling gray to brown at 5.2' to 6.4', 13.5' to 14.5', 15.4' to 17.4'; green calcite-filled vugs at 17.7' (25 mm long); abundant medium vugs at 20' to 21.2', drusy, dark gray irregular lines in bottom 2'; also vertical fracturing in bottom 2' (Core recovery 14.8' or 4.52 m) | 17.2 | (5.2) | 22.4 | (6.8) |
| 6 | Limestone; light brown, very fine to finely crystalline, dense, irregular gray markings, some laminae parallel to bedding; light colored finely crystalline spherical masses 5 mm to 10 mm in lower 4'. (Core recovery 6.2' or 1.91 m) | 6.3 | (1.9) | 28.7 | (8.7) |
| 5 | Limestone; gray to brown, nodular but less distinct at bottom of section, lithographic. (Core recovery 1.3' or 0.41 m) | 1.5 | (0.5) | 30.2 | (9.2) |
| 4 | Dolostone; bottom 4' limy, light brown to gray, very fine to coarsely crystalline; very porous zones at 33.3' to 34.2'; sugary texture from dolomite crystals, brown, as large as 0.5 mm; mottling, brown to dark gray from 34.1' to bottom but less distinct in bottom 1.7'; vugs, medium to large, drusy, in bottom 4'; sparse indistinct fossils scattered through section. (Core recovery 7.8' or 2.39 m) | 8.1 | (2.5) | 38.3 | (11.7) |
| 3 | Limestone; light brown in first 2' grading to gray in rest of section, dense, very finely crystalline to lithographic; very indistinct mottling in middle of section; black seams one foot from top; white chert with a cherty hash in bottom 0.2'; dark gray chert spheres 3 mm to 20 mm diameter, chert zone is 1.1' long to | | | | |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 3 (cont.) | bottom of section. (Core recovery 7.1' or 2.16 m) | 7.6 | (2.3) | 45.9 | (14.0) |
| 2 | Limestone; brown to gray, nodular becoming less distinct and mottled toward bottom; very finely crystalline, coral fossils; small vugs fairly abundant near top of section; several thin cherty zones. (Core recovery 3.8' or 1.17 m) | 4.2 | (1.3) | 50.1 | (15.3) |
| 1 | Limestone; gray becoming light gray at 53', darker gray zones throughout section; dense, finely crystalline, abundant dark gray fine stylolitic seams in bottom 3' of section; also becoming finer at bottom, but not lithographic. (Core recovery 6.7' or 2.06 m) | 6.9 | (2.1) | 57.0 | (17.4) |
| | Total | 57.0 | (17.4) | 57.0 | (17.4) |

(Total core recovery 52.9' or 92.8%)

Note: Core stored at IMR, Michigan Technological University.

Box #1, 0' to 26.6'; Box #2, 26.6' to 53.7'; Box #3, 53.7' to 57.0'

Evidence of the "Edgewise Breccia" at 45.8'.

Hole plugged with concrete for 0.6' at the top with expectation to drill to deeper depth next season.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 4.25 miles west and .75 mile north of Trout Lake on the north shoulder of east-west gravel road 1700 ft. east of the Mackinaw-Chippewa County line in the SW¼ NE¼ SW¼ Section 18, T44N, R6W, Chippewa County. |
| DATE DRILLED: | June 11, 1974 |
| DRILLED BY: | Allan Johnson and John Jostock, IMR, Michigan Technological University and Harry Sorensen, Jerry Lewis and Richard Lilienthal, Michigan Geological Survey. |
| ELEVATION: | 880.5' (See notes) |
| DEPTH CORED: | 80.7' (246 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 5, 1974. |

LOCATION 5

CORE DESCRIPTION

HENDRICKS DOLOMITE

TROUT LAKE LOCALITY

CHIPPEWA COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 15 | Limestone; light gray to light brown, very finely crystalline, calcite inclusions, occasional drusy cavities, vertical fracture. (Core recovery 3.7' or 1.14 m) | 3.7 | (1.1) | 3.7 | (1.1) |
| 14 | Limestone; light gray to dark gray, fine grading to medium at base, dense indistinct layering, sparse drusy vugs. (Core recovery 3.5' or 1.07 m) | 4.2 | (1.3) | 7.9 | (2.4) |
| 13 | Limestone; light gray to gray, brown in mottled zones, fine to very finely crystalline to lithographic at bottom, calcite inclusions, drusy cavities, mottling more prominent in lower 7', more open vugs above 19' level. (Core recovery 25.8' or 7.87 m) | 30.3 | (9.3) | 38.2 | (11.7) |
| 12 | Limestone; gray with yellow-green tinted mottling, massive, very finely crystalline sparse small vugs, corals. (Core recovery 2.1' or 0.64 m) | 2.1 | (0.6) | 40.3 | (12.3) |
| 11 | Limestone; light gray to brown, lithographic, small open vugs with some filled or drusy with calcite. (Core recovery 6.7' or 2.03 m) | 6.7 | (2.0) | 47.0 | (14.3) |
| 10 | Limestone; slightly dolomitic, very light gray, very finely crystalline, dense. (Core recovery 0.7' or 0.23 m) | 0.8 | (0.3) | 47.8 | (14.6) |
| 9 | Limestone; light gray, lithographic, light brown and dark gray laminae, small vugs. (Core recovery 1.3' or 0.41 m) | 1.3 | (0.4) | 49.1 | (15.0) |
| 8 | Limestone; very light brown, chalky, very finely crystalline, some medium, dense, massive, faint gray irregular lines, vuggy, drusy zone from 55.6' to 56.7'. (Core recovery 11' or 3.35 m) | 11.5 | (3.5) | 60.6 | (18.5) |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 7 | Limestone; light brown with dark gray irregular mottling; lithographic, coral fossils indicated. (Core recovery 1.3' or 0.38 m) | 1.7 | (0.5) | 62.3 | (19.0) |
| 6 | Limestone; light gray, finely crystalline to lithographic, dense, gray mottling, sparse coral fossils mostly near bottom. (Core recovery 4.2' or 1.27 m) | 4.2 | (1.3) | 66.5 | (20.3) |
| 5 | Limestone; light and dark gray, strong mottling grading into nodular with brown matrix at base, occasional small vugs, fossil coral at base. (Core recovery 5.8' or 1.78 m) | 6.1 | (1.8) | 72.6 | (22.1) |
| 4 | Limestone; gray, very finely crystalline, dense, sparse dark gray mottling, sparse small vugs, a 0.4' zone with green calcite-filled vugs 2' from top following irregular parting. (Core recovery 3.7' or 1.14 m) | 3.7 | (1.2) | 76.3 | (23.3) |
| 3 | Clay seam; red, plastic. (Core recovery 0.1' or 30 mm) | 0.1 | (0.03) | 76.4 | (23.3) |
| 2 | Limestone; gray, nodular with some brown matrix, dark gray stromatolitic structures. (Core recovery 1.5' or 0.46 m) | 1.5 | (0.5) | 77.9 | (23.8) |
| 1 | Limestone; light brown to light gray, finely crystalline to lithographic, dense, fine stylolites, irregular vertical vuggy zones, vugs partially filled with calcite. (Core recovery 2.6' or 0.77 m) | 2.8 | (0.8) | 80.7 | (24.6) |
| | Total | 80.7 | (24.6) | 80.7 | (24.6) |

(Total core recovery 74.1' or 91.8%)

Note: Core stored in 3 wooden boxes at IMR, Michigan Technological University.

Box #1, 0' to 30.0'; Box #2, 30.0' to 56.6'; Box #3, 56.6' to 80.7'

On the basis of lithology and the approximate stratigraphic position extrapolated from the southward dip of 50' per mile, the lower portion of Unit 8 may possibly be correlative to the "Edgewise Breccia". It was described by Ehlers in 1973 and is exposed in the top bed of the Sawheidle Quarry located in Section 14, T42N-R16W, Schoolcraft County.

Elevation determined by Dumpy leveling beginning at an elevation of 865 ft. at the intersection of a dirt road from the south and an east-west gravel road one quarter mile west of the east section line of section 18 thence traversing westward along the east-west road to the drill hole location. Levelling traverse made by Harry Sorensen and Jerry Lewis on September 20, 1974.

Hole plugged with concrete to depth of 5'.

Reference: Ehlers, G. M., 1973, (R. V. Kesling, ed.), Stratigraphy of the Niagaran Series of the Northern Peninsula of Michigan, Museum of Paleontology, Papers on Paleontology No. 3, 200 pp.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 8.8 miles east and 1.0 mile south of Trout Lake in the SW¼ SE¼ NW¼ Section 29, T44N-R4W, Chippewa County. Borehole on east edge of road trail leading southward up escarpment into Scott Quarry. |
| DATE DRILLED: | September 14 & 16, 1974 |
| DRILLED BY: | Allan Johnson and Larry MacDonald, IMR, Michigan Technological University and Harry Sorensen and Jerry Lewis, Michigan Geological Survey. |
| ELEVATION: | 830' (see note below) |
| DEPTH CORED: | 83.8' (25.6 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 5, 1974. |

LOCATION 6

CORE DESCRIPTION

HENDRICKS DOLOMITE

SCOTT QUARRY LOCALITY

CHIPPEWA COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | | |
| 11 | Dolostone; gray to brown, faint mottling in bottom 3', medium to finely crystalline, porous with drusy vugs throughout but more prominent in upper part, fossil coral indicated *Favosites?*, stylolite. (Core recovery 6.2' or 1.88 m) | 6.8 | (2.1) | 6.8 | (2.1) |
| 10 | Limestone; gray, medium to finely crystalline, finer at base, dark gray layered zones in upper 1', fossil coral at base. (Core recovery 7.4' or 2.26 m) | 7.8 | (3.4) | 14.6 | (4.5) |
| 9 | Limestone (nodular zone); gray to brown with dark gray mottling, faint reddish brown mottling at 16.7' to 17', coral fossils. (Core recovery 2.3' or 0.71 m) | 3.4 | (1.0) | 18.0 | (5.5) |
| 8 | Limestone; gray, medium to fine grained, some dark gray scattered layered zones, dense, no visible porosity. (Core recovery 7.2' or 2.18 m) | 8.2 | (2.5) | 26.2 | (8.0) |
| 7 | Limestone (nodular zone); gray to brown, more gray than brown at top, mottling more prevalent toward bottom, medium crystallinity, occasional white chert nodules, coral fossils. (Core recovery 5.0' or 1.52 m) | 7.0 | (2.1) | 33.2 | (10.1) |
| 6 | Limestone; light gray, finely crystalline, dense, long vertical fracture. (Core recovery 3.4' or 1.04 m) | 3.5 | (1.1) | 36.7 | (11.2) |
| 5 | Limestone (nodular zone); gray to brown mottling, medium to finely crystalline, irregular dark gray partings, stylolitic partings, coral fossils. (Core recovery 4' or 1.22 m) | 4.0 | (1.2) | 40.7 | (12.4) |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 4 | Limestone; in places dolomitic, gray to brownish, nodular near center and at base (1' below 43.3' and 1.2' below 47.3'), medium crystallinity, coral fossil. Note: dolomitic zone browner in color. (Core recovery 7.8' or 2.39 m) | 7.9 | (2.4) | 48.6 | (14.8) |
| 3 | Limestone; light gray, dense, medium to finely crystalline, white chert at base. (Core recovery 5.2' or 1.57 m) | 5.3 | (1.6) | 53.9 | (16.4) |
| 2 | Limestone (nodular zone); gray with brown mottling, fine to medium crystallinity, vuggy throughout interval, occasional white chert, coral fossils. (Core recovery 11.9' or 3.63 m) | 14.2 | (4.4) | 68.1 | (20.8) |
| 1 | Limestone; (top 1.8' dolomitic with chert nodule in center) gray to dark gray, slightly mottled, medium to finely crystalline, a 2' vuggy zone at 77.4', bottom 4.6' is a uniform dense, gray, finely crystalline limestone with some light brown layered zones, occasional small vugs throughout interval. (Core recovery 15.7' or 4.78 m) | 15.8 | (4.8) | 83.8 | (25.6) |
| | Total | 83.8 | (25.6) | 83.8 | (25.6) |

(Total core recovery 76.1' or 91.6%)

Note: Core stored in 3 wooden boxes at IMR, Michigan Technological University.

Box #1, 0' to 28.0'; Box #2, 28.0' to 56.0'; Box #3, 56.0' to 83.8'

Elevation surveyed in by Dumpy leveling to intersection of Dick Road with Highway 40 located approximately 0.5 mile to the north. Elevation from U. S. topographic quadrangle at intersection is 814'.

Hole plugged with concrete to depth of 5'.

Hole estimated to be about 10' below lower *Pentamerus* bed of the Schoolcraft formation of the Manistique Group.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 7 miles west and 1.2 miles south at Pickford, SE¼ NE¼ NE¼ Section 11, T43N-R2W, Mackinac City. (750' south of NE corner of section in west shoulder of road) |
| DATE DRILLED: | June 12 & 13, 1974 |
| DRILLED BY: | Allan Johnson and John Jostock, IMR, Michigan Technological University and Harry Sorensen, Jerry Lewis and Richard Lilienthal, Michigan Geological Survey |
| ELEVATION: | 761.2'(Topographic map and Dumpy leveling) |
| DEPTH CORED: | 77.7' (23.7 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Harry Sorensen and Allan Johnson, July and December, 1974 |

LOCATION 7

CORE DESCRIPTION

HENDRICKS DOLOMITE

PICKFORD LOCALITY

MACKINAC COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 13 | Limestone; gray to light brown with pinkish tinge, lithographic, fine stylolites; small vugs, drusy to filled with calcite crystals (Typical Fiborn limestone). (Core recovery 1.7' or 0.51 m) | 1.7 | (0.5) | 1.7 | (0.5) |
| 12 | Limestone; dolomitic, very light brown grading to light brown, finely crystalline, massive, dense, chalky, fossils (small brachiopod) (Core recovery 3' or 0.91 m) | 3.7 | (1.1) | 5.4 | (1.6) |
| 11 | Limestone; variably dolomitic, brownish-gray to gray, finely crystalline to medium crystalline at base, dense, massive, lime mud pellets? Shards 2 to 10 cm from 8.2' to 8.4' and rusty hematite staining in same areas associated with indistinct fossils, scattered small vugs. (Core recovery 3.9' or 1.19 m) | 4.6 | (1.4) | 10.0 | (3.0) |
| 10 | Limestone; gray with dark gray mottled zones (corals), finely crystalline, scattered medium and small vugs. (Core recovery 1.1' or 0.33 m) | 1.1 | (0.4) | 11.1 | (3.4) |
| 9 | Limestone; gray, finely crystalline, dense uniform texture and color, nearly structureless, white chert (chalky) as lenses in lower half of section; scattered small to medium vugs, some hematite rust near base (0.3'). (Core recovery 6.9' or 2.11 m) | 9.0 | (2.7) | 20.1 | (6.1) |
| 8 | Limestone; gray to brown in mottled and nodular zones, dolomitic limestone from 27.8' to base of section at 30.9', finely crystalline, nodular (coral zone) from top to 27.8' where core grades into mottled dolomitic limestone, "shale" pebble conglomerate. "Shale" pebble horizons also at 24.5' to 24.7' and 26.5' to 26.8'. Small to medium vugs, drusy throughout, more abundant in | | | | |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 8 (cont.) | nodular zone, white chalky chert in upper 6' of nodular zone. (Core recovery 10.8' or 3.30 m) | 10.8 | (3.3) | 30.9 | (9.4) |
| 7 | Limestone; light gray to gray, lithographic at top to finely crystalline at base, dense, massive grading into mottled and then nodular (coral zone) at base, small to medium drusy. (Core recovery 2.8' or .86 m) | 2.8 | (0.9) | 33.7 | (10.3) |
| 6 | Limestone; (conglomerate zone) gray with light brown pebbles (flat lenses and pebbles 1 mm to 1 cm, fairly dense, trace of fossils, brachiopods?) at top. (Core recovery 1.7' or .53 m) | 1.6 | (0.5) | 35.3 | (10.8) |
| 5 | Limestone; gray, very finely crystalline dense, conglomeratic zone within 5 m of base. (Core recovery 1.9' or .58 m) | 1.9 | (0.6) | 37.2 | (11.4) |
| 4 | Limestone; gray to brown, finely crystalline, nodular (coral?) zone, some white chalky chert in center, occasional small to medium vugs. (Core recovery 2.6' or .79 m) | 2.9 | (0.8) | 40.1 | (12.2) |
| 3 | Limestone with dolomitic limestone zones: 42.3' to 44.2', 45.9' to 47.5', 51.9' to 52.2'; light gray to gray to brown, dolomitized areas generally more brown, very fine to finely crystalline, dark brown, thin irregular wavy laminae at top grading to gray color in center of section and upper part of lower half; stylolites, dark, plentiful; dense, very few vugs and these more plentiful near base; several .5 m thicknesses of white chert above 50'. (Core recovery 15.4' or 4.73 m) | 16.5 | (5.1) | 56.6 | (17.3) |
| 2 | Limestone; gray to brown, nodular grading to mottled dolomitic limestone at 63.7' and becoming more faintly mottled toward bottom; lithographic to finely crystalline from top down; corals and large drusy vugs in nodular section, dolomitic zones more dense. (Core recovery 10.2' or 3.15 m) | 10.2 | (3.1) | 66.8 | (20.4) |
| 1 | Limestone; gray with dolomitic zones at 68.9' to 74.2' and bottom 0.5' of section, dolomitic zones are light brown; limestone to 68.9' has dark gray laminae, grades into gray-brown dolomitic limestone with dark fine laminae, very fine to finely crystalline, dense, only small vugs in one 0.5' zone 1.5' from bottom. (Core recovery 10.7' or 3.3 m) | 10.0 | (3.3) | 77.7 | (23.7) |
| | Total | 77.7 | (23.7) | 77.7 | (23.7) |

(Total core recovery 72.8' or 93.7%)

Note: Core stored in 3 boxes at IMR, Michigan Technological University.

Box #1, 0' to 28.0'; Box #2, 28.0' to 54.5'; Box #3, 54.5' to 77.7'

Hole plugged to depth of 5' with concrete.

| | |
|---|---|
| LOCATION: | Approximately 7.25 miles north and 1.25 miles east of Cedarville in a small abandoned gravel pit 600' NE of the SE-NW road leading into Northwoods Camp in the NW¼ SE¼ SW¼ Section 20, T43N, R1E, Chippewa County. |
| DATE DRILLED: | September 12 & 13, 1974 |
| DRILLED BY: | Allan Johnson and Larry MacDonald, IMR, Michigan Technological University and Harry Sorensen and Jerry Lewis, Michigan Geological Survey. |
| ELEVATION: | 710' approximately (from 7½-minute topographic map) |
| DEPTH CORED: | 70.3' (21.4 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 4, 1974. |

LOCATION 8

CORE DESCRIPTION

HENDRICKS DOLOMITE

NORTHWOODS CAMP LOCALITY

CHIPPEWA COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | | |
| 9 | Dolostone; limy in places, light gray to light brown, dense, fine to medium indistinct mottling at base. (Core recovery 7.1' or 2.16 m) | 7.1 | (2.2) | 7.1 | (2.2) |
| 8 | Dolostone; gray to brown, medium to coarsely crystalline drusy vugs, small vugs with white chert and chert replacement in stringers, very porous, fossiliferous (*Pentamerus* sp. abundant from 7.1' to 9.7' and with corals below). (Core recovery 7.7' or 2.34 m). *Pentamerus* sp. and corals. | 8.3 | (2.5) | 15.4 | (4.7) |
| 7 | Dolostone; light gray to light to dark brown with gray mottling and layering; quite vuggy with some drusy in lower half of section, fine to medium crystallinity, fossil gastropod indicated. (Core recovery 4.7' or 1.42 m) | 5.7 | (1.7) | 21.1 | (6.4) |
| 6 | Limestone; light gray with wavy and even layering, finely crystalline, dense. (Core recovery 1.8' or 0.53 m) | 2.0 | (0.6) | 23.1 | (7.0) |
| 5 | Dolostone; light brown in center, light gray in upper and lower part of section, some mottling that is more pronounced in middle of section, vugs and drusy vugs from 29.3' to 30.7', limy interval from 32.2' to 32.4' which is dark gray and brown and characterized by layering, white nodular chert zones, corals. (Core recovery 14.9' or 4.55 m) | 15.2 | (4.7) | 38.3 | (11.7) |
| 4 | Limestone (nodular zone); gray with light buff markings, grading from nodular to mottled and dolomitic at the base, medium crystallinity at top and medium to fine at the bottom, white chert nodules and sparse vugs in upper half. (Core recovery 7.2' or 2.21 m) | 7.9 | (2.4) | 46.2 | (14.1) |

| Unit No. | Lithology & Description | Unit Thickness (Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 3 | Dolostone; gray to brown grading to more brownish at bottom, characterized by dark gray mottling, fine to medium crystallinity, white chert nodules in lower 2', coral fossils sparse. (Core recovery 5.6' or 1.7 m) | 6.4 | (1.9) | 52.6 | (16.0) |
| 2 | Limestone; light gray, mottled and with light brown markings, very finely crystalline to lithographic, occasional vugs, fossil indications in upper portion (Core recovery 7.2' or 2.21 m) | 7.6 | (2.4) | 60.2 | (18.4) |
| 1 | Dolostone; predominantly brown, brown and dark gray mottling at top, very light gray at bottom, gray limestone from 65.1' to 66.2', medium crystallinity grading to fine at bottom, white chert near top of section. (Core recovery 9.3' or 2.84 m) | 10.1 | (3.0) | 70.3 | (21.4) |
| | Total | 70.3 | (21.4) | 70.3 | (21.4) |

(Total core recovery 65.5' or 93.1%)

Note: Core stored in 6 cardboard boxes at IMR, Michigan Technological University.

Box #1, 0 to 12.1'; Box #2, 12.1' to 24.4'; Box #3, 24.4' to 36.7'; Box #4, 36.7' to 48.2'; Box #5, 48.2' to 61.0'; Box #6, 61.0' to 70.3'

Hole plugged with concrete to depth of 5'.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

| | |
|---|---|
| LOCATION: | Approximately 0.3 miles north of Stalwart on the east road shoulder or approximately 0.1 mile north of SW corner of Section 19, T43N, R2E and about 14 ft. west and 10 ft. south of power pole No. PD2-201-30, Chippewa County. |
| DATE DRILLED: | September 10 & 11, 1974 |
| DRILLED BY: | Allan Johnson and Larry MacDonald, IMR, Michigan Technological University and Harry Sorensen and Jerry Lewis, Michigan Geological Survey. |
| ELEVATION: | 697.4' |
| DEPTH CORED: | 67.9' (20.7 m) IEX (1" Core, 1½" hole) |
| LOGGED BY: | Allan Johnson, Jack VanAlstine and Harry Sorensen, December 4, 1974. |

LOCATION 9

CORE DESCRIPTION

HENDRICKS DOLOMITE

STALWART LOCALITY

CHIPPEWA COUNTY

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| | HENDRICKS DOLOMITE (Fiborn limestone member) OF THE BURNT BLUFF GROUP: | | | | |
| 12 | Limestone; light gray, medium to finely crystalline, occasional pores in top 0.7', structureless. (Core recovery 2.0' or 0.61 m) | 2.0 | (0.6) | 2.0 | (0.6) |
| 11 | Limestone (nodular zone); gray to dark gray with brown mottling, medium crystalline, vuggy, drusy cavities, dolomite in bottom 0.3' to 0.4', coral fossils *Favosites* sp.?, *Halysites* sp.?. Note: all nodules finely crystalline and matrix brownish (Core recovery 5.6' or 1.7 m) | 6.6 | (2.0) | 8.6 | (2.6) |
| 10 | Limestone; dolomitic, light gray to buff with faint mottling near top, finely crystalline, dense, occasional small vugs, sparsely fine pores. (Core recovery 2.7' or 0.84 m) | 3.4 | (1.1) | 12.0 | (3.7) |
| 9 | Limestone; dark gray and brown, medium to finely crystalline, thin wavy (stromatolitic) bedding (Core recovery 0.5' or 0.15 m) | 0.5 | (0.1) | 12.5 | (3.8) |
| 8 | Limestone; dolomitic, light gray to buff, fine grained, wavy dark gray laminae (1 mm to 0.25 mm wide), laminae more prevalent near top and bottom, grading to limestone at base. (Core recovery 5.9' or 1.8 m) | 6.0 | (1.8) | 18.5 | (5.6) |
| 7 | Limestone; with dolomitic limestone zones, light gray to buff and brown, medium to finely crystalline, characterized by wavy stromatolitic laminae, gray to dark gray, dense aphanitic light gray 5 mm to 30 mm thick toward upper middle part of section, laminae sparse in lower central section, pin-point vugs generally sparse throughout section. (Core recovery 20.1' or 6.12 m) | 21.3 | (6.5) | 39.8 | (12.1) |

| Unit No. | Lithology & Description | Unit Thickness Feet | (m) | Depth Cored Feet | (m) |
|---|---|---|---|---|---|
| 6 | Limestone; lithographic, nodular, gray to brown, fossil indications - gastropod? (Core recovery 0.7' or 0.2 m) ("Typical" Fiborn limestone) | 0.7 | (0.2) | 40.5 | (12.3) |
| 5 | Limestone (nodular zone); dense, light gray nodules with softer, finely crystalline matrix; upper 1.7' gray limestone grading sharply to nodular, some small vugs, some drusy. Coral fossil - *Favosites* sp.? (Core recovery 6' or 1.83 m) | 7.3 | (2.3) | 47.8 | (14.6) |
| 4 | Limestone; mottled brown and gray at top and brown grading to layered dark gray and brown at bottom, medium to fine grained, sparse vugs at top. (Core recovery 4.3' or 1.32 m) | 4.6 | (1.4) | 52.4 | (16.0) |
| 3 | Dolomitic limestone to limy dolomite; brown to buff with light and dark gray layered zones, stromatolitic in upper part, less prevalent near base, fine to medium crystalline, dense and massive, no visible porosity. (Core recovery 5.2' or 1.6 m) | 5.5 | (1.7) | 57.9 | (17.7) |
| 2 | Limestone; lithographic, gray to light brown, medium grained, dark gray layered zones in bottom 0.8'. (Core recovery 2.5' or 0.76 m) | 2.5 | (0.7) | 60.4 | (18.4) |
| 1 | Dolomite; limy, brown-gray, fine to medium grained, dense, faintly mottled at top and less so at bottom, small scale nodular and layered zone near center of section that is 0.7' thick. (Core recovery 7.5' or 2.29 m) | 7.5 | (2.3) | 67.9 | (20.7) |
| | Total | 67.9 | (20.7) | 67.9 | (20.7) |

(Total core recovery 63.1' or 92.9%)

Note: Core stored at IMR, Michigan Technological University, Houghton, Michigan.

Wooden Box #1, 0' to 27.6'; Wooden Box #2, 27.6' to 55.7'; Cardboard Box #3, 55.7' to 67.9'

Hole plugged with concrete to depth of 5'.

Measurements originally expressed in feet and inches have been converted to feet and rounded to the nearest tenth. Those originally expressed in centimeters are now meters, to the nearest tenth.

Appendix II: CHEMICAL ANALYSES

CHEMICAL ANALYSIS*
(Hendricks Formation Core Tests)

| Map No. | Sa. No. | From | To | Sample Thick. | % CaO | % Calcite $CaCO_3$ | % MgO | Dolomite $CaMg(CO_3)_2$ | Total Carbonate | % $SiO_2$ | % $Fe_2O_3$ | % $Al_2O_3$ | % Zn | % S | Total Impur. | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cooks Locality, Schoolcraft County | | | | | | | | | | | | | | | | |
| 1 | 1 | 0' | 6.5' | 6.5' | 29.4 | 3.2 | 19.8 | 90.6 | 93.8 | 5.01 | 0.36 | 0.88 | .003 | .003 | 6.26 | 100.06 |
| | 2 | 6.5' | 18.5' | 12.0' | 30.2 | 1.6 | 21.1 | 96.5 | 98.1 | 1.53 | 0.12 | 0.22 | .003 | .004 | 1.88 | 99.98 |
| | 3 | 18.5' | 34.3' | 15.8' | 30.3 | 1.2 | 21.3 | 97.4 | 98.6 | 0.91 | 0.11 | 0.16 | .003 | .004 | 1.19 | 99.79 |
| | 4 | 34.3' | 46.8' | 12.5' | 30.7 | 2.5 | 21.1 | 96.5 | 99.0 | 0.57 | 0.07 | 0.13 | .003 | .006 | .78 | 99.78 |
| | 5 | 46.8' | 59.2' | 12.4' | 30.8 | 2.7 | 21.1 | 96.5 | 99.2 | 0.46 | 0.10 | 0.18 | .002 | .006 | .75 | 99.95 |
| | 6 | 59.2' | 77.3' | 18.1' | 30.7 | 3.2 | 20.8 | 95.1 | 98.3 | 1.27 | 0.10 | 0.17 | .002 | .004 | 1.55 | 99.85 |
| | 7 | 77.3' | 81.5' | 4.2' | 30.9 | 3.1 | 21.0 | 96.7 | 99.8 | 0.76 | 0.06 | 0.07 | .002 | .006 | 0.90 | 100.10 |
| Gulliver No. 1 Locality, Schoolcraft County | | | | | | | | | | | | | | | | |
| 2 | 1 | 0' | 12.6' | 12.6' | 30.0 | 4.3 | 19.8 | 90.6 | 94.9 | 4.20 | 0.31 | 0.67 | .002 | .084 | 5.27 | 100.17 |
| | 2 | 12.6' | 24.2' | 11.7' | 29.5 | 3.0 | 20.0 | 91.5 | 94.5 | 4.43 | 0.30 | 0.71 | .002 | .163 | 5.61 | 100.11 |
| | 3 | 24.2' | 36.7' | 12.4' | 30.1 | 3.0 | 20.4 | 93.3 | 96.3 | 3.09 | 0.16 | 0.30 | .002 | .050 | 3.60 | 99.90 |
| | 4 | 36.7' | 56.9' | 20.2' | 30.5 | 2.5 | 20.9 | 95.6 | 98.1 | 1.42 | 0.14 | 0.18 | .003 | .038 | 1.78 | 99.88 |
| | 5 | 56.9' | 71.0' | 14.1' | 29.9 | 3.7 | 20.0 | 91.5 | 95.2 | 4.48 | 0.14 | 0.19 | .002 | .069 | 4.88 | 100.08 |
| | 6 | 71.0' | 86.1' | 15.1' | 30.0 | 1.2 | 21.1 | 96.5 | 97.7 | 1.86 | 0.14 | 0.19 | .001 | .065 | 2.26 | 99.96 |
| Gulliver No. 2 Locality, Schoolcraft County | | | | | | | | | | | | | | | | |
| 3 | 1 | 0' | 17.5' | 17.5' | 30.7 | 3.4 | 20.7 | 94.7 | 98.1 | 1.50 | 0.15 | 0.23 | .001 | .069 | 1.95 | 100.05 |
| | 2 | 17.5' | 34.6' | 17.1' | 29.6 | 0.2 | 21.2 | 97.0 | 97.2 | 2.48 | 0.11 | 0.15 | .001 | .004 | 2.75 | 99.95 |
| | 3 | 34.6' | 52.3' | 17.7' | 30.7 | 3.7 | 20.6 | 94.2 | 97.9 | 1.78 | 0.14 | 0.22 | .002 | .009 | 2.15 | 100.05 |
| Gould City Locality, Mackinac County | | | | | | | | | | | | | | | | |
| 4 | 1 | 0' | 10.0' | 10.0' | 53.7 | 92.8 | 1.2 | 5.5 | 98.3 | 1.14 | 0.27 | 0.16 | .002 | .006 | 1.58 | 99.88 |
| | 2 | 10.0' | 20.0' | 10.0' | 54.0 | 93.7 | 1.1 | 5.0 | 98.7 | 0.94 | 0.27 | 0.14 | .001 | .025 | 1.38 | 100.08 |
| | 3 | 20.0' | 30.2' | 10.2' | 47.2 | 67.3 | 6.9 | 31.3 | 98.6 | 0.89 | 0.18 | 0.14 | .002 | .010 | 1.22 | 99.82 |
| | 4 | 30.2' | 38.3' | 8.1' | 31.1 | 5.9 | 20.0 | 91.5 | 97.4 | 2.12 | 0.26 | 0.20 | .001 | .060 | 2.64 | 100.04 |
| | 5 | 38.3' | 50.1' | 11.8' | 48.7 | 78.2 | 3.5 | 16.0 | 94.2 | 5.53 | 0.20 | 0.13 | .002 | .070 | 5.93 | 100.13 |
| | 6 | 50.1' | 57.0' | 6.9' | 53.2 | 90.8 | 1.7 | 7.5 | 98.3 | 1.14 | 0.17 | 0.10 | .003 | .060 | 1.47 | 99.77 |
| Trout Lake Locality, Chippewa County | | | | | | | | | | | | | | | | |
| 5 | 1 | 0' | 7.9' | 7.9' | 51.0 | 81.7 | 3.74 | 17.1 | 98.8 | 0.70 | 0.09 | 0.10 | .002 | .016 | 0.91 | 99.71 |
| | 2 | 7.9' | 23.0' | 15.1' | 54.5 | 95.5 | 0.72 | 3.3 | 98.8 | 0.92 | 0.10 | 0.14 | .002 | .005 | 1.17 | 99.97 |
| | 3 | 23.0' | 38.3' | 15.3' | 53.9 | 93.9 | 0.97 | 4.4 | 98.3 | 1.24 | 0.20 | 0.23 | .002 | .013 | 1.69 | 99.99 |
| | 4 | 38.3' | 49.1' | 10.8' | 53.3 | 91.4 | 1.53 | 7.0 | 98.4 | 1.14 | 0.10 | 0.22 | .002 | .012 | 1.47 | 99.87 |
| | 5 | 49.1' | 60.6' | 11.5' | 35.5 | 22.8 | 16.30 | 74.6 | 97.4 | 2.28 | 0.16 | 0.23 | .002 | .011 | 2.68 | 100.08 |
| | 6 | 60.6' | 72.6' | 12.0' | 51.2 | 83.9 | 3.02 | 13.8 | 97.7 | 1.79 | 0.08 | 0.26 | .005 | .013 | 2.15 | 99.85 |
| | 7 | 72.6' | 80.8' | 8.2' | 53.6 | 93.3 | 0.95 | 4.3 | 97.6 | 1.82 | 0.12 | 0.22 | .002 | .018 | 2.18 | 99.78 |

CHEMICAL ANALYSIS*
(Hendricks Formation Core Tests)

| Map No. | Sa. No. | From | To | Sample Thick. | % CaO | % Calcite $CaCO_3$ | % MgO | % Dolomite $CaMg(CO_3)_2$ | Total Carbonate | % $SiO_2$ | % $Fe_2O_3$ | % $Al_2O_3$ | % Zn | % S | Total Impur. | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scott Quarry Locality, Chippewa County | | | | | | | | | | | | | | | | |
| 6 | 1 | 0' | 6.8' | 6.8' | 31.4 | 6.8 | 19.80 | 90.6 | 97.4 | 1.97 | 0.22 | 0.20 | .002 | .006 | 2.40 | 99.80 |
| | 2 | 6.8' | 18.0' | 11.2' | 50.9 | 83.4 | 3.01 | 13.8 | 97.2 | 2.55 | 0.13 | 0.25 | .002 | .008 | 2.94 | 100.14 |
| | 3 | 18.0' | 25.0' | 7.0' | 52.3 | 89.1 | 1.74 | 8.0 | 97.1 | 2.53 | 0.13 | 0.27 | .003 | .008 | 2.94 | 100.04 |
| | 4 | 25.0' | 33.2' | 8.2' | 49.1 | 81.0 | 2.68 | 12.3 | 93.3 | 6.62 | 0.09 | 0.14 | .002 | .006 | 6.86 | 100.16 |
| | 5 | 33.2' | 40.7' | 7.5' | 51.4 | 83.9 | 3.18 | 14.5 | 98.4 | 1.30 | 0.11 | 0.19 | .002 | .014 | 1.62 | 100.02 |
| | 6 | 40.7' | 48.6' | 7.9' | 38.6 | 34.4 | 13.90 | 63.6 | 98.0 | 1.81 | 0.14 | 0.22 | .001 | .005 | 2.18 | 100.18 |
| | 7 | 48.6' | 58.0' | 9.4' | 48.8 | 73.7 | 5.35 | 24.5 | 98.2 | 1.62 | 0.09 | 0.13 | .002 | .012 | 1.85 | 100.05 |
| | 8 | 58.0' | 68.1' | 10.1' | 44.8 | 58.2 | 8.78 | 40.2 | 98.4 | 1.22 | 0.16 | 0.20 | .005 | .006 | 1.59 | 99.99 |
| | 9 | 68.1' | 83.8' | 15.7' | 51.6 | 86.6 | 2.21 | 10.1 | 96.7 | 2.97 | 0.10 | 0.13 | .002 | .026 | 3.23 | 99.93 |
| Pickford Locality, Mackinac County | | | | | | | | | | | | | | | | |
| 7 | 1 | 0' | 1.7' | 1.7' | 53.4 | 91.9 | 1.40 | 6.4 | 98.3 | 1.28 | 0.17 | 0.24 | .001 | .004 | 1.70 | 100.00 |
| | 2 | 1.7' | 10.0' | 8.3' | 36.4 | 26.8 | 15.4 | 70.4 | 97.2 | 2.06 | 0.25 | 0.29 | .002 | .003 | 2.61 | 99.81 |
| | 3 | 10.0' | 20.1' | 10.1' | 47.9 | 74.4 | 4.43 | 20.3 | 94.7 | 4.95 | 0.14 | 0.15 | .001 | .004 | 5.25 | 99.95 |
| | 4 | 20.1' | 30.9' | 10.8' | 45.3 | 65.0 | 6.41 | 29.3 | 94.3 | 5.39 | 0.17 | 0.22 | .002 | .004 | 5.79 | 100.09 |
| | 5 | 30.9' | 40.1' | 9.2' | 52.6 | 89.6 | 1.70 | 7.8 | 97.4 | 2.20 | 0.11 | 0.12 | .003 | .006 | 2.44 | 99.84 |
| | 6 | 40.1' | 56.6' | 16.5' | 40.7 | 43.5 | 11.7 | 53.5 | 97.0 | 2.44 | 0.20 | 0.37 | .002 | .005 | 3.02 | 100.02 |
| | 7 | 56.6' | 66.8' | 10.2' | 45.4 | 61.8 | 7.75 | 35.4 | 97.2 | 2.39 | 0.10 | 0.24 | .002 | .004 | 2.74 | 99.94 |
| | 8 | 66.8' | 77.7' | 10.9' | 37.6 | 32.7 | 13.9 | 63.6 | 96.3 | 3.03 | 0.24 | 0.50 | .002 | .004 | 3.78 | 100.08 |
| Northwoods Camp Locality, Chippewa County | | | | | | | | | | | | | | | | |
| 8 | 1 | 0' | 9.7' | 9.7' | 30.0 | 2.7 | 20.5 | 93.8 | 96.5 | 2.88 | 0.30 | 0.46 | .002 | .008 | 3.65 | 100.15 |
| | 2 | 9.7' | 21.1' | 11.4' | 29.8 | 1.6 | 20.8 | 95.1 | 96.7 | 3.00 | 0.13 | 0.10 | .002 | .005 | 3.24 | 99.94 |
| | 3 | 21.1' | 23.1' | 2.0' | 44.7 | 58.2 | 8.7 | 39.8 | 98.0 | 1.43 | 0.17 | 0.24 | .002 | .010 | 1.85 | 99.85 |
| | 4 | 23.1' | 38.3' | 15.2' | 31.8 | 8.7 | 19.3 | 88.3 | 97.0 | 2.54 | 0.20 | 0.27 | .002 | .012 | 3.02 | 100.02 |
| | 5 | 38.3' | 46.3' | 8.0' | 47.2 | 72.5 | 4.74 | 21.7 | 94.2 | 2.56 | 0.19 | 0.12 | .004 | .060 | 6.02 | 100.22 |
| | 6 | 46.3' | 52.6' | 6.3' | 30.6 | 7.7 | 18.9 | 86.4 | 94.1 | 5.33 | 0.21 | 0.40 | .002 | .110 | 5.06 | 99.16 |
| | 7 | 52.6' | 60.3' | 7.7' | 52.8 | 88.5 | 2.29 | 10.5 | 99.0 | 0.83 | 0.11 | 0.09 | .002 | .056 | 1.09 | 100.09 |
| | 8 | 60.3' | 70.3' | 10.0' | 37.5 | 30.5 | 14.7 | 67.2 | 97.7 | 1.76 | 0.18 | 0.36 | .002 | .053 | 2.36 | 100.06 |
| Stalwart Locality, Chippewa County | | | | | | | | | | | | | | | | |
| 9 | 1 | 0' | 8.6' | 8.6' | 45.7 | 64.1 | 7.03 | 32.2 | 96.3 | 2.39 | 0.41 | 0.16 | .002 | .025 | 2.99 | 99.29 |
| | 2 | 8.6' | 18.5' | 9.9' | 31.4 | 8.4 | 19.2 | 87.8 | 96.2 | 3.02 | 0.37 | 0.34 | .008 | .014 | 3.75 | 99.95 |
| | 3 | 18.5' | 28.5' | 10.0' | 35.6 | 25.0 | 15.5 | 70.9 | 95.9 | 3.23 | 0.24 | 0.20 | .006 | .020 | 3.70 | 99.60 |
| | 4 | 28.5' | 39.8' | 11.3' | 36.0 | 27.3 | 14.9 | 68.2 | 95.5 | 3.90 | 0.21 | 0.24 | .002 | .032 | 4.38 | 99.88 |
| | 5 | 39.8' | 52.2' | 12.4' | 44.4 | 60.9 | 7.4 | 33.8 | 94.7 | 4.63 | 0.18 | 0.13 | .002 | .062 | 5.00 | 99.70 |
| | 6 | 52.2' | 57.9' | 5.7' | 30.9 | 9.5 | 18.4 | 84.2 | 93.7 | 5.72 | 0.41 | 0.55 | .002 | .069 | 6.75 | 100.45 |
| | 7 | 57.9' | 60.4' | 2.5' | 52.3 | 90.0 | 1.33 | 6.1 | 96.1 | 3.55 | 0.17 | 0.23 | .002 | .104 | 4.06 | 100.16 |
| | 8 | 60.4' | 67.9' | 7.5' | 30.5 | 8.7 | 18.4 | 84.2 | 92.9 | 6.01 | 0.43 | 0.62 | .003 | .045 | 7.11 | 100.02 |

* Analysis by Institute of Mineral Research, Michigan Technological University, Houghton, Michigan.

# A. A. CREGO
## Timber and Farm Lands

Trout Lake, Mich.

Sept. 18th, 1923,

Mr. Alex Grosbeck,

Lansing, Mich.

Dear Sir-

I noticed in a recent issue of The Detroit News, that you are intending to acquire some limestone quarries for the state. I have 240 acres situated in section 18 town 44 north of range 6 west, this deposit is the same ledge of stone that is under the Fiborn Quarry.

It is very accessable for quarrying and manufacturing. The Frank Chesbrough lumber mills is on an adjoining forty with side tracks operating to the D.S.S.&.A. railroad.

The rock on this land is on a ledge and can be mined at a considerable depth without pumping any water what so ever, providing you want additional acreage there can be more acquired at this place. If you are looking for good rock cheap don't let this pass without investigation.

Yours very truly,

s/ A. A. Crego

September 21, 1923

Hon. A. J. Groesbeck, Governor,
State of Michigan,
Lansing    Michigan.

Dear Sir:

The letter from Mr. A. A. Crego, of Trout Lake, referred by you to Mr. R. A. Smith, is being held upon his desk until his return from the field.

Yours truly,

WIR:B    Geologist

---

October 1, 1923

Mr. A. A. Crego,
Trout Lake Michigan.

Dear Sir:

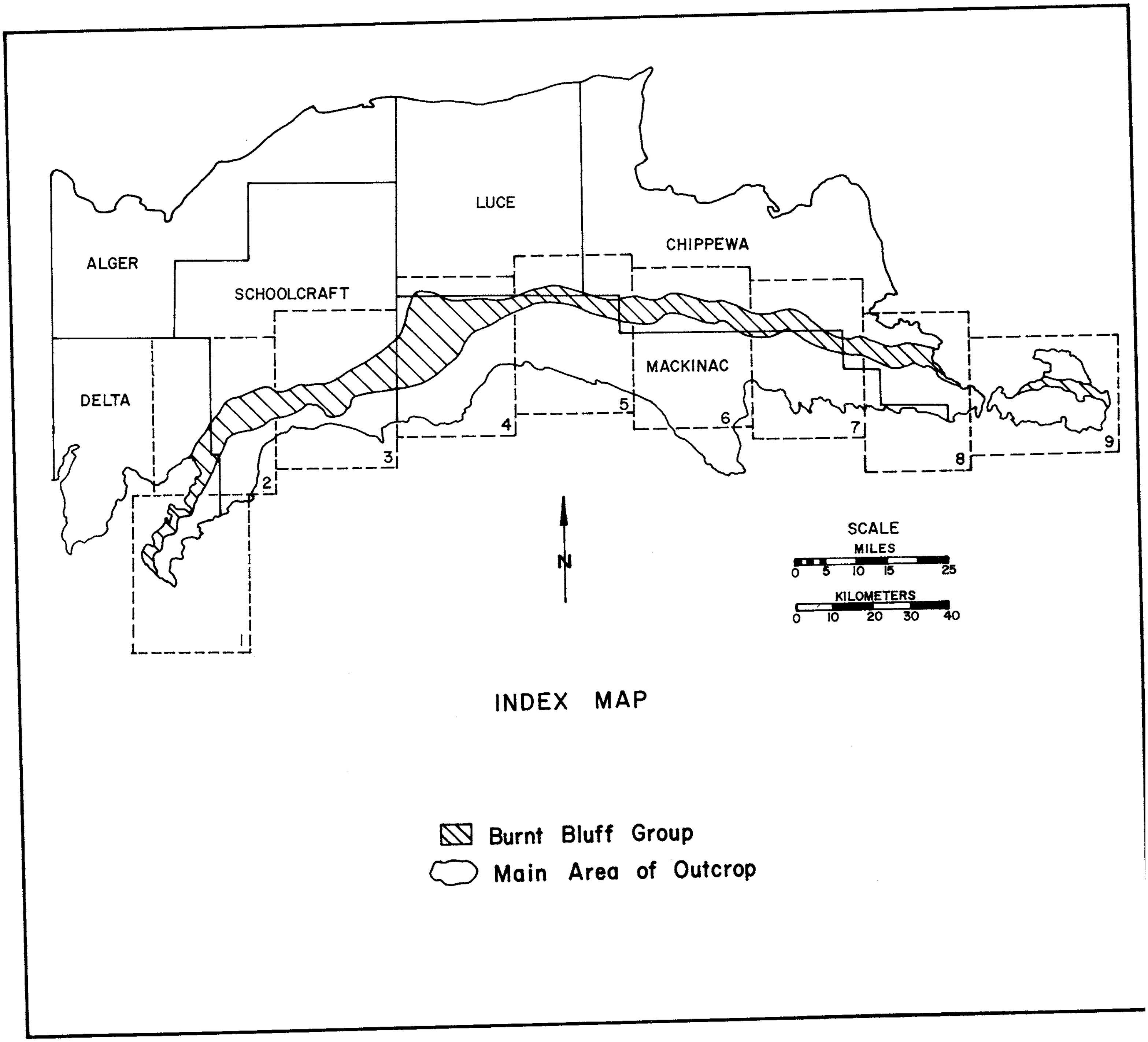
Your letter of September 18 to Governor A. J. Groesbeck has been referred to me for reply. It was received during my absence in the field. I returned this morning, and note with much interest your description of the limestone lands in the vicinity of Trout Lake, particularly in Section 18, T. 44 N.,R.6 W.

I examined these lands in 1913 when making a limestone survey of the State. There is no question but what these lands contain a large amount of stone of commercial grade. Quite probably if the State contemplates placing a cement plant in the northern part of the State a more detailed and careful investigation will be made, even to the extent of drilling. At this present time, however, the plans appear to be restricted to the Southern Peninsula. Your information is being placed on file, and undoubtedly will be considered again when cement projects for the Upper Peninsula are being taken under advisement.

Very truly yours

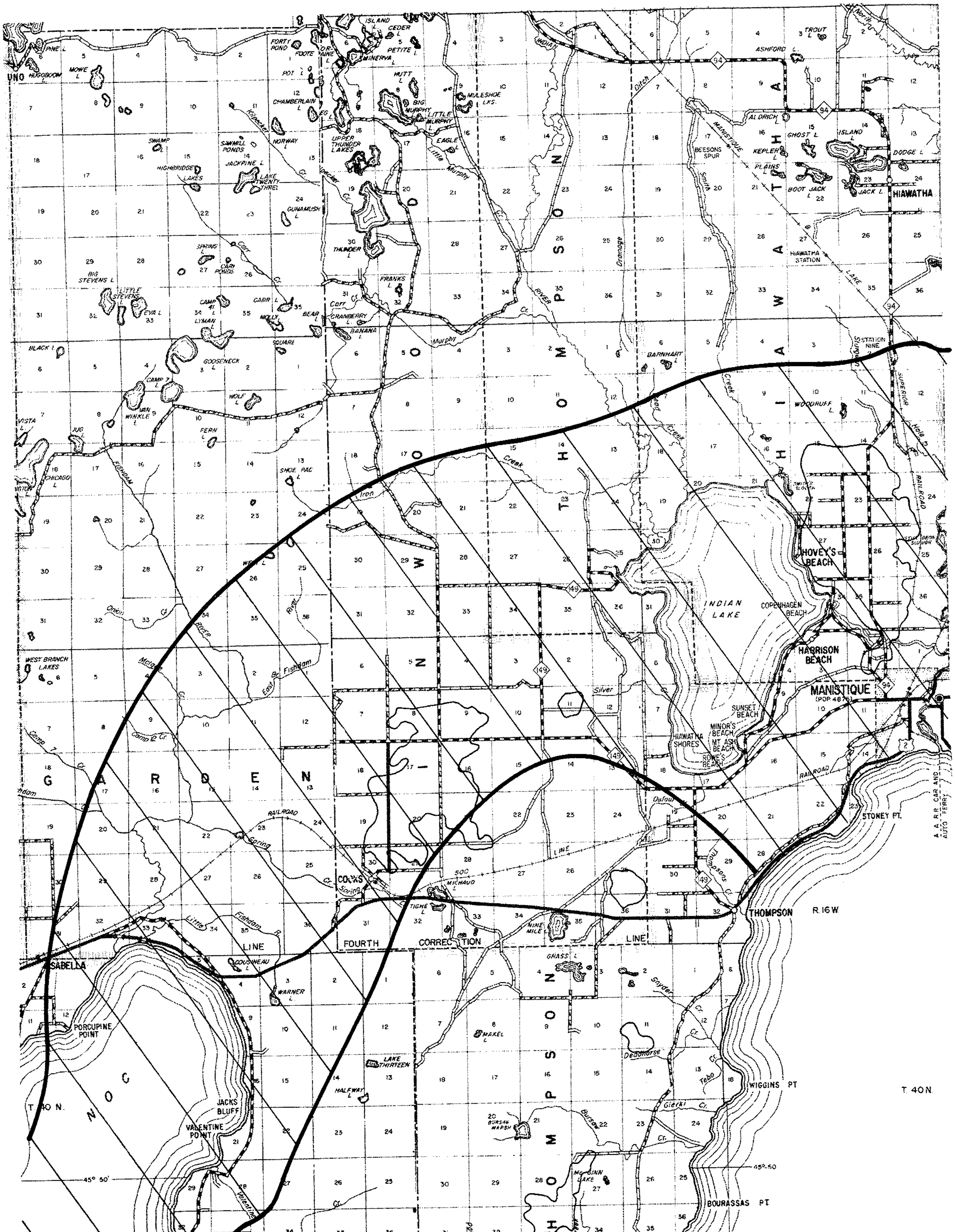
ras/b

Appendix IV : GEOLOGIC MAPS

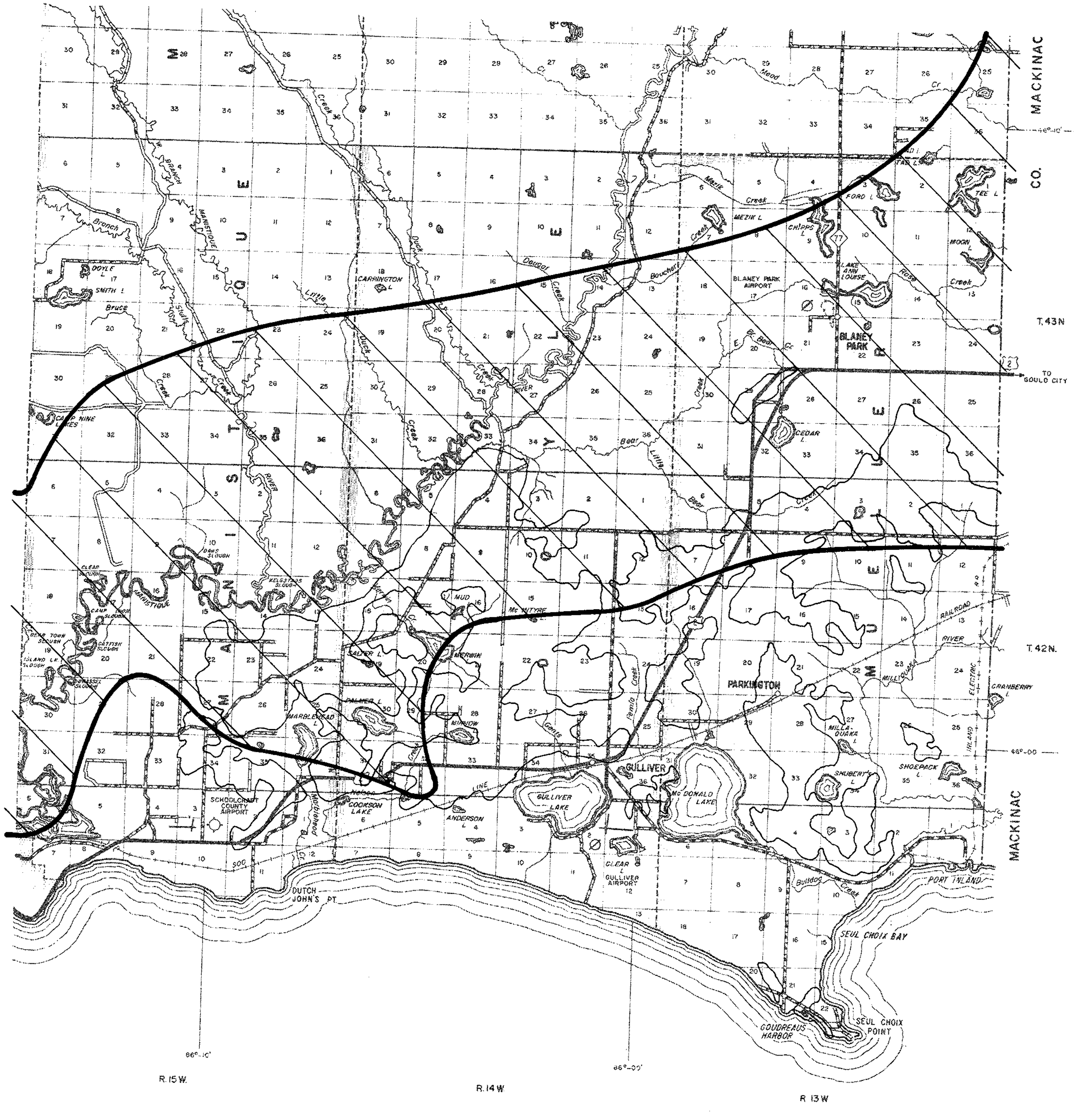


ANSELS POINT
VANS HARBOR
GARDEN BLUFF
GOULEYS HARBOR
PUFFY BAY
GARDEN BAY
GARDEN
(POP 336)
LACOMB BAY
T. 39 N
SOUTH RIVER BAY
SNAKE ISLAND
MIDDLE BLUFF
FAYETTE
SAND BAY
BURNT BLUFF
MUD L
T 38 N
F A I R B A N K S
SUCKER LAKE
45° 40
LITTLE L
SAC BAY
FAIRPORT
ROCKY ISLAND
LITTLE SUMMER ISLAND
R 19 W
POINT DETOUR
T 37 N
SUMMER ISLAND
POVERTY ISLAND
86° 40
BUCK FEVER L
HALF MOON L
PORTAGE BAY
FISHERY L
CHARBONEAU L
86° 30'
R 18 W
PT. OKEEFE
HIRAM PT.
R.17 W
PARENT BAY
COLE PT.
LITTLE HARBOR
MILLERS PT.
PILLOWS PT.
PT AUX BARQUES
86° 20

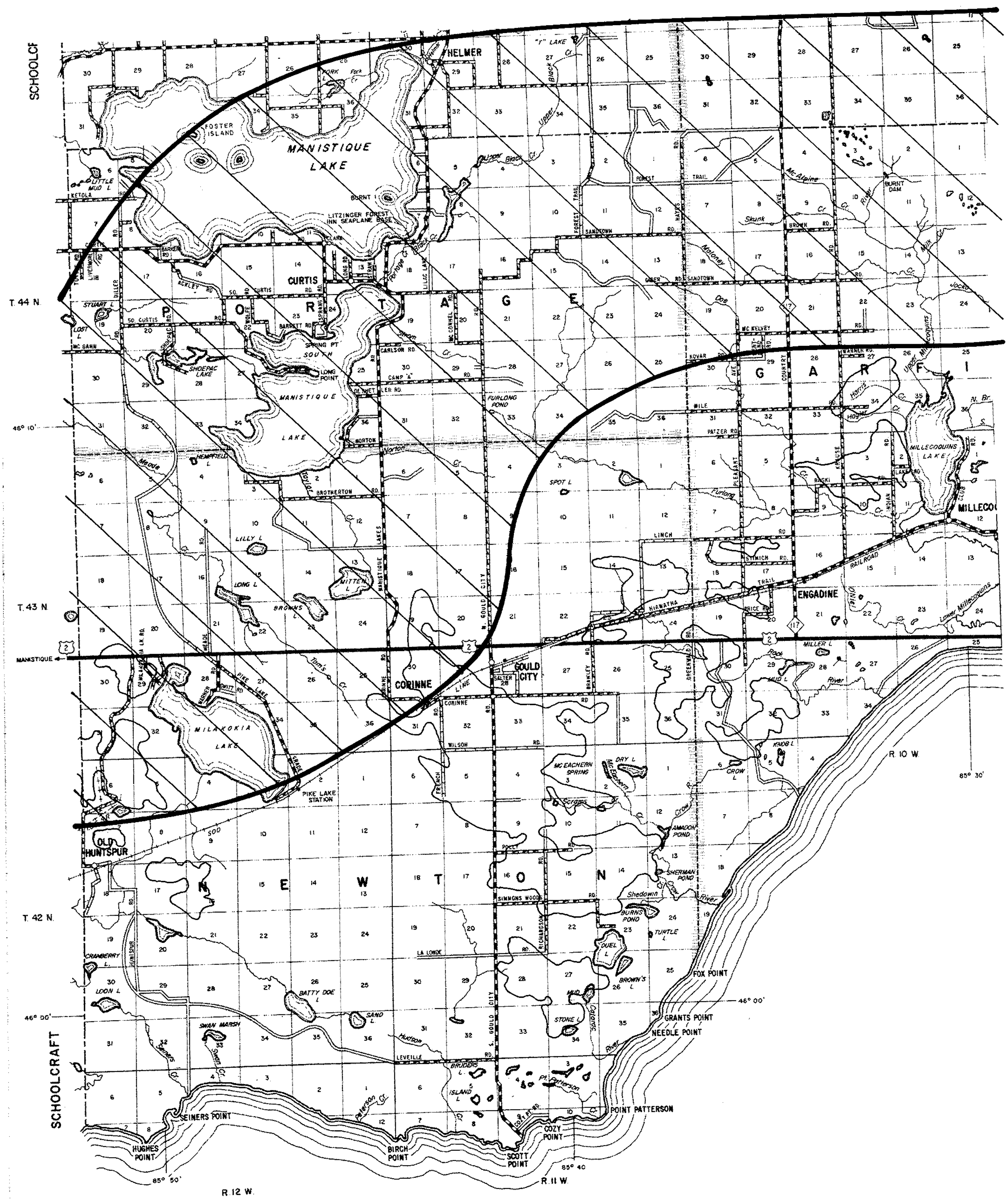

MAP I


UNO
MANISTIQUE
(POP 4875)
HIAWATHA
THOMPSON
ISABELLA
COOKS
INDIAN LAKE
HOVEY'S BEACH
COPENHAGEN BEACH
HARRISON BEACH
SUNSET BEACH
MINOR'S BEACH
MT ASH BEACH
ROWE'S BEACH
HIAWATHA SHORES
STONEY PT.
WIGGINS PT
BOURASSAS PT
PORCUPINE POINT
JACKS BLUFF
VALENTINE POINT
HIAWATHA STATION
STATION NINE
BEESONS SPUR
ASHFORD
FOURTH CORRECTION LINE
SOO LINE
RAILROAD
GARDEN
THOMPSON
HIAWATHA
DOYLE
NOC
R.16W.
T.40N.
T 40 N.
45° 50'
A.A.R.R. CAR AND AUTO FERRY
MICHAUD
TIGHE
NINE MILE L
GRASS L
COUSINEAU L
WARNER L
LAKE THIRTEEN
HALFWAY L
BURSAW MARSH
McGINN LAKE
MAKEL L
UPPER THUNDER LAKES
BIG MURPHY
LITTLE MURPHY
THUNDER L
FRANKS L
CRANBERRY L
BANANA L
ISLAND L
JACK L
BOOT JACK L
PLAINS L
KEPLER L
GHOST L
ALDRICH L
DODGE L
TROUT L
MULESHOE LKS.
EAGLE L
HUTT L
MINERVA
CHAMBERLAIN L
NORWAY L
SAWMILL PONDS
JACKPINE L
LAKE TWENTY THREE
GUNAMUSH L
HIGHBRIDGE LAKES
SWAMP L
MOWE L
SPRING L
CARR PONDS
CARR L
BIG STEVENS L
LITTLE STEVENS L
EVA L
CAMP 41 L
LYMAN L
MOLLY L
BEAR L
SQUARE L
BLACK L
GOOSENECK L
CAMP 7 L
WOLF L
VAN WINKLE L
VISTA L
JUG L
FERN L
CHICAGO L
SHOE PAC L
WEST BRANCH LAKES
BARNHART L
WOODRUFF L
Fishdam R
Iron
Creek
Silver
Snyder Cr.
Tebo Cr.
Gierki Cr.
Bursaw
Deadhorse
Poodle
Smith
Marsh
Ditch
Little Murphy
Carr Cr.
Spring
Little Fishdam
Valentine
Camp 7 Cr.
Camp 12 Cr.
East Br. Fishdam
Thompsons Cr.
Superior
KATES

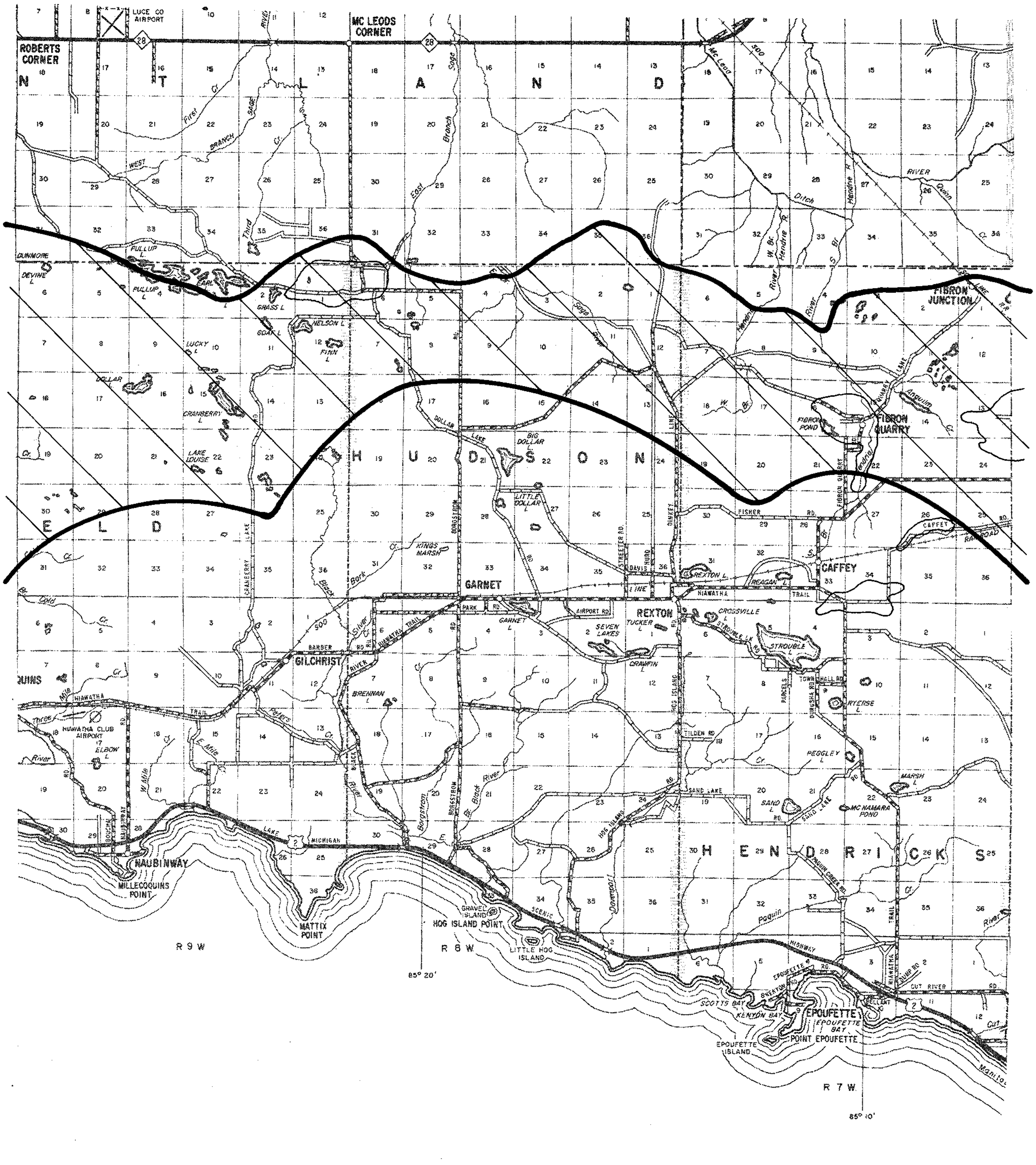
MAP 2


MACKINAC CO.
MACKINAC
T.43N
T.42N.
R.15W.
R.14W
R.13W
BLANEY PARK
BLANEY PARK AIRPORT
TO GOULD CITY
CEDAR L
PARKINGTON
GULLIVER
GULLIVER LAKE
McDONALD LAKE
SCHOOLCRAFT COUNTY AIRPORT
COOKSON LAKE
ANDERSON L
CLEAR L
GULLIVER AIRPORT
DUTCH JOHN'S PT.
PORT INLAND
SEUL CHOIX BAY
SEUL CHOIX POINT
GOUDREAUS HARBOR
MILLECOQUINS L
SHOEPACK L
CRANBERRY L
CARRINGTON L
MARBLEHEAD L
PALMER L
MUD L
MERWIN
MEZIK L
CHIPPS L
FORD L
TEE L
MOON L
LAKE ANN LOUISE
DOYLE L
SMITH L
CAMP NINE LAKES
Mead Cr
Mezik Creek
Bouchard Creek
Dougal Creek
Duck Creek
Bear Cr
Rose Creek
Bulldog Creek
Millecoquins River
Manistique River
Bruce
Branch
86°-10'
86°-00'
46°-10'
46°-00'

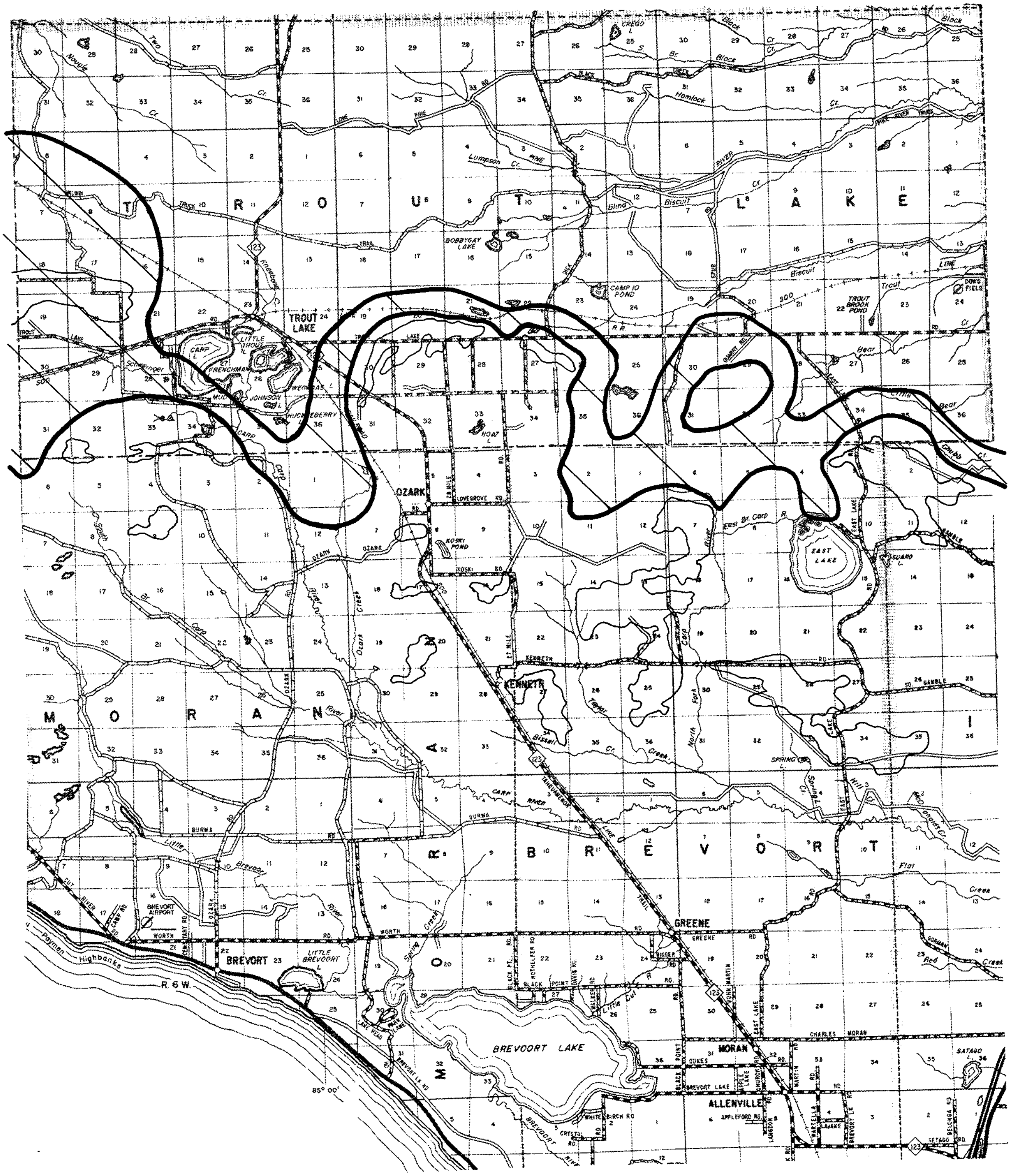
MAP 3


SCHOOLCRAFT
HELMER
MANISTIQUE LAKE
FOSTER ISLAND
BURNT I.
LITZINGER FOREST INN SEAPLANE BASE
CURTIS
SPRING PT.
SOUTH MANISTIQUE LAKE
LONG POINT
SHEDEPAC LAKE
STUART L.
LOST L.
LITTLE MUD L.
P O R T A G E
G A R F I
FURLONG POND
SPOT L.
LILLY L.
LONG L.
MITTEN L.
BROWNS L.
HEMPFIELD L.
MILLECOQUINS LAKE
MILLECO
ENGADINE
Lower Millecoquins
T. 44 N.
T. 43 N.
T. 42 N.
46° 10'
46° 00'
MANISTIQUE
CORINNE
GOULD CITY
MILAKOKIA LAKE
PIKE LAKE STATION
OLD HUNTSPUR
MILLER L.
MUD L.
KNOB L.
CROW L.
DRY L.
MC EACHERN SPRING
AMADON POND
SHERMAN POND
BURNS POND
TURTLE L.
DUEL L.
BROWN'S L.
STONE L.
N E W T O N
CRANBERRY L.
LOON L.
BATTY DOE L.
SAND L.
SWAN MARSH
FOX POINT
GRANTS POINT
NEEDLE POINT
POINT PATTERSON
COZY POINT
SCOTT POINT
BIRCH POINT
SEINERS POINT
HUGHES POINT
R. 10 W.
R. 11 W.
R. 12 W.
85° 30'
85° 40'
85° 50'

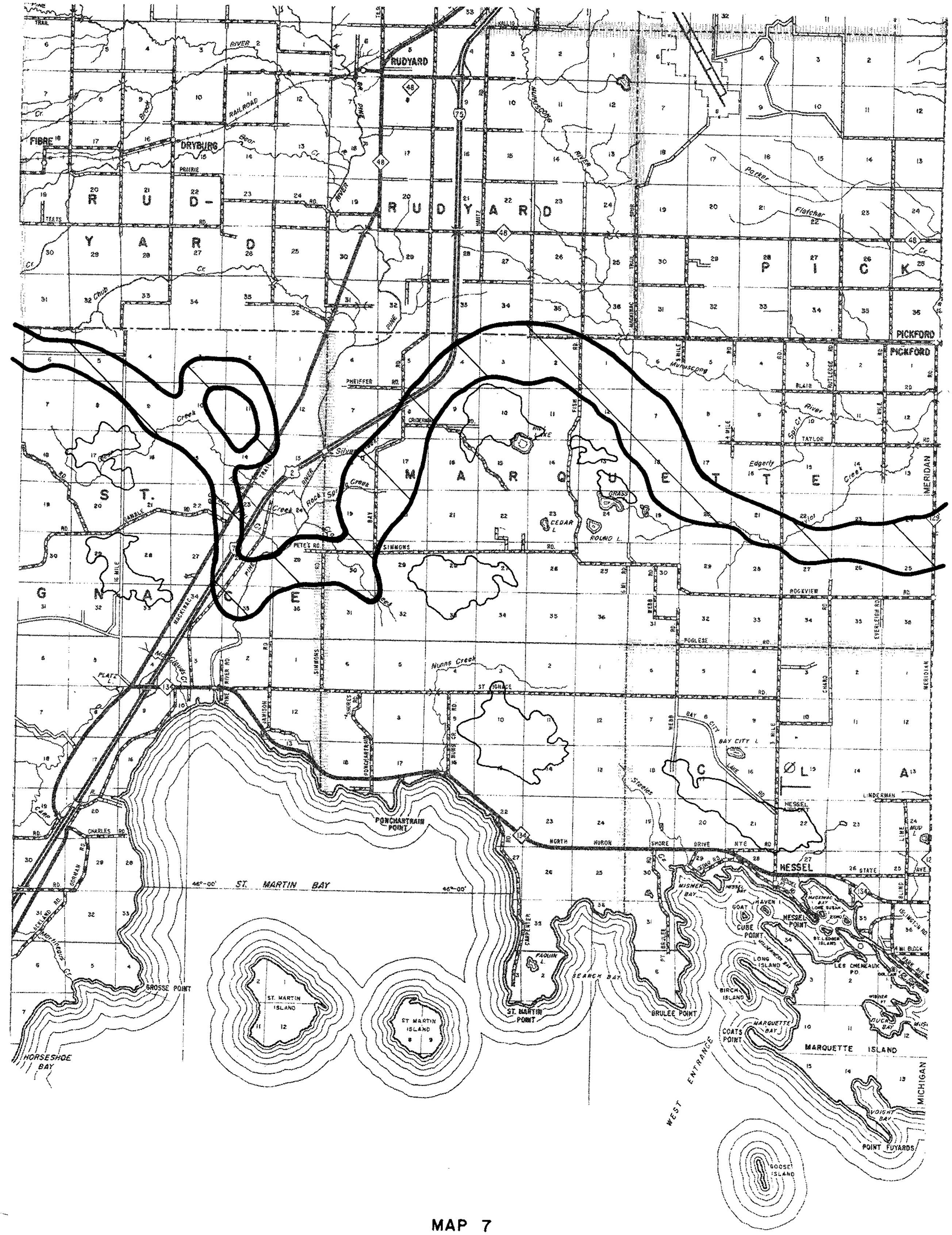
MAP 4


ROBERTS CORNER
MC LEODS CORNER
LUCE CO AIRPORT
FIBRON JUNCTION
FIBRON QUARRY
HUDSON
GARNET
REXTON
CAFFEY
CROSSVILLE
GILCHRIST
NAUBINWAY
MILLECOQUINS POINT
MATTIX POINT
HOG ISLAND POINT
LITTLE HOG ISLAND
GRAVEL ISLAND
EPOUFETTE
EPOUFETTE BAY
POINT EPOUFETTE
EPOUFETTE ISLAND
SCOTTS BAY
KENYON BAY
HENDRICKS
HIAWATHA CLUB AIRPORT
R 9 W
R 8 W
R 7 W
85° 20'
85° 10'

MAP 5


TROUT LAKE
MORAN
BREVORT
OZARK
KENNETH
GREENE
MORAN
ALLENVILLE
BREVORT
BREVOORT LAKE
EAST LAKE

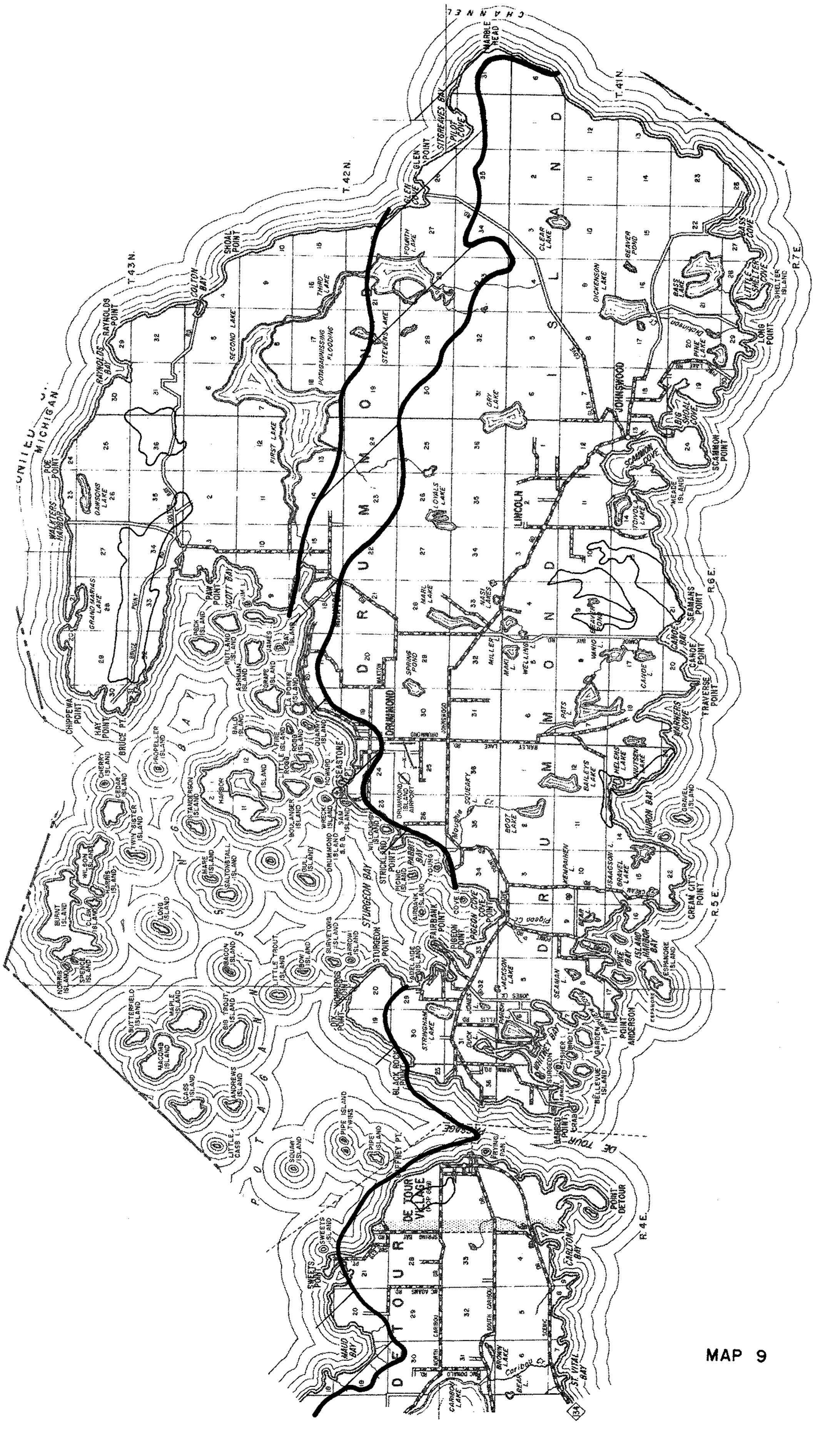
MAP 6


RUDYARD
FIBRE
DRYBURG
R U D Y A R D
P I C K
PICKFORD
M A R Q U E T T E
S T. I G N A C E
C L A
HESSEL
ST. MARTIN BAY
PONCHARTRAIN POINT
ST. MARTIN ISLAND
ST. MARTIN POINT
GROSSE POINT
HORSESHOE BAY
SEARCH BAY
BRULEE POINT
MARQUETTE ISLAND
WEST ENTRANCE
POINT FUYARDS
GOOSE ISLAND
LES CHENEAUX
MERIDIAN
MICHIGAN

MAP 7

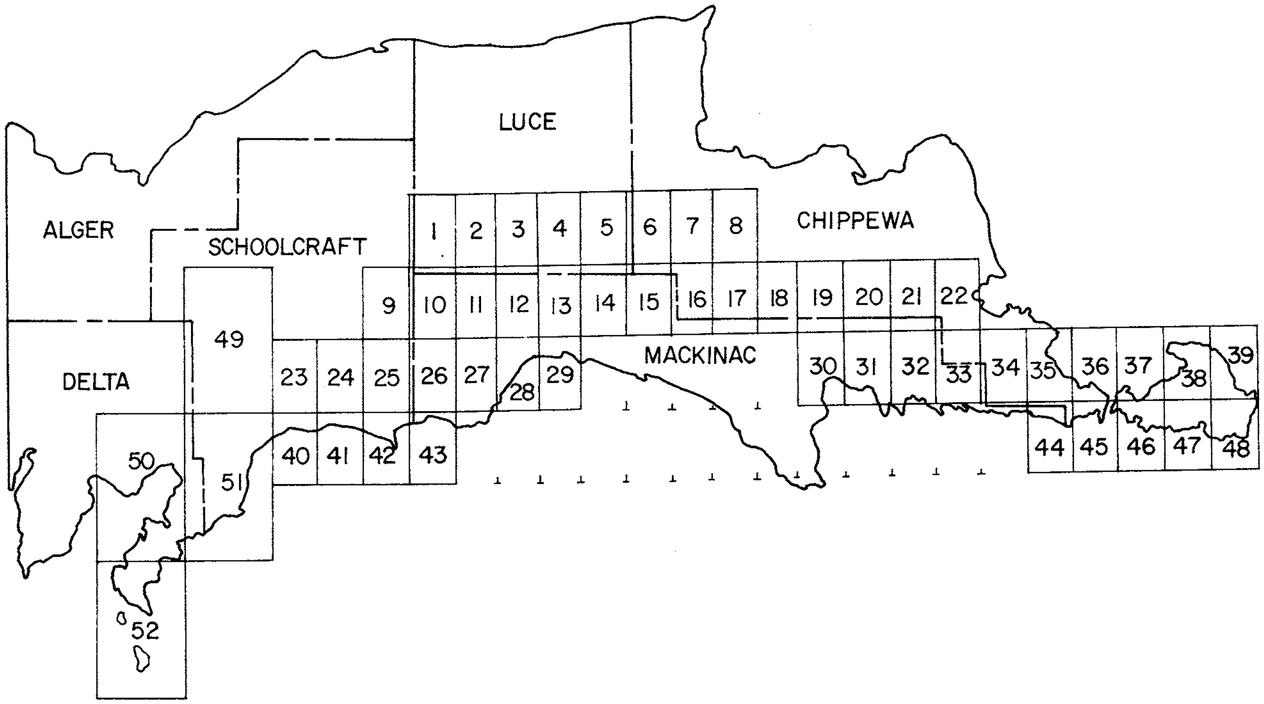

MUNUSCONG LAKE
MUNUSCONG BAY
BARBEAU POINT
STEAMBOAT ISLAND
ROACH POINT
BIRCH POINT
ROCKY POINT
PILOT ISLAND
PINE ISLAND
MAPLE POINT
TWIN ISLAND
STIRLINGVILLE
F O R D
RIVERSIDE
GOGOMAIN
POINT AUX FRENES
ROUND ISLAND
BASS REEF ISLAND
LOVE ISLAND
RABER BAY
RABER
LIME ISLAND
LITTLE LIME I.
RABER POINT
NORTHWOODS AIRPORT
ROCKVIEW
STALWART
COVACH L.
R A B E R
BENDER LAKE
GOETZVILLE
TRAYNOR
SAM TAYLOR LAKE
SWEDE
CARLTON LAKE
McADAMS L.
FOREMAN LAKE
ZIEGLER LAKE
FULMER L.
D E T O U R
CARIBOU LAKE
BIG TROUT
LITTLE TROUT LAKE
CEDARVILLE
LEACH L
LOON PT.
HILL ISLAND
LA SALLE
BAY POINT
URIE PT.
GOVERNMENT BAY
STRONGS ISLAND
CORYELL ISLAND
CROW ISLAND
WHITEFISH POINT
ROVER ISLAND
SCOTTY BAY
BEAVER TAIL POINT
DUDLEY ISLAND
ALBANY HARBOR
HURON POINT
GRAVELLY ISLAND
BOOT ISLAND
GOVERNMENT ISLAND
SAND BAY
MIDDLE ENTRANCE
EAST ENTRANCE
SADDLEBAG ISLAND
ST. VITAL POINT
CRANBERRY LAKE
BEAR L
R.3E.
T.41 N.
LES CHENEAUX ISLANDS
84°20'
84°00'

MAP 8


DRUMMOND
JOHNSWOOD
LINCOLN
SEASTONE
DE TOUR VILLAGE
POINT DETOUR
MARBLE HEAD
STURGEON BAY
HURON BAY
SCAMMON COVE
MICHIGAN
T. 43 N.
T. 42 N.
T. 41 N.
R. 4 E.
R. 5 E.
R. 6 E.
R. 7 E.

MAP 9

## Appendix V: TOPOGRAPHIC MAP INDEX




United States Geological Survey topographic map coverage of the study area

### 7½-minute quadrangles; scale 1:24,000

1. Hardwood Island
2. McMillan
3. Newberry
4. Roberts Corner
5. Soo Junction
6. Hubert
7. Eckerman
8. Strongs
9. Germfask
10. Curtis W
11. Curtis E
12. Millecoquin
13. Gilchrist
14. Garnet
15. Rexton
16. Trout Lake
17. Ozark
18. Ozark NE
19. Fibre
20. Rudyard
21. Pickford NW
22. Pickford
23. Smith Lake
24. Merwin Lake
25. Blaney Park
26. Milakokia Lake
27. Gould City
28. Engadine
29. Naubinway
30. Charles
31. Ponchartrain Shores
32. Hessel
33. Pickford SE
34. Stalwart
35. Goetzville
36. Lime Island
37. Burnt Island
38. Drummond
39. Drummond SE
40. Manistique E
41. Gulliver
42. Seul Choix Pt.
43. Hughes Pt.
44. Albany Island
45. Detour Village
46. Whitney Bay
47. Meade Island
48. Marble Head

### 15-minute quadrangles; scale 1:62,500

49. Steuben
50. Garden
51. Cooks
52. Fairport

## GLOSSARY

| | |
|---|---|
| DOLOMITE | The mineral, $CaMg(CO_3)_2$. |
| CALCITE | The mineral, $CaCO_3$. |
| DOLOSTONE | A rock, composed largely of the mineral dolomite. |
| LIMESTONE | A rock, in broadest sense including dolostones, in more restricted sense, composed essentially of the mineral calcite. |
| LITHOGRAPHIC | A finely textured limestone. |
| NORMATIVE ANALYSIS | Calculating mineral content from chemical analysis of one or more constituents, elements or radicals. |
| HIGH-PURITY LIMESTONE | A limestone containing 95% or more calcite. |
| DOLOMITIC LIMESTONE | A limestone containing between 10 and 50% dolomite. |
| LIMY DOLOSTONE | A dolostone containing between 10 and 50% calcite. |
| STROMATOLITIC | Wavy bedding in carbonate rocks probably due to stromatolitic algae. |
| DOLOMITIZATION | The process by which other calcium carbonate minerals are altered to dolomite by magnesium metasomatism. |
| DIAGENESIS | Any change occurring within sediments subsequent to deposition and before complete lithification that alters the mineral content and physical properties of the sediments. |
| METASOMATISM | The chemical change of minerals due to interaction with fluids. |

REPORT OF INVESTIGATION 18 1978
DRILL CORE INVESTIGATION OF THE FIBORN LIMESTONE MEMBER IN SCHOOLCRAFT, MACKINAC, AND CHIPPEWA COUNTIES, MICHIGAN

DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY DIVISION
BOX 30028
LANSING, MICHIGAN 48909